EFFECTS OF ENZYMES AND EXTRUDED WHEAT BRAN IN FIBRE–ENRICHED BREAD BAKING

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Abstract

Currently, increasing attention is given to enrichment of people's diet with dietary fibre. The aim of the present study was to improve the quality of fibre-enriched wheat bread by enzyme supplementation. The possible use of enzyme preparations of β-xylanase from *A.niger*, α-amylase from *A.oryzae* and glucoamylase from *A.niger* as bread improvers were tested in bread containing different amount (15–20 % of flour) of extruded wheat bran. Extruded bran was chosen for the positive nutritional and safety effects of the extrusion process. Extruded bran supplementation of wheat flour, in general, had pronounced effects on dough properties yielding higher water absorption and smaller extensibility in compare with those obtained without bran. The bran always contributed to a decrease of the bread volume and crumb porosity and changed the texture properties. Exploitation of enzymes considerably improved bread quality and prolonged shelf life. The tested multienzyme mix (β-xylanase, α-amylase and glucoamylase) was more efficient than individual β-xylanase in improving the bread quality. Enzyme addition allowed increasing the amount of bran up to 20 % without negative effects on bread acceptability.

Key words: wheat bread, extruded wheat bran, enzyme supplementation, dough properties, bread quality

Introduction

The importance of the dietary fibre is increasing due to the beneficial effects on the reduction of the cholesterol levels and the risk of colon cancer (Anderson, 1991; Tavani *et al.*, 2003). Health authorities, world-wide, recommend a decrease in the consumption of animal fats and proteins and an increase of cereal intake which is an important source of dietary fibre. Nevertheless, white bread is a commonly consumed type of bread. Therefore, the development of enriched bread with a higher dietary fibre content should be the best way to increase the fibre intake.

Bread can be enriched with dietary fibre, including bran, such as wheat (Sidhu *et al.*, 1999) and rye (Laurikainen *et al.*, 1998), β-glucans (Knuckles *et al.*, 1997), carob and pea fibres (Wang *et al.*, 2002). However the addition of fibres causes the neglected effect on the final bread quality. Bran supplementation usually weakens the structure and baking quality of wheat dough and decreases bread volume and elasticity of the crumb. The effect has been attributed to the dilution of gluten, which would affect the gas–holding capacity of the dough (Gomez *et al.*, 2003; Rosell *et al.*, 2006; Wang *et al.*, 2002). As the specific volume of bread is one of the important characteristics determining acceptability, different bran pre-treatment have been used to improve the volume of bread supplemented with bran. For example, washing the bran to remove harmful components, grinding the bran to obtain a smaller particle size, using various heat treatments to inactivate enzymes, or prefermentation of bran with yeast or with yeast and lactic acid bacteria have been successfully used to improve the quality of bread supplemented with bran (de Kock *et al.*, 1999; Salmenkallio-Marttila *et al.*, 2001). Also some of the negative effects of bran on gluten development can be compensated for by using of some additives such as gluten (Gan *et al.*, 1989) or baking enzymes (Laurikainen *et al.*, 1998; Shah *et al.*, 2006)

This study is dedicated to investigate the application of new sources of dietary fibre – extruded wheat bran to enriched wheat bread with a higher dietary fibre content. The beneficial effects of extrusion cooking on food safety and stability are well established in regard to inactivation of enzymes, some endogenous toxic compounds, and destruction of micro–organisms. The aim of the present work was to improve the quality of bran-enriched wheat bread by using carbohydrate degrading enzymes.

Materials and Methods

Commercial bakers' wheat flour (12.6% moisture, 12.4% protein, 28.5% wet gluten and 0.58% ash) was obtained from AB "Kauno grudai" (Lithuania). Extruded wheat bran (50.3% d.m. dietary fibre) produced using single-screw extruder was donated by a local flour mill Ustukiu malunas Ltd. (Lithuania). The enzyme preparations such as Bakezyme HSP6000 (β-xylanase from *A.niger*), Bakezyme P500 (α-amylase from *A.oryzae*), and Bakezyme AG800 (glucoamylase from *A.niger*) from DSM Food Specialties (The Netherlands) were chosen for the tests.

Dough characteristics. The effects of extruded bran and enzymes on dough rheology during mixing were determined by Brabender Farinograph (Brabender OHG, Duisburg, Germany) folowing the ISO 5530–1 (1993). All determinations were made at least in duplicate, and the average values were adopted.

Baking test. A straight dough breadmaking process was performed. Basic dough formula on 100 g flour basis consisted of salt (1.7 g), compressed yeast (1.5 g), and the amount of water required to reach a 500 FU of consistency. In the tested breads, the wheat flour was replaced by 15 and 20% of extruded bran. The effects of enzymes in breads with extruded bran were studied by adding β-xylanase (0.002 g 100 g^{-1} of flour) or multienzyme mix (0.002 g of β-xylanase , 0.0075 g of glucoamylase, and 0.0005 g of α–amylase of 100 g^{-1} of flour) to the dough. Each recipe mix was baked twice and three replicates were in each case taken for analyses.

Bread quality evaluation. Bread quality parameters included weigh, volume (determined by rapeseed displacement method [AACC Method 72–10, 1995]), specific volume, crumb porosity and texture. The crumb porosity was measured according to Lithuanian standard method LST 1442 (1996). Texture profile analysis (TPA) was performed using an Instron Universal Testing Machine Model 3343 (Instron Engineering Group, UK). Crumb slices of 1.3 cm were 40% compressed (compression rate 1 mm s^{-1}) and from the two bite force distance compression curve the texture parameters such as hardness, cohesiveness, springiness, gumminess and chewiness were derived (Armero and Collar, 1997).

Additionally acceptability test was carried out at the sensory laboratory of Food Institute of Kaunas University of Technology (Lithuania). A panel of 8 assessors was selected from the staff of the Food Institute according to ISO 8586–1 (1993). The overall acceptability of each sample was rated on a 150 mm hedonic line scale, where 0 means extreme dissatisfaction and 150 – extreme satisfaction.

Statistical analysis. Data obtained were analysed using statistical package SPSS for Windows (SPSS Ver.15.0, SPSS Inc., Il., USA, 2006). Significance of differences between control and treated samples was evaluated using Duncan's multiple range tests at a 5% level.

Results and Discussion

Influence of extruded bran and enzymes on dough properties. Extruded wheat bran suplementation (15–20 %) of wheat flour had pronounced effects on dough mixing behaviours measured by the farinograph (Table 1). Fibre addition mainly modified the water absorption. The 20% extruded bran increased the water absorption from 59.1 to 71.9 and decreased the dough softening from 88 to 59 FU. Similar effects on water absorption were observed when adding natural wheat bran or rye bran (Laurikainen *et al.*, 1998). Extruded bran addition did not modify the dough development time and stability, in opposition to the results reported by Laurikainen *et al.* (1998), who found a decrease of the stability when adding rye bran. The addition of β-xylanase decreased the water absorption of wheat dough with bran by 3%, approximately. The effect of β-xylanase on the other Farinograph characteristics was insignificant. Multienzyme mix had smaller effect on the degree of softening than that of the single β-xylanase used.

Table 1

Effect of extruded bran and enzymes on wheat dough mixing properties

Bread samples	Water absorption (%)	Dough development time (min)	Dough stability (min)	Degree of softening (FU)
Without bran	59.1±0.1	2.2±0.2	2.3±0.1	88±6.1
With 15 % bran	70.1±0.3	2.4±0.3	1.8±0.2	58±4.3
+ xylanase	67.2±0.2	2.0±0.7	2.0±0.1	57±5.2
With 20 % bran	71.9±0.3	2.5±0.4	1.9±0.4	59±3.1
+ xylanase	69.1±0.3	2.2±0.5	2.2±0.5	56±6.7
+ multienzyme mix	68.8±0.4	2.2±0.2	2.2±0.1	72±3.4

Influence of extruded bran and enzymes on bread quality. The effect of extruded bran supplementation on the bread quality characteristics is summarized in Fig. 1 and Fig. 2. The specific volume and crumb porosity always decreased as consequence of bran addition, which has been also reported by other authors (Knuckles *et al.*, 1997; Laurikainen *et al.*, 1998). The effect was more evident when levels of bran were increased from 15% to 20%. The 20% extruded bran reduced bread specific volume and crumb porosity by 31.4% and 7.2%, respectively, in compare with the control bread (Fig. 1). Carbohydrate degrading enzymes can be added to obtain larger bread volume and crumb porosity. The effect of multienzyme mix containing β-xylanase, glucoamylase and α-amylase was more notable than the effect of β-xylanase alone. In this case the specific volume of bread with 20% extruded bran increased by 44.4%, and crumb porosity by 6.8% in compare with bread without enzymes.

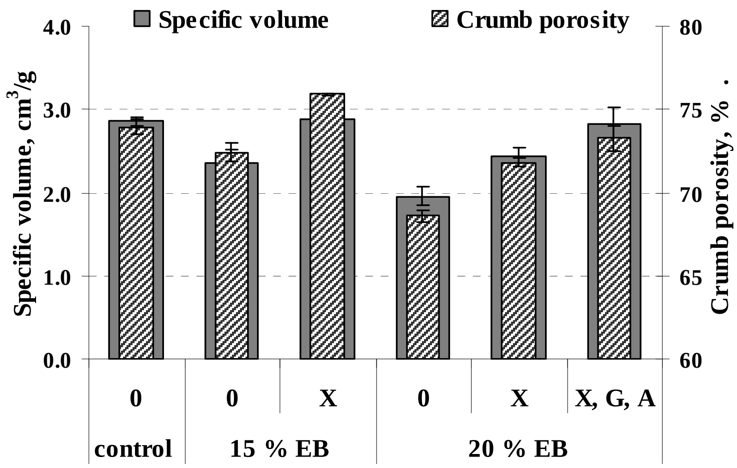

Figure 1. Effect of extruded bran (EB) and enzymes (X – β-xylanase, X, G, A – multienzyme mix, 0 – without enzymes) on bread quality parameters

Bread with extruded bran additions had significantly harder; less springy and cohesive crumb texture than the control bread (Fig. 2). The 20% extruded bran increased the crumb hardness by 2.3 times and decreased the springiness and cohesiveness by 45% and 57%, respectively, in compare with the control bread The changes in other texture parameters were not significantly different between the tested breads. The addition of enzymes modified texture parameters of wheat bread supplemented with bran. The bread made with β-xylanase as well as with multienzyme mix was rated less hard, but more cohesive than bread made without enzymes.

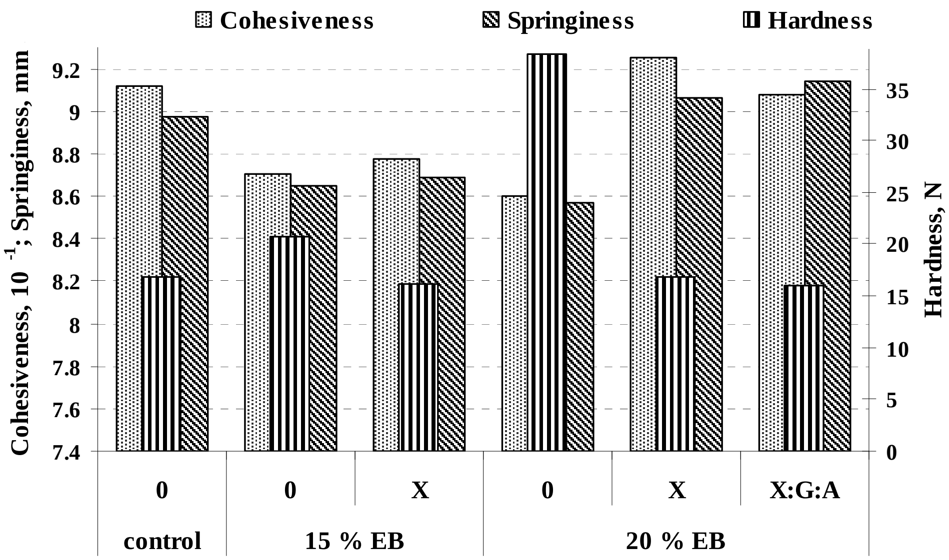

Figure 2. Effect of extruded bran (EB) and enzymes (X – β–xylanase, X,G,A – multienzyme mix, 0 – without enzymes) on bread crumb texture

Influence of extruded bran and enzymes on bread overall acceptability. Significant differences in acceptability were obtained with increasing the level of bran, which reduced the overall acceptability by 38% (Fig. 3). In general, panellists preferred bread without bran addition. Nevertheless, enzymes increased significantly the acceptability of bran supplemented bread. Panellists preferred bread with extruded bran and enzyme addition in compare with the control bread. Bread supplemented with 20% extruded bran and multienzyme mix obtained the highest score for acceptability.

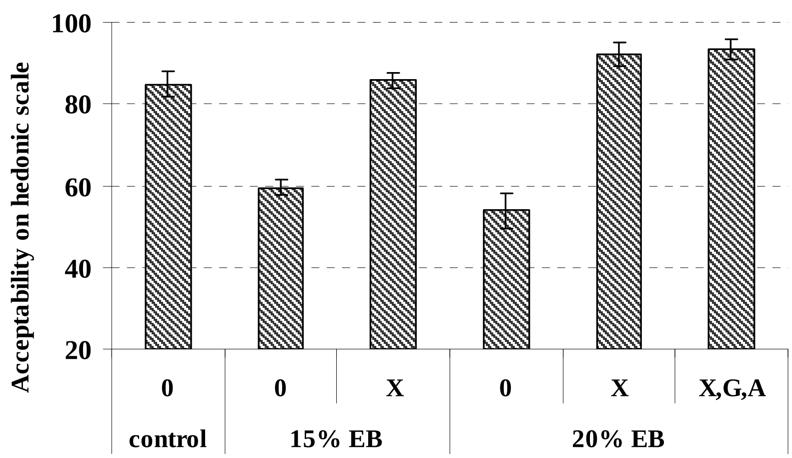

Figure 3. Effect of extruded bran (EB) and enzymes (X – xylanase, X,G,A – multienzyme mix, 0 – without enzymes) on bread overall acceptability

Conclusions

1. Extruded wheat bran supplementation (15–20%) of wheat flour had pronounced effects on dough properties yielding higher water absorption in compare with regular wheat flour dough.
2. The extruded bran decreased the wheat bread volume and crumb porosity and changed texture properties increasing the crumb hardness and decreasing the springiness and cohesiveness. The observed differences were more evident when levels of bran were increased from 15% to 20%.
3. Carbohydrate degrading enzymes can be added to improve quality of bread supplemented with bran. Multienzyme mix of β-xylanase , α–amylase and glucoamylase

showed better bread quality improving effect**s** than β-xylanase alone. Enzyme addition allowed increasing the amount of extruded bran till 20% without negative effect on the bread acceptability.

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