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USE OF TRITICALE IN THE BAKING INDUSTRY

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Key words: triticale flour, wheat flour, bread, pastry, biscuits.

The use of triticale flour in bread, pastry and biscuit baking was studied. No adverse effect of this flour was observed in bread baking, but the replacement of wheat flour by triticale flour in pastry and biscuits requires modifications of the traditional production technology.

The currently experienced grain shortages may apparently be substantially relieved by the introduction in farming of triticale, a new cereal obtained by crossing wheat (*Triticum*) and rye (*Secale*). So far, 11 registered or about to be registered triticale varieties have been bred in Poland, namely Bolero, Dagro, Grado, Lasko, Largo, Presto and Salwo (all from the Poznań Plant Breeding Station), as well as Algo, Jago, Mago and Malno (from the Małyszyn Plant Breeding Station). With the exception of Jago, all those are winter varieties.

Triticale combines the low requirements of rye with the high yield of wheat, and the initially observed extremely high protein content attracted a lot of attention to it.

The protein content in triticale ranges from 12 to 22% [1-3, 5]. Detailed studies of the individual protein fractions in triticale [8] showed them to be generally similar to the respective proteins in wheat or rye, but there are significant quantitative differences. Triticale protein contains much greater quantities of lysine, which thanks to this ceases to be a limiting amino acid, unlike in wheat and rye [5, 8, 10].

The most important component of flour, from the technological viewpoint, is gluten. On average, triticale flour contains 31-45% of gluten [1, 2, 9, 10] which, however, is hard to leach out, inelastic, hard and easily broken [10].

The characteristic of dough made from triticale flour depends on the quantity and quality of the proteins of this cereal. This dough is more viscous than wheat dough, which is being explained [1] by a greater amount of soluble proteins. Another reason for this may be the large amount of mucus, inherited by triticale from rye, which surrounds gluten proteins and hinders the formation of the gluten network [1-3, 5, 7].

Another important component of triticale grain is starch [5, 6]. Its content ranges from 49.1 to 57.1%, and it differs from starches in the parent cereals by a lower amylose content and higher sedimentation coefficient. The shape and size of triticale starch grains are similar to those of wheat and rye starch grains. The initial pasting temperature of triticale starch is close to that of wheat starch, but the final pasting temperature is lower than in starches of the parent cereals. Amylographic analysis showed that triticale displays a generally high amylolytic activity which, however, is not always accompanied by low falling number and visible sprouts [1-3, 7-9].

Many studies (quoted in [5]) indicate that triticale grain may be successfully applied in industry, for example in milling, bread, pastry and pasta production, in breweries, and in food concentrates production (breakfast cereals).

In 1982 the Department of Cereals Technology of the Warsaw Agricultural University launched studies of the use of triticale flour in baking various breads and pastries.

MATERIALS

Experiments were performed with Lasko triticale flour; the grain (1984 crop) was obtained from the Plant Breeding Station in Laski near Warka, and milled in a farm mill; flour yield was about 70%. The chemical composition of the flour was as follows:

— humidity	13.1%
— total protein (N × 5.83)	10.3% dry weight
— total ash	0.61% dry weight
— starch	71.2%
— wet gluten	none was eluted
— acidity	3.0°.

The obtained flour displayed the following farinographic and amylographic features (according to AACC):

— farinographic determinations:	
water absorption	60.5%
departure time	1.5 min
stability time	6.0 min
peak time	1.8 min
time to break down	9.0 min
elasticity	95 B.u
— amylographic determinations:	
initial pasting temperature	58.0°C
final pasting temperature	78.3°C
maximum viscosity	220 B.u
— falling number	239 sec.

METHODS

After a series of laboratory experiments (not reported here), tests on semi-technological scale were carried out in the Experimental Bakery of the Research Institute of Baking Industry in Warsaw, in the Warsaw Pastry Factory, and in the Pastry Plant in Płońsk.

The following methods of baking with triticale flour were employed:

— the direct (single-phase) method for wheat bread,
— the indirect (two-phase: leaven-dough) method for wheat bread,
— the direct (single-phase) method for rye bread, with or without lactic acid,
— the multi-phase (preferment-sour-dough) method for mixed bread; this method had two versions, with the preferment made either with triticale or rye flour.

The dough for every experiment was made of 20 kg of flour.

The pastries (sandcake, gingerbread, and shortcake pie shells) were baked according to recipes used in pastry factories (Nos 75-24, 914-66, and 59-15, respectively), replacing wheat flour with triticale flour. In the case of gingerbread, triticale flour replaced the wheat and rye flours that are used normally.

Biscuits of the "Marco", "Pinokio", and "Roxana" brands were baked according to recipes of the Płońsk pastry plant, replacing the traditionally used wheat flours with triticale flour. In each experiment, dough was made of 15 kg of flour in a laboratory mixer, and the rest of the technological process was carried out on the plant's production lines.

Traditionally baked pastries and biscuits served as control.

RESULTS

In laboratory experiments, bread was baked according to various methods, including the typical methods of baking wheat and rye bread. The best results were obtained with the three-phase method using rye preferment. Triticale preferment gave disappointing results, among others because of its low acidity which led to a similarly low acidity of the bread made from it. There was no such problem when rye preferments were used, and the amount of rye flour they introduced into the dough was less than 10%. Selected characteristics of these breads are given in Tab. 1.

The bread obtained with the three-phase method using rye preferments rose well, its loaf shape was correct, the crumb was very elastic, and both flavour and odour were pleasing. The porosity and humidity of the crumb were typical for wheat bread. The triticale bread remained fresh (and hence edible) for a longer period.

In experiments with pastries (sandcake, gingerbread, and shortcake pie shells) the traditionally used wheat flour was replaced completely with triticale flour. The greatest improvement occurred in gingerbread which increased in vo-

Table 1. Selected physico-chemical characteristics of various triticale breads

Method of dough fermentation	Total baking loss (%)	Bread yield (%)	Bread volume (from 100 g of flour) cm³	Crumb porosity (%)	Crumb moisture (%)	Crumb acidity o
Direct (as for wheat bread)	17.4	130.4	291	72	45.4	2.0
Indirect (as for wheat bread)	14.3	136.0	280	67	47.0	2.2
Direct (as for mixed bread with lactic acid)	15.3	134.4	290	75	44.3	3.4
Direct (as for mixed bread without lactic acid)	16.2	130.4	287	72	46.0	2.0
Three-phase (preferment from triticale flour)	16.8	131.2	301	78	43.8	3.8
Three-phase (preferment from rye flour)	17.7	131.7	331	81	44.3	5.9

Table 2. Characteristic of triticale cakes

Product	Control: wheat flour		100% triticale flour	
	total baking loss (%)	volume (cm^3)	total baking loss (%)	volume (cm^3)
Sandcake	7.6	1130	7.7	1150
Gingerbread	6.4	946	6.3	984

lume and had longer shelf life (Tab. 2). Changes in loaf weight and humidity losses during storage were similar in gingerbreads made from triticale and in the traditional product.

Sandcake baked with triticale flour had the same weight as the traditional wheat-flour product, but loaf volume was slightly greater. Total baking loss was greater in the new product, whereas weight and humidity changes during storage were the same.

The shortcake shells baked from trticale flour instead of wheat flour had typical shapes (acquired in the moulds) and good organoleptic properties. The only changes during storage were slight humidity decreases, similar to those observed in the traditional products. The triticale-flour shells were found to be harder. It is possible to obtain the correct texture of the product but this requires changes in technology. Suitable experiments are being performed, and positive results are expected.

The next stage of experiment with triticale flour was the baking of three different kinds of biscuits ("Marco", "Pinokio", "Roxana"), with the traditionally used wheat flour replaced entirely by the tested flour. All experiments were performed in commercial production conditions.

The experimental biscuits were analysed 24, 96 and 120 h and one month after baking, and compared with traditional products. The analysis included measurements of changes in the biscuits' hardness and tenderness, using an Instron 1140 apparatus. The general conclusion from this analysis is that triticale can be used to produce the biscuits in question.

The best results were obtained when wheat flour was replaced with triticale flour in the production of "Pinokio" biscuits. The experimental products were very similar to the traditional biscuits, and their properties remained practically unchanged during storage. They lost none of their tenderness, which is an improvement over the traditional biscuits.

The "Marco" biscuits baked from triticale flour were also similar to the traditional product, but their structure was perceptibly harder. This hardness increased during storage.

The replacement of wheat flour with triticale flour was least advantageous in the case of Roxana biscuits which were very hard, and got still harder during storage. This might perhaps be remedied by a change of technology, and suitable experiments are under way.

Research into an extensive utilization of triticale in food industry, and in cereal technology in particular, are worth supporting. There is growing interest in the cultivation of this new cereal, both in Poland and abroad, resulting from the constant search for high-yielding crops giving good-quality grain at low energy

Table 3. Dough parameters and proportions of ingredients in making bread from Triticale flour

Ingredients and process parameters	Production phase
	Preferment
Rye flour	10% of the total amount of flour used
Water	until preferment yield of 400% is obtained
Fermentation time	24 hrs
Fermentation temperature	28-29°C
	Sour
Triticale flour	up to 50% of the total amount of flour used
Water	until a sour yield of 200% is obtained
Yeast	1-2% of the total amount of flour used
Fermentation time	3 h
Fermentation temperature	32°C
	Dough
Triticale flour	remaining amount of flour up to the required total
Water	until total dough yield of 160-165% in obtained
Salt	1.5% of the total amount of flour used
Fermentation time	30 min
Fermentation temperature	32°C
Dough piece weight	as required
Final fermentation time	25-45 min depending on dough piece weight
Final fermentation temperature	32°C
Baking time	depends on dough piece weight
Baking temperature	235-245°C

inputs. Triticale is one such crop, and a further encouragement of studies of its use in food industry is that very positive evaluation of the Polish varieties abroad.

CONCLUSIONS

1. Triticale flour may be used in bread baking and related processes (pastry and biscuit production).

2. The use of triticale flour in bread production is possible in practice. Parameters of the proposed technology are given in Tab. 3.

3. The use of triticale flour in making pastry and biscuits requires modifications of the existing technologies, aimed at a full utilization of the distinct properties of this flour and at obtaining a superior product. Suitable experiments are under way.

LITERATURE

1. Biskupski A.: Przegl. Piek. i Cukiern., 1979, **23** (8), 145.
2. Biskupski A., Subda H., Bogdanowicz M.: Hod. Rośl. Aklimat. i Nas., 1979, **24** (6), 382.
3. Biskupski A., Wolski T., Bogdanowicz M., Subda H., Tymieniecka E.: Hod. Rośl. Aklimat. i Nas., 1982, **27** (6), 461.
4. Glattes H.: Die Mühle 1981, **118** (21), 283.
5. Haber T.: Zeszyty naukowe SGGW-AR. Rozprawy naukowe 120, Warszawa 1979.
6. Haber T., Haberowa H., Miszczuk A.: Zagadn. Piek., 1986, **21** (2), 20.
7. Kozmina N. P., Woroncowa I. A., Chaczaturian E. J.: Chleb. i Kondit. Promysl., 1976, **20** (11), 22.
8. Muntzing A.: Supplements to J. of Plant Breeding., 1979 (10), 63.
9. Pogirnoj N. E., Grizo W. A.: Piszcz. Technol'., 1979, **22** (1), 136.
10. Stefanowska G.: Post. Nauk Roln., 1973, **21** (5), 37.

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WYKORZYSTANIE PSZENŻYTA W PRZETWÓRSTWIE ZBOŻOWYM

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Streszczenie

Duże możliwości złagodzenia istniejącego bilansu zbożowego w Polsce stwarza wyhodowanie i wprowadzenie do szerokiej uprawy nowego zboża, jakim jest pszenżyto. Jest to zboże, które łączy w sobie niewielkie wymagania żyta z dość dobrą wydajnością i wartością technologiczną pszenicy. Biorąc pod uwagę skład chemiczny i wartość technologiczną, pszenżyto może być z powodzeniem wykorzystane nie tylko jako pasza, ale także na cele technologiczne, m.in. w młynarstwie, piekarstwie, ciastkarstwie, do produkcji makaronów, w browarnictwie czy przemyśle koncentratów spożywczych.

Próby wykorzystania pszenżyta do produkcji pieczywa, wyrobów ciastkarskich, jak: babka piaskowa, piernik bakaliowy i korpusy do babeczek z ciasta kruchego oraz trzech rodzajów popularnych w kraju herbatników „Marco", „Pinokio" i „Roxana" podjęto w Katedrze Technologii Zbóż i Koncentratów Spożywczych SGGW-AR.

Wykorzystując mąkę uzyskaną z przemiału ziarna pszenżyta odmiany „Lasko" (przemiał dokonany był w młynie gospodarczym), wykonano próby na skalę półtechniczną w piekarni doświadczalnej, zakładach ciastkarskich i zakładach przemysłu cukierniczego.

Przy wypieku pieczywa z mąki pszenżytniej zastosowano różne metody prowadzenia ciasta, typowe zarówno dla pieczywa pszennego, żytniego, jak i mieszanego. W wyniku przeprowadzonych prób stwierdzono, że najlepsze wyniki uzyskano stosując przygotowanie ciasta metodą trójfazową (żurek — kwas — ciasto), przy czym do produkcji wskazane jest stosowanie żurku żytniego o wydajności 350-400%. Stosując taką metodę uzyskuje się podwyższoną kwasowość chleba pszenżytniego, korzystniejszą ze względów organoleptycznych. Stosowanie żurku wyprowadzonego z mąki pszenżytniczej nie dawało zadowalających wyników. Zaproponowano metodę wypieku chleba pszenżytniego.

Przy otrzymywaniu wyrobów ciastkarskich i herbatników stosowano receptury obowiązujące w poszczególnych zakładach produkcyjnych, zamieniając jednak tradycyjnie stosowane mąki, pszenne lub żytnie w 100% mąkę pszenżytnią.

Wykorzystanie mąki pszenżytniej do produkcji wybranych wyrobów ciastkarskich lub herbatników jest, podobnie jak do produkcji chleba, możliwe. Niemniej jednak, w celu pełnego wykorzystania gatunkowych walorów technologicznych mąki pszenżytniej, odmiennych od pszenicy czy żyta, jak też w celu uzyskania wyższej jakości wyrobów gotowych, konieczne są pewne modyfikacje procesów technologicznych. Prace takie są w toku.