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STUDIES OF CHEMICAL COMPOSITION OF POLISH TRITICALE VARIETIES. I. CHEMICAL COMPOSITION OF GRAIN

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Key words: Triticale varietes, chemical composition, differences

The chemical composition of eight Triticale varieties cultivated in Poland was investigated. The contents of the basic chemical components as rule ranged between those in the parental species, and there were only slight differences between the various Triticale varieties in this respect. Protein content averaged at around 12.2% dry matter Triticale varieties contained more P, K, Ca, Mn and Zn than the parental species, and similar quantities of Mg, Na, Fe and Cu. Despite some differences, none of the varieties stood out as regards the content of the determined mineral components. Samples were obtained from three plant breeding farms, and the region of cultivation had only a minor effect on the content of the determined components, only some of the differences were statistically significant.

INTRODUCTION

Intensive work on the genetics and breeding of Triticale has been going on in Poland for about last 20 years. The purpose of this work is to breed high-yield varieties that could be effectively cultivated in the climatic and soil conditions prevailing in Poland, giving good-quality grain for use not only as fodder but also as raw material in food industry, particulary in baking.

Triticale breeding in Poland is based primarily on hexaploid forms originating form Hungary, Canada, USA and Mexico [16]. The list of cultivated plants currently features ten Triticale varieties, and others are being developed. Given this, it seems advisable to systematically study the quality of Triticale grain grown in Poland, especially as regards its chemical composition. The available analyses provide only incomplete data.

MATERIAL AND METHODS

The following Triticale varieties (harvested in 1986): Lasko, Grado, Dagro, Bolero, Salvo, Largo, Presto and the strain LAD 285 were investigated also investigated were samples of the parental species wheat var Grana and rye var Dańkowskie Złote. The cereals were grown in identical agro-technical conditions on three plant breeding farms: Choryń, Dańków and Laski. In total 29 samples were studied.

The grain quality, water content, ash, total protein, starch and reducing sugars were determined according to routine methods [9]. The mineral components — K, Ca, Na, Mg, Fe, Mn, Zn, and Cu — were determined by atomic absorption spectrophotometry after mineralization of the sample in a mixture of concentrated $HCLO_4$ and HNO_3 [8]; total phosphorus was determined colorimetrically by the molybdate method according to Briggs [5]; phytin compounds — by the method of Lopez-Moreno [15].

The significance of differences between samples from different breeding farms was assessed with the nanparametric range test [4].

RESULTS AND DISCUSSION

Despite certain discrepancies among the determined quality indices, the Triticale varieties did not differ substantially as regards organoleptic qualities or physical properties of grain. The 1000 kernel weight ranged from 31 to 51 g, exceeding the value for rye by 6—10 g and being almost identical with that for the „standard" wheat variety. The loose weight of Triticale grain was lower than that of wheat and rye, this being due to a slight shrivelling of kernels. The highest loose weight was exhibited by samples from Choryń (ca 70 kg/hl on average), and the lowest by samples from Laski (ca 65 kg/hl on average). The differences between the varieties were maximally around 8 kg/hl. In most samples the content vitreous grains did not exceed 20%.

Results of determinations of protein, starch and reducing sugars are presented in Table 1. Total protein content in the investigated samples ranged from 10.2 to 13.9% of dry matter. The grain richest in protein was that of strain LAD 285 (12.3—13.9%). The Laski samples were found to contain on average ca 1.4% dry matter more protein than samples from Choryń and Dańków, and this was a statistically highly significant difference.

Triticale from Choryń and Laski contained more protein than wheat (by about 0.5% d.m. on average). The protein content in Dańków samples was half way between the respective contents in wheat and rye. In all the Triticale samples, protein content was about 2% d.m. higher than in rye.

Table 1. Content of protein, starch and reducing sugars in grain (in % dry matter)*

Sample	Total protein	Starch	Reducing sugars
Triticale:			
Lasko	11.5—13.7	64.2—68.2	0.63—0.77
Grado	11.8—13.0	64.4—71.0	0.64—1.19
Dagro	11.9—12.7	65.8—70.2	0.67—0.89
Bolero	10.2—12.8	66.0—69.8	0.68—0.76
Salvo	11.3—13.8	62.8—65.4	0.57—0.88
Largo	11.9—12.8	64.5—67.4	0.66—0.93
Presto	10.7—12.9	65.0—67.8	0.78—1.37
LAD 285	12.4—13.9	60.4—65.8	0.63—0.78
**	11.5—13.2	64.5—67.9	0.66—0.93
wheat	11.8—13.4	60.5—63.1	0.57—0.62
rye	9.4—11.5	68.1—72.2	0.96—0.99

* — Data in the table indicate the range of values determined in samples of the same Triticale variety obtained from three plant breeding farms

** — The only differences that were statistically highly significant concerned protein content in samples from Choryń and Laski, and samples drom Dańków and Laski

The protein contents determined in our study remain in the range reported by other authors [1—3, 6, 7, 12, 17]. In the early stages of Triticale breeding, the grain that was obtained was highly shrivelled and rich in protein, often exceeding 20% d.m. [6, 16]. As work on this cereal progressed, kernel shape improved, the endosperm became better filled out, and protein content dropped. Today many authors find that this content is basically the same as in wheat or only slightly higher. This was also observed in our research.

Starch content in Triticale was ca 66% d.m. on average, midway between the value for wheat (62% d.m.) and rye (70% d.m.). There were no considerable differences in starch contents between the various Triticale varieties and between samples of each variety grown on different farms. Worth noting in this context is the previous work by Kujawski et al. [12] who studies Polish Triticale strains finding that the starch content in grain ranged much more widelly — from 52 to 71% d.m.

The content of reducing sugars in Triticale was about 0.8% d.m. on average, again between the values for wheat (ca 0.6%) and rye (ca 1.0%). There were no great differences between Triticale varieties, the exception beging the Presto variety which had about 1.2% d.m. of reducing sugars.

Ash content in Triticale grain (Table 2) was ca 2.00% d.m. on average, generally higher than in the parental species (ca 1.84% d.m.). The determined values ranged relatively widely from 1.80 to 2.20% d.m. and the differences were both between the individual varieties and between samples of the same

Table 2. Ash, total and phytic phosphorus content in grain*

Sample	Ash % dry matter	P_{total} mg/100g dry matter	P_{phyt} mg/100g dry matter
Triticale			
Lasko	2.04—2.19	462—489	322—338
Grado	1.84—2.06	409—452	278—310
Dagro	1.96—2.03	409—438	267—307
Bolero	1.92—2.02	423—447	299—320
Salvo	1.96—2.13	422—467	288—289
Largo	1.98—2.00	461—470	326—331
Presto	1.80—1.91	401—420	267—287
LAD 285	2.01—2.20	482—523	343—357
*	1.96—2.04	446—449	304—311
wheat	1.71—1.99	389—463	270—330
rye	1.82—1.86	374—431	127—224

* — See footnote to Table 1

variety from different farms. The high ash content in Triticale grain was also noted in earlier publications [1, 2, 6, 7, 10, 14, 17, 18] and was explained by the fact that pericarp in Triticale is thicker than in wheat.

Table 3. Potassium, calcium, sodium and magnesium content in grain (mg/100 g dry matter)*

Sample	K	Ca	Na	Mg
Triticale				
Lasko	545—629	26—38	4.3—9.0	116—135
Grado	559—593	23—30	3.3—7.3	118—134
Dagro	574—607	21—29	6.5—8.9	125—131
Bolero	598—676	24—32	4.9—7.7	114—126
Salvo	623—667	24—30	4.4—8.8	116—138
Largo	505—605	23—32	4.4—5.5	120—132
Presto	547—593	19—27	4.3—7.2	116—133
LAD 285	526—556	27—45	4.1—8.8	137—153
*	566—616	24—32	4.7—7.1	123—133
wheat	446—482	18—28	3.0—6.0	120—131
rye	505—550	18—29	4.4—5.3	107—124

* — See footnote to Table 1

Table 4. Iron, manganese, zinc and copper content in grain (ppm in dry matter)*

Sample	Fe	Mn	Zn	Cu
Triticale				
Lasko	38—53	42—71	29—32	5—11
Grado	35—43	35—66	23.5—31	5—8
Dagro	36—42	40—57	27—35	5—12
Bolero	41—44	39—67	27—34.5	6—11
Salvo	41—43	43—63	22—28	5—10
Largo	44—55	44—62	31—33.5	5.5—10
Presto	42—46	40—54	31—35	5—9
LAD 285	43—46	50—72	33—38	6—9
*	40—45	42—64	29—32	6.5—9
wheat	40—51	21—37	5.5—7	6—8.5
rye	41—49	30—36	16—21	6—10

* — See footnote to Table 1

Tables 2—4 present the content of mineral compounds.

Triticale grain contained more phosphorus than the parental species — 447 mg/100 g dry matter (Table 2). There were big differences between the varieties, amounting to as 114 mg. The highest phosphorus content was in strain LAD 285 (482—523 mg/100 g d.m.). These values are similar to those given by Lorenz et al. [14]

Most of the phosphorus (62—75%) was bound in the form of phytin compounds, same as in other cereals. Differences between the investigated varieties amounted to as much as 84 mg P_{phyt}/100 g d.m. and so it is possible to select varieties with the smallest quantities of these compounds. The values determined in our research are similar to those given by Singh and Reddy [18] and Singh and Sedeh [19].

Triticale grain contained more potassium and calcium than the parental species, while the content of magnesium and sodium were in the range between the content in wheat and rye (Table 3). There were some differences in the content of these elements between the varieties; the differences due to the place of cultivation were much smaller, as was confirmed by statistical analyses: the only differences that were statistically significant were those regarding potassium content in samples from Choryń and Laski, and calcium content in samples from Laski and Dańków. The values we found were mostly in agreement with data given by other authors [13, 16], with a few discrepancies only. For example in Triticale studies by Lorenz et al. [14] potassium content did not exceed 430 mg, while magnesium content was as high as 200 mg/100 g d.m.

The average calcium content in the Triticale grain was about 28mg/100 g d.m. and was in general higher than either in rye or wheat. This is in agreement with studies by other authors [10, 13, 18, 19]. There were differences in the content of this element both between varieties (up to 16 mg) and between places of cultivation. The greatest amount of calcium was in Triticale sample from Laski (ca 32 mg on average), and the smallest amounts — in samples from Dańków (ca 24 mg on average). This difference turned out to be statistically significant. As is know cereal contain small amounts of calsium, so one could hardly expect Triticale, a genetic cross of wheat and rye, to have higher content of this component. One must bear in mind, however, than given the hesvy presence of cereal products in the diet even small differences in calcium content can have important nutritive consequences.

Table 4 presents data concerning the trace elements. Triticale contained more manganese and zins than wheat or rye, and the content of iron and cooper were similar to those in the parental species.

Similary as in case of macroelements the content of microelements differed fairly considerably from variety to variety, the differences being even two-or three-fold, while differences due to the place of cultivation were as a rule statistically insignificant.

The content of manganese in Triticale was ca 52 ppm on average, with two-fold values between different varieties. The highest content of this element (50—72 ppm) was in the strain LAD 285. The difference between manganese content in sample from Choryń and Laski (64 and 42 ppm, respectively) was statistically significant.

Iron content ranged from 35 to 55 ppm, and zinc content from 23 to 38 ppm. These values are four to six fould higher than in wheat. There were no significant differences in zinc content between samples of the same Triticale variety originating form different farms.

In all samples trace amount of copper determined: ca 7.6 ppm. on average. This value is close to the copper content in the parental species. The place of cultivation was fourd to have no effect on copper content in the grain, but in some varieties this content was about twice as high as in others.

The values concerning trace elements content in Triticale given in the literature are few and wide-ranging. For example, Lorenz et al. [13, 14] and Singh and Reddy [18] claim that iron content in Triticale may even exceed 100 ppm, that zinc content is in the wide range of 18—45 ppm, and copper content may be as high as 16 ppm. Kozak and Tarkowski [10, 11] quote data for manganese and zinc similar to those we found, but twice higher values for copper.

For the majority of determined mineral components, the differences turned out to be statistically insignificant. Comparisons of samples from Choryń and Dańków revealed that all the observed differences (with the exception of values

for manganese) were statistically insignificant. Only some of the differences between samples form Choryń and Laski, and samples from Dańków and Laski (i.e. regions differing most as regards climate and soils) were confirmed statistically, namely the differences in potasium, iron and manganese content in samples from Choryń and Laski, and manganese, calcium and magnesium content in samples from Dańków and Laski.

CONCLUSIONS

1. The quality of grain of the investigated Triticale varieties did not differ much. Compared with the parental species, Triticale grain had lower loose weight and higher 1000 kernels weight.

2. The content of basic chemical components in Triticale was as a rule in the range between the respective values for the parental species. The differences between the investigated varieties were small. The average protein content was ca 12.2% d.m.

3. The investigated Triticale samples usually contained more P, K, Ca, Mn and Zn than the parental species, while Mg, Na, Fe and Cu content were in the range between the respective content in wheat and rye. There were certain differences in the mineral composition of the grain belonging to different varieties, but no Triticale was markedly different in this respect from the other. The effect of the region of cultivation on the content of mineral components was neglegible.

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BADANIA NAD SKŁADEM CHEMICZNYM POLSKICH ODMIAN PSZENŻYTA.
I. SKŁAD CHEMICZNY ZIARNA PSZENŻYTA

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Streszczenie

Zbadano skład chemiczny 8 polskich odmian pszenżyta wyhodowanych w 3 stacjach hodowli Roślin: Choryń, Dańków i Laski i porównano je z macierzystymi gatunkami pszenicy i żyta. Stwierdzono, że wskaźniki oceny towaroznawczej ziarna badanych odmian pszenżyta były mało zróżnicowane. W porównaniu z pszenicą i żytem pszenżyto charakteryzowało się niższą masą gatunkową i wyższą masą 1000 ziarn. Zawartość podstawowych składników chemicznych w ziarnie pszenżyta była z reguły pośrednia pomiędzy zawartością tych składnikłw w gatunkach rodzicielskich i mało zróżnicowana pomiędzy odmiananmi. Zawartość białka wynosiła średnio ok. 12,2%. Badane próbki pszenżyta zawierały więcej P, K, Ca, Mn i Zn w porównaniu z gatunkami macierzystymi, a zawartość Mg, Na, Fe i Cu była zbliżona do zawartości tych składników w ziarnie pszenicy i żyta. Stwierdzono wprawdzie różnice w zawartości niektórych składniów mineralnych między odmianami, ale żadna z badanych odmian pszenżyta nie wyróżniała się pod tym względem. Rejon uprawy miał minimalny wpływ na zawartość składników mineralnych w ziarnie i tylko niektóre różnice znalazły potwierdzenie w ocenie statystycznej.