

GLUTEN-FREE MIXTURES AND THEIR UTILISATION IN THE SPECIAL DIET PRODUCTS

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ABSTRACT

Gluten-free mixtures from the Czech raw materials for production of gluten-free products were developed. The effects of various gluten-free materials (lupine- carob-, amaranth-, sorghum- and teff flour, inulin-, pectin- and potatoes fibre, tapioca-, waxy corn- and modified starches, pea isolate) on the sensory properties of gluten-free bread were studied. The formulas were proved using the laboratory bakery machine and then in the semi-industrial scale in the special gluten-free operation in Jizera Bakeries. The sensory quality of breads and rolls from new mixtures were evaluated by celiac patients. There were also studied, analyzed and sensory evaluated storage life of breads, and rolls from the developed mixture at 25 °C, 4 °C and -18 °C in the 3 types of packaging (microten, polyethylene and polypropylene). One of the formulas (without potential allergens of soy and milk) is now used in Jizera Bakeries for production of breads, rolls, sweet deserts etc. This mixture is also suitable for production of pastries.

Key words: gluten-free bread, gluten-free rolls, gluten-free mixture, special diet products preparation, special diet products technology, celiac disease, storage, sensory properties

INTRODUCTION

Gluten-free products (foodstuffs) are fundamental for population group suffering from celiac disease. The main sign of celiac disease (celiac sprue, gluten-sensitive enteropathia) is intolerance to gluten, resulting in failure of small intestine mucous membrane. The dermatic form of this disease is Duhring herpetiform dermatitis and some patients do not tolerate gluten without failure of small intestine. In the Czech Republic there are 40 000 - 50 000 of celiac patients, but many other patients are not diagnosed.

Dysfunction of nutrients resorption and subsequent absence of base nutrients, minerals, vitamins, higher penetration of antigens, possible immunologic defects and higher risk of malign tumors are implications of celiac disease. Principle of the treatment is whole-life gluten-free diet.

Wheat and species, rye, barley, oat, crossbreeds-triticale are not acceptable for gluten-free diet. Acceptable raw materials for gluten-free products are some other cereals – corn, rice and pseudo cereals- buckwheat, millet, amaranth, sorghum quinoa, teff. As gluten is necessary for production of dough with good baking quality, it is difficult to produce gluten-free products with good physical and sensory quality.

MATERIALS AND METHODS

Basic materials:

amaranth flour, amaranth pearls, buckwheat, carob flour, corn flour, corn starch, deproteinated wheat starch, flour from rice Natural Lagris, flour from rice Parboiled Lagris, lupin flour, modified tapioca starch, potatoes flour, potatoes starch, powdered gelatin, sorghum flour, waxy corn starch

Additives:

ascorbic acid, citric acid, enzyme Grindamyl A 1000 a H 190, guar gum, half fat powdered milk, instant dry yeast, inulin, karagenan, pea isolate, pectin XSS 100, pectin MRS 351, potato fiber, powder lecithin

Analytical methods:

AOAC: *dry matter, protein, ash, total dietary fiber, lipids*

polysaccharides, energy – calculation

gliadin – sandwich Elisa kit, Immunotech & Beckmann Coulter Company

thiamin B1 - RP-HPLC; sample preparation: acidic and subsequent enzymatic hydrolysis is applied to liberate thiamin, conversion of thiamin to thiochrom by oxidation thiochrom determination column: Separon SGX C18 elution system: methanol: phosphate buffer pH 7 (v/v 1:1) injection: 20 ml detection: fluorescence;

pyridoxin B2 - ČSN procedure Nr. 56 0054;

riboflavin B 6 - ČSN procedure Nr. 56 0056;

niacin ČSN procedure Nr. 56 0051;

pantothenic acid - ČSN procedure Nr. 56 0060;

vitamin E - HPLC; sample preparation: alkali saponification, column: SG, elution system: hexan:isopropanol (v/v 99:1), detection: fluorescence at λ_{ex} 290 nm, λ_{em} 330 nm;

minerals - Na, K, Ca, Mg, Fe, Cu, Zn - flame AAS; P - photometry

Sensory methods:

flavour, appearance, taste, texture and general sensory quality of samples, 12 assessors, 7-point scale

Bakery tests:

laboratory bakery machine, in the semi-industrial scale in the special gluten-free operation in the manufacture Jizerské pekárny, Ltd.

RESULTS AND DISCUSSION

Gluten-free mixtures from the Czech raw materials for processing of gluten-free products were developed.

Results of this work are 7 formulas of gluten-free mixtures:

A) with natural gluten-free raw materials

- 1) white bread without milk and soy: potatoes starch, corn starch, rice flour, amaranth flour, inulin, lupine flour, glucose, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid
- 2) dark bread without milk and soy: potatoes starch, corn starch, sorghum flour, inulin, lupine flour, glucose, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid

B) with deproteinated wheat starch

- 3) with dry milk, without soy: deproteinated wheat starch, dry milk, glucose, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid
- 4) with dry milk and soluble dietary fiber, without soy: deproteinated wheat starch, dry milk, glucose, guar gum, inulin, pectin, lecithin, iodine table salt, citric acid, ascorbic acid
- 5) with lupine flour, without milk and soy: deproteinated wheat starch, lupine flour, glucose, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid

C) with optimized nutritional value

- 6) white bread and pastry: deproteinated wheat starch, lupine flour, pea isolate, glucose, inulin, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid
- 7) dark bread and pastry: deproteinated wheat starch, lupine flour, pea isolate, glucose, guar gum, lecithin, iodine table salt, citric acid, ascorbic acid.

The breads prepared from the mixture B5 was compared with common bread for healthy population, e. g. bread "Sumava". The Czech bread is prepared from wheat flour with high content of gluten, rye flour and with fermentum. The gluten-free bread usually has abnormal taste, crumbly structure, short shelf-life and form profile. Bread made from our new mixture can be made without form, has pleasant taste, good texture, 7 day shelf-life and price lower than imported mixture. As to nutritional value, our gluten-free breads have lower content of protein (Tab. 1), the white one has also lower content of dietary fibre. So we developed 2 formulas with optimized nutritional value. Differences in mineral and vitamin content are not important; fortification of gluten-free breads is not necessary according to doctors. Patients in acute stage of celiac disease are medicated with minerals and vitamins. High sense, especially for pregnant women with celiac disease would have fortification with panthotenic acid.

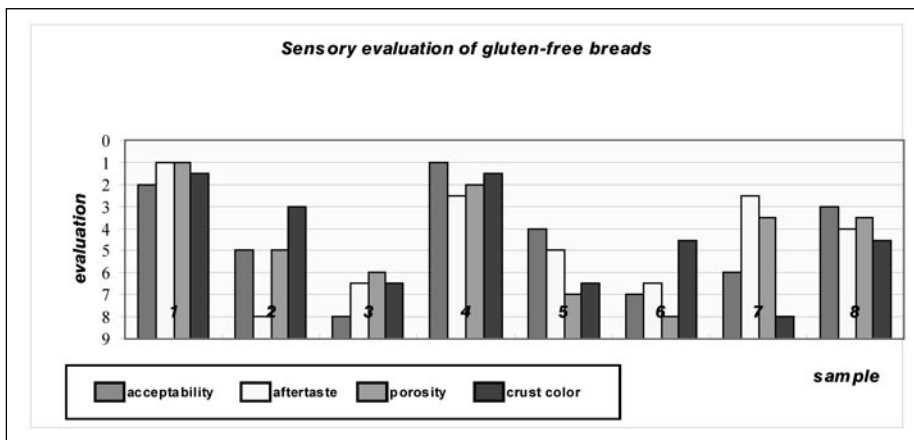
Table 1: Composition of gluten-free breads and usual Czech bread "Sumava"

<i>content of</i>	<i>unit</i>	<i>white bread</i>	<i>dark bread</i>	<i>bread with gluten.</i>	<i>RDI (per day)</i>
dry matter	% (w/w)	64,4	65,25	63,65	-
protein		3,27	3,11	9,49	80 g
fat		3,57	3,56	2,63	75 g
polysacharides		85	82,38	77,66	400 g
total dietary fibre		6,35	8,73	8,03	25-35 g
soluble dietary fibre		3,28	1,57	2,97	-
ash		1,81	2,22	2,19	-
energ. value	kJ/100g	1633	1585	1579	11000
gliadin	mg/100g	1,32	1,28	nd	max.
thiamin		0,016	0,031	0,31	1 –1,5 mg
riboflavin		0,075	0,081	0,077	1,2 –2,6 mg
pyridoxin		0,031	0,046	0,173	2 –3 mg
niacin		0,47	0,61	1,57	5 – 20 mg
panthoten. acid		0,11	0,17	0,35	5 – 15 mg
tocoferols		0,54	0,66	0,75	25 –30 U.I.
carotenoids		0,19	0,17	0,11	-
Na		786	903	809	2500 mg
K		130	153	259	2000 mg
Ca		39	44	43	800 mg
Mg		21	24	59	300 mg
Fe		1,27	4,14	2,36	14 mg
Cu		0,93	0,11	0,26	1,5 mg
Zn		0,43	0,44	1,86	15 mg
P		129	120	225	800 mg
Mn		0,36	0,38	1,52	2,5 mg

results calculated on dry matter

The formula B5 (mixture without potential allergens of soy and milk) is now used in Jizera bakeries for producing gluten-free breads, rolls, sweet deserts etc. and mixtures for home. This mixture is also suitable for pastries preparing.

Effects of various gluten-free raw materials on sensory properties of gluten-free bread prepared at first in the laboratory bakery machine and then in the semi-industrial scale in the special gluten-free opeation in Jizera Bakeries were studied. Sensory quality as assessed by specialists in the sensory laboratory, by celiac patients and also by participants of the meetings of 2 organizations of celiac patients and also by participants of the seminar "Present state in the gluten-free diet area from the point of view chemists-analysts, food producers, doctors and patients", Prague 2003 (Fig. 1).



sample 1 (base formula)	deproteinated wheat starch, fermentum, dry milk whole fat, glucose, guar gum, lecitin, iodine table salt, citric acid, ascorbic acid
sample 2	one half of dry full fat milk substituted with soya full fat flour
sample 3	all of dry milk substituted with soy flour
sample 4	supplement soluble fibers pectin and inulin
sample 5	without ascorbic acid, citric acid substituted citric concentrate
sample 6	without ascorbic acid, citric acid substituted citric concentrate, supplement apple fiber
sample 7	white bread made from the imported mixture
sample 8	dark bread made from the imported mixture

Figure 1 Sensory evaluation of gluten-free breads, made semi-industrial scale

In addition to that storage life at 25 °C (in the laboratory), 4 °C (in the refrigerator) and -18 °C (in the freezer) of gluten-free white breads and rolls from the developed mixture was also studied. Three types of packing materials: microtene, polyethylene and polypropylene sacks were used. Samples were sensory, microbial and chemically analyzed. We recommend storing of gluten-free products in refrigerator or freezer in polypropylene or polyethylene sacks.

CONCLUSION

The effects of various gluten-free raw materials (lupine-, carob-, amaranth- and sorghum flours, inuline-, pectin- and potatoes fibre, tapioca- and waxy corn starch, pea's isolate) on the physical and sensory properties of gluten-free bread were studied.

7 formulas of gluten-free mixtures were developed; recipes were proved in the operation of Jizera's Bakery and products were sensory analyzed by celiac patients

The storage life at 25 °C, 4 °C and -18 °C in the three types of packing was studied, analyzed and sensory evaluated; we recommend storing of gluten-free products in refrigerator or freezer in polypropylene or polyethylene sacks.

One of the formulas (the mixture without potential allergens of soy and milk) is now used in Jizera's Bakery for production of breads, sweet deserts etc.; this mixture is also suitable for preparing of pastries.

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BEZGLUTENSKE SMJESE I NJIHOVA PRIMJENA U SPECIJALNIM DIJETNIM PROIZVODIMA

SAŽETAK

Za proizvodnju proizvoda bez glutena razvijena je smjesa iz čeških sirovina bez glutena. Ispitan je utjecaj različitih sirovina bez glutena (brašna: vučjeg boba, rogača, amaranta, sirka i tef-a, inulina, pektina i krumpirova vlakna, škrobovi od tapioke i voštanog kukuruza, modificirani škrobovi, izolati škroba) na senzorska svojstva na kruh bez glutena. Pečenja su provedena u laboratorijskom aparatu za pečenje kruha a nakon toga u polu industrijskom mjerilu u specijalnom pogonu za proizvodnju bezglutenskog kruha u Jizerské pekaranicama. Senzorska kakvoća kruha i peciva od novih mješavina provedena je s grupom pacijenata koji boluju od celijakije. Također je provedena analiza i senzorska evaluacija trajnosti kruha i peciva proizvedenih od razvijenih mješavina, skladištenih temperaturama od 25 °C, 4 °C i -18 °C u tri različita tipa ambalaže (mikroten, polietilen i polipropilen). Jedna od formulacija (bez potencijalnih alergena soje i mlijeka) našla je primjenu u Jizerské pekarnicama za proizvodnju kruha, peciva, slatkih deserta i dr. Mješavine su također pogodne za proizvodnju kolača.

Glavne riječi: bezglutenski kruh, bezglutensko pecivo, bezglutenska mješavina, priprava specijalnih dijetnih proizvoda, tehnologija specijalnih dijetnih proizvoda, celijakija