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Food with addition of little-known legume varieties

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Abstract. The nutritional value of little known legumes was studied. Grass pea, old variety of pea, dark varieties of beans and chickpea were processed into flour, farina, flakes and malt. These raw materials were added into bread, bakery products, pastas, spreads and desserts; tempeh was prepared by fermentation with *Rhizopus* mould. Foods with legumes were submitted to nutritional evaluation and sensory analysis. The addition of legumes to bakery goods increased proteins and fibre content and decreased the energy value. The level of ODAP and α- galactosides decreased significantly during tempeh preparation.

Key words: legumes utilization, grass pea, bean, chickpea, pea, nutritional value

INTRODUCTION

Legumes are dry seeds of plants from the *Fabaceae* family. They are a good source of many nutritionally important substances, especially the high-quality proteins with typically high content of lysine and a lower content of sulphur amino acids. Hence it is suitable to combine legumes in food with cereals and to balance the resulting amino acid composition of the food. The content of total dietary fibre in dry matter (DM) reaches about 30% and the resistant starch in legumes also behaves like a fibre. Unavailable oligosaccharides present in legumes act as a flatulence producing substance in sensitive persons but simultaneously serve as a probiotic for intestinal microflora. Legumes are rich in B vitamins, especially niacin, riboflavin and thiamine. The positive nutritional assessment of legumes is also due to the mineral content – calcium and phosphorus - and by the trace element content – iron, manganese and zinc (Campbell, 1997; Messina, 1999).

Legumes are a well known cultural crop with long history of utilization. Pea, lentil and bean are the most consumed in the Czech Republic, soybean, in less quantity. The consumption of legumes is only about 2.2 kg per person, per year. Legumes are an important diet component of persons preferring healthy foods, vegetarians, diabetics and coeliac patients. The aim of our work was to test the application of little known species or varieties of legumes into food products and simultaneously to improve the nutritional value of products.

MATERIALS AND METHODS

Grass pea „TB18“, dark grain chickpea „Irenka“, dark bean variety „TB19“ and the pea variety (*Pisum sativum* var. *medullare*) grown by Research Institute for Fodder Crops were utilized in this project. Legumes´ malting was performed in the Research Institute of Brewing and Malting in Brno. Table 1 shows the basic composition of these raw materials. The commercial starter culture of *Rhizopus oligosporus* - Tempeh Starter Type B from TOP Cultures (Belgium) was used for the tempeh preparation according to the manufacturer's instructions. Flour, farina, flakes and malt were prepared from legumes and then incorporated into bakery products and pasta. Tempeh was made from dehulled cooked seeds.

Table 1. The basic composition of legumes (g 100 g^{-1} of sample).

Sample	Grass pea	Grass pea malt	Chickpea	Chickpea malt	Pea	Pea malt	Bean
Dry matter	90.8	94.0	91.5	93.5	90.7	93.5	91.5
Proteins	27.6	25.5	17.7	19.2	27.8	20.6	24.3
Lipids	1.5	1.7	3.5	3.6	1.7	1.50	1.8
Ash	3.4	3.8	3.6	3.6	3.2	3.2	4.8
TDF	23.8	24.5	22.7	30.7	24.6	25.6	26.0

The other raw materials were purchased from the retail network. A home bread-making machine with optional programs for normal, whole grain and gluten free bread preparation was used for bread baking. The nutritional value evaluation and sensory analysis of chosen samples with the addition of legumes were carried out.

Dry matter was determined by drying the sample to a constant weight at 105 °C, proteins by the Kjeldahl method (Nx6.25), ash by dry ashing at 520 °C, fat by chloroform extraction after acidic hydrolysis, total dietary fibre (TDF) by the AOAC enzymogravimetric method, ODAP (β-N-oxalyl-L-α,β-diaminopropionic acid) by spectrophotometric method after alkaline hydrolysis and after reaction with OPA (Hussain et al., 1994), non-protein nitrogen compound by Kjeldahl method after precipitation by 12% trichloroacetic acid (TCA), α-galactosides by HPLC with Lichrospher-NH_2 column and refractometric detection. Results in the tables are taken as the mean of two individual determinations. Sensory analysis was performed in the specialised laboratory under the conditions as specified by ISO 6658 and 8589. A trained descriptive analysis panel (n = 10–12) was used in this study.

RESULTS AND DISCUSSION

The addition of legumes did not inhibit dough fermentation, but the texture and sensory properties of bread were changed. This fact is in line with Dalgetty & Baik (2006). They influenced dough properties and bread quality by the fortification with soluble or insoluble legume fibre. In this work the texture, fibre and protein content were emphasised during the bread preparation; raw materials with high fibre content were also included. Sourdough bread, bread raised by yeast and gluten-free bread with

different proportions of legumes were prepared in laboratory. The mixtures for home and industrial bread preparation employing yeast as leavening agent were also developed. The shelf life of breads containing legumes was not different from normal bread, but the addition of too much legume flour (33%) resulted in crumb friability. The specific taste of legumes was not masked when grass pea flour was added at this level; on the contrary, the chickpea taste was less distinct. The gluten-free breads needed constant cold storage time due the friability. The addition of legumes increased the protein content in breads and sweet yeast cakes (Tables 2 and 3). This fact is especially important in gluten-free breads that are based on starch application in recipes. Table 2 shows also the decrease of energy value in the samples with higher fibre content.

Table 2. The nutritional composition of breads with addition of legumes (g 100 g^{-1} of fresh sample).

Sample	Legumes amount (% flour)	Dry matter	Proteins	Lipids	Ash	TDF	Energy ($kJ100g^{1}$)
Grass pea A*	14.0	62.7	6.3	1.2	2.4	5.5	955
Grass pea B	19.2	63.3	7.5	1.1	2.5	5.8	957
Grass pea C*	33.0	62.0	9.7	1.0	2.4	7.7	903
Gluten free	21.8	58.7	5.6	1.4	2.1	8.8	840
Bean*	19.2	62.9	9.1	0.8	2.6	6.5	930
Pea*	19.2	62.3	9.1	1.0	2.4	7.0	919
Grass pea malt*	19.2	62.8	10.0	1.0	2.4	5.7	950
Grass pea+ carob*	20.0	57.4	8.8	1.0	2.4	5.8	856
Grass pea+apple fibre*	20.0	59.7	10.9	0.9	2.0	6.1	896
Grass pea + psyllium*		59.5	10.3	0.9	2.0	7.1	875
Grass pea+oat bran *	20.0	59.5	10.3	1.3	2.1	7.0	882
Grass pea+whole grain wheat+oat bran*	20.0	59.8	10.2	1.5	2.4	7.8	874
Grass pea+whole grain wheat flour+ apple fibre*	20.0	60.3	9.8	1.3	2.4	10.0	841
Grass pea+resistant starch*	20.0	60.0	10.4	1.0	2.1	5.4	915
Grass pea	14.9	62.7	10.0	1.3	2.2	5.2	966
Bean	14.9	62.2	10.3	1.0	2.2	5.2	950
Grass pea, resistant starch, apple fibre	19.5	60.0	11.2	1.2	1.9	5.7	914
Grass pea+carob	19.5	60.9	11.1	1.0	2.3	6.1	912
Grass pea+whole grain flour+carob	19.5	57.1	10.3	1.3	2.0	7.5	836
Chickpea +fibre	19.5	59.2	9.7	1.3	2.0	7.9	865
Chickpea+apple fibre*	20.0	57.0	9.8	1.1	2.0	7.9	824
Standard bread	0.0	60,4	7,3	1,2	1,9	2,8	972

*sourdough bread

Table 3. The basic composition of yeast cake (g 100 g^{-1} of fresh sample).

Sample	Wheat	Grass pea	Chickpea	Pea	Bean
Dry matter	77.0	77.7	75.3	75.7	77.5
Proteins	5.1	5.4	6.1	5.7	6.6
Lipids	25.1	23.2	23.5	22.1	23.4
Ash	1.2	1.1	1.2	1.3	1.3

Flour from legumes was incorporated into the cheese sticks, and salt pancake and chickpea flour, into the sweet cake (Table 4). Grass pea flour and flour from other legumes can be used in the amount of 30% (based on wheat flour) in pastas and in less quantity when combined with buckwheat or rice flour to make gluten-free pastas. The results of analysis of laboratory-made pastas are in Table 5.

Table 4. The basic composition of bakery goods with legumes, (g 100 g^{-1} of fresh sample).

Sample	Dry matter	Proteins	Lipids	Ash	TDF
Cheese sticks, grass pea	95.5	19.1	26.1	3.1	9.0
Yeast cheese sticks, grass pea	91.9	17.3	10.3	2.3	7.7
Yeast cheese sticks, bean	83.0	16.0	7.4	2.4	5.4
Yeast pancake, grass pea, seeds	69.4	14.3	3.5	2.2	10.0
Chickpea cake	76.7	6.9	15.4	1.6	2.8

Table 5. The basic composition of pastas with legumes, (g 100g^{-1} of sample).

Sample	Dry matter	Proteins	Lipids	Ash
Wheat/grass pea 10%	88.7	11.9	0.9	0.7
Wheat/bean	90.3	13.3	1.3	0.8
Wheat/bean/egg	90.3	14.6	2.2	1.1
Wheat/chickpea/egg	90.6	13.3	2.6	1.0
Wheat/grass pea 20%	90.5	13.7	1.2	1.0
Wheat/grass pea 30%	90.6	14.6	1.3	1.2
Grass pea/rice/egg white	90.3	13.9	2.0	1.9
Grass pea/buckwheat/egg white	89.8	18.4	1.1	2.5

Malted chickpea was soaked and cooked. After homogenization a thick farinaceous mass was obtained. It was used separately or with the barley malt as the base for spreads and sweet desserts. Sweet desserts were flavoured by fruit compound, caramel, cocoa or were mixed with ground sunflower seeds. The typical legume taste was still present. In the spreads chickpea was mixed with vegetable, oil and spice.

The chosen samples of bread and salty sticks were submitted for sensory analysis. The results are presented in the Fig. 1. The evaluation of samples was generally quite positive, although the individual panelists sometimes exhibited their eating preference. The sample of bread with carob received the worst evaluation of sensory parameters because of its dark colour and unusual taste. The sample of cheese sticks obtained the best evaluation.

The effect of legume treatment and fermentation with *Rhizopus oligosporus* is shown in Tables 6 and 7. The content of TDF decreased significantly due the de-

hulling process. The insoluble fibre was removed and the amount of soluble fibre fraction increased at the end of the process. The content of insoluble fibre decreased also during the prolonged fermentation. In comparison with the commercial soybean tempeh, laboratory-made legume samples show lower fat, proteins and fibre content.

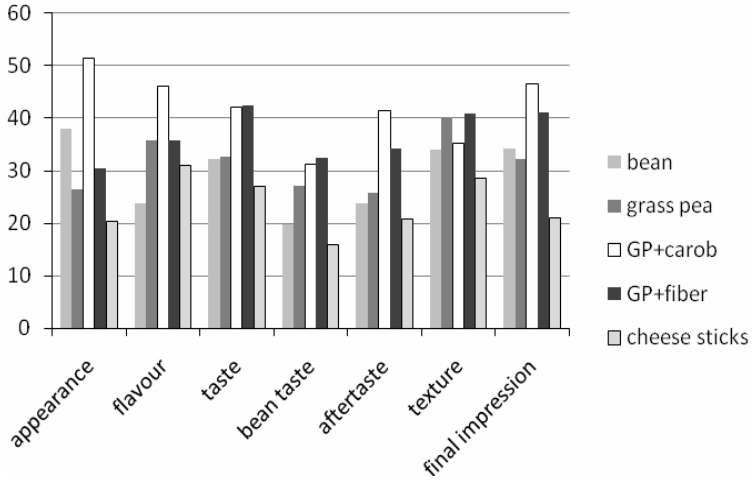

Figure 1. The sensory analysis of breads and sticks. The unstructured scales were used for the evaluation (flavour, appearance, taste, texture and final impression 0 - excellent, 100 – disgusting; aftertaste: 0 – not present, 100 – very strong).

Table 6: The comparison of grass pea tempeh composition with the composition of soy tempeh, (g $100g^{-1}$ of DM).

Sample	Proteins	Lipids	Ash	TDF	Insoluble fibre	NPN /prot.
Grass pea	29.6	1.5	3.8	24.4	22.0	17.5
Grass pea malt	29.6	1.5	3.6	30.2	25.7	18.1
Tempeh, grass pea, 24 h	38.3	1.2	2.2	12.8	11.5	36.4
Tempeh, grass pea, 48 h	44.1	1.3	2.4	17.8	13.8	-
Tempeh , grass pea malt	34.4	0.9	1.8	12.8	8.4	22.0
Tempeh soy	51.2	8.6	2.8	17.0	17.0	4.7

NPN/prot. = the amount of non-protein nitrogen compounds (g 100 g^{-1} of proteins)

Table 7: The basic composition of tempeh made from legumes and legumes combined with cereals, (g $100g^{-1}$ of DM).

Sample	Proteins	Lipids	Ash	TDF
Pea	38.5	2.2	1.8	12.5
Bean	25.2	1.6	2.3	18.3
Chickpea	22.7	1.8	2.2	14.9
Oat/grass pea	24.2	4.6	2.3	14.0
Grass pear/rice 1/1	22.6	2.4	2.1	13.8
Grass pea/rice 2/1	27.3	3.3	1.6	11.1
Grass pea/corn 1/1	24.9	3.2	1.6	12.8
Grass pea/corn1/2	20.7	2.5	1.5	14.5

The ODAP content in grass pea samples harvested in 2007 ranged between 0.4 and 0.6 g 100 g^{-1} of dry matter. This range of results followed grass pea samples between varieties with medium or higher ODAP content (Srivastava & Khokhar, 1996; Yan et al., 2006). The ODAP content was determined in grass pea tempeh and the reduction of ODAP in the range 64.5–86.5% was found. The final ODAP content in tempeh samples could be decreased not only by fermentation but also by mixing boiled grass pea with cereal raw material. Tempeh made from legumes combined with cereals contained very low level of lipids; the protein content depends on the amount of used cereals. Tempeh prepared only from legumes or from the mixture of legumes and rice (corn) is suitable for a gluten-free diet. The changes of α-galactosides during the tempeh fermentation were also followed; raffinose content dropped to 0–50% of the original level and verbascose and stachyose were totally removed.

CONCLUSIONS

The chosen varieties of legumes were added, in the amounts of 15–30%, into pastas and bakery products. The addition of legume flour and flakes increased the protein and fibre content and slightly decreased food energy. Tempeh prepared from the tested seeds was of an acceptable quality; in grass pea tempeh ODAP was partly removed beside α–galactosides

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