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PHYSICO-CHEMICAL PROPERTIES OF TRITICALE STARCH USED FOR COMMERCIAL STARCH PRODUCTION

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Physicochemical properties of starch (pasting characteristic, water binding capacity, water solubility, reducing value, grains, protein and fat content of 8 Polish triticale varieties were examined. Triticale starch exhibits a higher viscosity after cooling to 50°C than starches obtained for wheat and rye. All starches were distinguished by significant difference of fat contents.

INTRODUCTION

Our earlier investigations on starch, which originated from 53 Polish triticale strains of the years 1978 and 1979, confirmed the suggestions of other authors that with respect to some trials, e.g. viscosity, triticale starch may appear similar or even compares favourably with parental species viz. wheat and rye [1, 8, 9]. Also all triticale strains investigated by us were characterized by high yield of starch per hectare and their starches by favourable functional properties, i.e. high past viscosity and their stability during heating as well as desirable graininess [2, 3, 4, 5, 6, 7, 11]. Those properties were also confirmed in further investigations on starch from Polish triticale strains and varieties, cultivated in years 1982-1987 [12]. They allowed us to suppose that triticale could be a suitable raw material for commercial starch production and triticale starch can be utilized in a similar way as wheat starch.

In our investigation carried out so far [12] the grains of some triticale varieties displayed an intensive activity of amylolytic enzymes and therefore starch isolated under laboratory conditions was characterized by an increased reducing value. In this connection, such increased enzymes activity is to be considered an undesirable technological property of triticale grains as a raw material for starch production.

In the investigations presented in this study attempts were made to reduce the increased triticale amylolytic activity (which can change the properties of

isolated starch) by using such a method of starch isolation in which inactivation of amylolytic enzymes would occur. This condition is satisfied a diluted sodium hydroxide solution for washing starch granules away from flour.

MATERIAL AND METHODS

Material for investigation was the starch isolated from flour obtained from grinding the grain of 8 Polish triticale varieties: "Bolero", "Dagro", "Largo", "Lasko", "Malno", "Presto", "Ugo" as well as from a wheat variety "Emika" and a rye variety "Dańkowskie Żłote" cultivated in 1988/9 in variety experiments conducted in the Experimental Station of Evaluating varieties at Śrem-Wójtostwo. These kinds of starch were isolated by laboratory method using 0.5% sodium hydroxide water solution [10].

Following parameters were determined:

- crude protein by Kjeldahl [13],
- crude fat in Soxhlet apparatus using tetrachloride carbon [13],
- reducing value by Richter method [13],
- graininess on Sartorius sedimentation scales using anhydrous ethyl alcohol as a liquid phase,
- water binding capacity and solubility of starch in water by modified Leach method [13],
- pasting characteristics of 7.2% water starch suspension by means of rotation viscosimeter Rheotest 2 [2] assuming an expected increase and decrease in temperature of 1.5°C/min.

RESULTS AND DISCUSSION

Starch of Triticale variety under study contained small amounts of protein, like wheat and rye starch, however, a considerably lower amount of crude fat in comparison with wheat starch [Table 1]. Rye starch displayed a minimum content of this component. The reducing value of triticale starch was at the same level as in parental species [Table 1]. Being therefore much lower compared to the starch isolated by traditional method, using 0.1% water solution of NaCl [11, 13]. It can be explained by inactivation of amylolytic enzymes which takes place when NaOH is used for starch isolation [10]. Mean graininess of triticale starch did not differ from that of wheat starch, and in case of granules $< 13.8 \mu\text{m}$ and $\geq 13.8 \mu\text{m}$ also from the graininess of rye starch [Tab. 1]. All kinds of starch displayed a high amount of grain with a diameter of $\geq 13.8 \mu\text{m}$ which, in our opinion, is favourable for the point of view of starch suitability for commercial use. Mean values for both water binding capacity and water solubility of triticale starches [Tab. 2] were higher in all measured temperatures in comparison with wheat starch [except for water binding capacity at 80°C]. However, in temperature 60-80°C they were equal [water binding capacity] or

Table 1. Content of noncarbohydrate components and graininess of triticale starch

Studies trait	Triticale starches		Wheat starch	Rye starch
	range of variability	mean		
crude protein (% d.s.) — N x 5.7	0.15-0.26	0.22	0.26	0.18
crude fat (% d.s.)	0.12-0.24	0.20	0.67	0.08
reducing value (glucose %)	0.57-0.77	0.70	0.77	0.67
percentage of starch granules of following size:				
≥ 31.0 μm	19-36	29	25	49
21.9-30.9 μm	35-44	38	43	28
13.8-21.8 μm	16-27	21	21	10
< 13.8 μm	10-15	12	11	13
≥ 13.8 μm	85-90	88	89	87

Table 2. Swelling characteristic of triticale starch

Studied trait	Triticale starch		Wheat starch	Rye starch
	range of variability	mean		
Water binding capacity (g/l g d.s.) (temp.)				
60°C	7.0- 7.8	7.3	6.9	7.5
70°C	8.0- 8.8	8.4	7.6	8.6
80°C	9.6-11.3	10.4	10.7	10.8
90°C	18.2-29.0	21.5	14.4	17.0
Solubility in water (%) (temp.)				
60°C	1.8- 4.1	2.9	2.3	5.3
70°C	4.0- 6.9	5.1	4.3	8.5
80°C	6.2- 9.4	8.2	6.4	13.4
90°C	29.2-31.6	30.3	21.2	28.5

lower [solubility in water] compared to rye starch. At 90°C triticale starch exhibited a higher water binding capacity and solubility than rye starch. Pasting characteristic indices [Tab. 3] show that triticale and rye starches begin the pasting process earlier than wheat starch. Triticale starches of almost all varieties displayed a higher maximum viscosity than the parental species starch. Triticale paste viscosity at 96°C was the majority of triticale varieties lower compared to the viscosity of wheat and rye starches, however, the pastes from all triticale starches were characterized by considerable stability of viscosity during heating at 96°C for 20 min, like the rye starch paste. After cooling to 50°C the viscosity of triticale starch paste displayed a marked increase compared to wheat and rye starches.

Table 3. Pasting characteristic of triticale starch

Studied trait	Triticale starches		Wheat starch	Rye starch
	range of variability	mean		
Pasting temperature (°C)	69.0-76.5	73.5	82.5	70.0
Maximum viscosity (mPa.s)	254-401	345	287	257
Temperature at maximum viscosity (°C)	88.0-96.0	93.0	96.0	96.0
Viscosity after 20 min. at 96°C (mPa.s)	51-290	151	191	182
Viscosity after cooling to 50°C (mPa.s)	553-1333	943	260	200

The results of this study have confirmed those ones obtained earlier that the starches of nearly all triticale varieties are characterized by a desirable graininess [similar to that of wheat starch] and a higher paste viscosity than of wheat and rye starches. The method of starch isolation applied in this study, using 0.5% solution of NaOH resulted in an inactivation of amylolytic enzymes, which was reflected in a considerably decreased reducing value of triticale starch with respect to the studies conducted earlier [12] and maintaining it at the level of parental species. The physicochemical properties studied by us of 8 Polish triticale varieties are indicative of their suitability to commercial starch production.

CONCLUSIONS

1. Due to an increased enzymatic activity of mature triticale grains it is recommended to use for starch isolation 0.5% NaOH solution. The triticale starch obtained in this way does not display increased reducing values.

2. Starch from 8 triticale varieties does not differ considerably from the control standard wheat starch "Emika" with respect to protein and graininess, however, they exhibit lower fat content and a slightly higher water binding capacity as well as higher solubility in water and higher viscosity indices [especially after cooling] and more considerable stability during cooking.

3. On account of physicochemical properties of starch are concern [similar to wheat starch] the studied triticale varieties, can successfully replace wheat for commercial starch production. The varieties "Dagro" and "Ugo" are characterized by particularly favourable technological indices.

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FIZYKOCHEMICZNE WŁAŚCIWOŚCI SKROBI Z POLSKICH ODMIAN PSZENŻYTA

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Streszczenie

Przebadano fizykochemiczne właściwości skrobi wyodrębnionej metodą laboratoryjną (przy użyciu wodorotlenku sodu w celu inaktywacji enzymów) z 8 polskich odmian pszenżyta (Dagro, Grado, Bolero, Lasko, Malno, Ugo, Largo, Presto) w porównaniu ze skrobią z pszenicy „Emika” i żyta „Dańkowskie Złote”. Wyodrębnione skrobie przebadano odnośnie do: charakterystyki kleikowania 7.2% wodnych suspensji w wiskozymetrze rotacyjnym Rheotest 2, wiązania wody i rozpuszczalności (w zakresie 60-90°C), redukcyności, ziarnistości oraz zawartości białka i tłuszczu.

Uzyskane wyniki pozwalają stwierdzić, że przebadane skrobie pszenżytnie charakteryzują się wyższą lepkością po ochłodzeniu kleików do 50°C w porównaniu ze skrobią pszenną i żytnią. Natomiast pozostałe właściwości skrobi pszenżytniej nie odbiegają od właściwości skrobi pszennej i żytniej użytych jako standardy z wyjątkiem zawartości tłuszczu, która w badanych zbożach jest bardziej zróżnicowana.