POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

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Pol. J. Food Nutr. Sci.
2007, Vol. 57, No. 2(A), pp. 151-155

INFLUENCE OF SELECTED PLANT FIBRES UPON PHYSICAL PROPERTIES OF BREAD DOUGH AND BREAD

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Key words: bakery half-products, plant fibre, rheological properties, texture

This paper presents results of a research into the influence of selected plant fibre (of different water solubility) upon physical properties of bread dough and bread. The effect of fibre addition upon rheological properties of bread dough and bread was tested using a rotational rheometer HAAKE RT20 with the measuring system plate-plate (HPP 20) and the test of the oscillation affected OCS. The influence of fibre upon final product texture was tested as well. For texture measurements a testing machine INSTRON4301 was used (penetration test). Based on the results obtained it was concluded that the addition of plant fibre had an influence upon rheological properties of dough and texture of the final product.

INTRODUCTION

At present, plant fibre becomes more and more popular and important component of food, demand for which is increased from the consumers' side [Wang, *et al*., 2002; Wierzbicka *et al*., 2003].

In Poland, the average consumption of plant fibre is approx. 15-20 g/day, at a recommended intake of 25-40 g/day [Hasik & Gawęcki, 2003]]. Such a low fibre consumption leads to many disorders. Enrichment of bakery products with fibre allows to increase the consumption of this component and leads to a decrease in energy content of these products [AACC, 2001; Mielcarz, 2004].

Actual definition prepared by AACC (American Association of Cereal Chemists) is as follows: "Plant fibre consists of eatable plant parts or non-starch carbohydrates, resistant to digestion and absorption in intestines, and which are subjected to a total or partial fermentation in large intestines. Fibre includes polysaccharides, oligosaccharides, lignin and plant additional substances. Due to an important role of fibre in rational nourishment, it is purposeful to enrich diet with this component [Abdul-Hamid & Siew Luan, 2000]. It can be obtained by addition of products rich in fibre such as cereals, brans and fibre preparations to the bread and bakery products. Fibre preparations are used as additives to the described products in order to decrease the energy value, increase bread volume and improve its texture [Asp, 1997; Thebaudin *et al.*, 1997].

Apart form health-promoting properties, fibre added to food products influences its physical and technological properties: it influences texture and consistency, decreases fat content, facilitates the formation of emulsions, facilitates water binding, prevents lumping and sticking, and changes product's colour.

The presence of fibre in a bakery product increases its nutritive value, but also influences its end quality. Therefore, it is necessary to test rheological properties of semi-prepared bakery products from wheat and rye flour, dosed in various relations, and to define the effect of fibre on texture of ready products and their sensory evaluation.

The purpose of this study was to determine the influence of plant fibre with a soluble fraction upon rheological properties of dough and bakery products.

MATERIALS AND METHODS

For all tests, mixed bread prepared from wheat flour type 750 and rye flour type 720 was used. The part of wheat flour in relation to the total mass of flour designed for baking was 50, 40 and 30%, while of rye flour, respectively, 50, 60 and 70%. The fibre added to flour was 5, 15 and 30% content in relation to the amount of flour.

The following fibres were used in the experiment: oat fibre with a soluble fraction (16%) and wheat fibre with a soluble fraction (16%).

The test dough was prepared from 500 g of flour, compressed yeasts, dry leaven, fibre and salt. Rheological tests were carried out on dough samples with a given content of wheat and rye flour and plant fibre. Bread was baked for 35 min at a temp. of 180°C. Texture measurements were carried out after moving bread to room temperature.

Rheological proprieties of dough were studied using a rotary rheometer RT 20 with the measuring system plate-plate

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(HPP 20) and the test of the oscillation affected OCS [Gomez *et al*., 2003]. The values of the following parameters were measured: storage modulus (G'(Pa)) and deformation (γ(-)). Each measurement was carried out in three replications. The results were as follows: measuring gap (GAP) – 3 mm, oscillation frequency – 1 Hz, stress– 600 Pa, measurement time – 180 s, temperature of measurement – 25°C, and sample mass – 2 g.

Instrumental measurements of the texture were carried out using a testing machine – Instron 4301, products were evaluated with the penetration test.

The test was carried out with a constant speed of penetrometer movements (50 mm/min). During penetration tests the following parameters were measured: hardness (N) – maximal penetration force and elasticity (mm)– movement of the maximal penetration force.

RESULTS AND DISCUSSION

Based on the results obtained is was concluded that the addition of plant fibre had an influence on rheological properties of dough and the texture of the ready product. At the first stage of research, determinations were carried out for the effect of fibre addition on changes in rheological properties of dough with a different percentage of wheat and rye flour (Figure 1).

An increase of storage modulus with the amount of added fibre was observed for particular samples prepared with different percentages of wheat and rye flour (Figures 1 and 2). Higher values of storage modulus were observed for dough with the addition of wheat fibre in comparison to oat fibre. The highest increase was observed for dough with flour proportion from 30% to 70%, *i.e*. from 80.52 kPa to 221.9 kPa.

Then, wheat flour percentage to rye flour percentage was found to affect changes in rheological structure of dough with different amounts of added fibre. The highest value of storage modulus (G') was reported for a dough sample prepared with the use of wheat and rye flour in a ratio of 30% to 70% with addition of oat fibre of 30% (vol/vol). The average value of this modulus was 80.52 kPa (Figure 3). A decrease in the amount of added oat fibre to 5% resulted in a decrease in storage modulus to 18.4 kPa for dough with flour proportion of 30% to 70%.

Similarly as in the case of oat fibre addition, the highest value of storage modulus (G') was observed for dough sample prepared with the use of wheat and rye flour at a

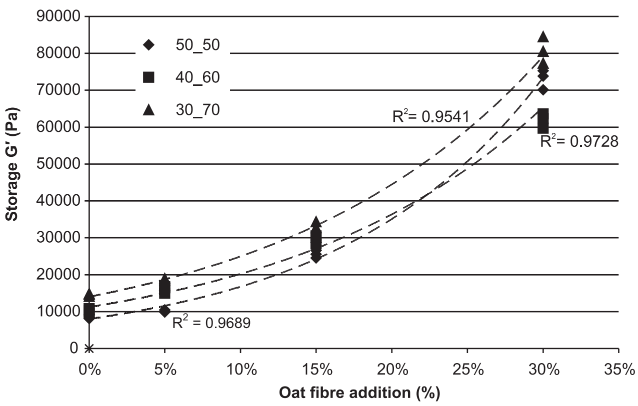

FIGURE 1. Changes in storage modulus (G') of adhesive-resilient structures represented by dough with different ratios of wheat and rye flour, depending on oat fibre addition.

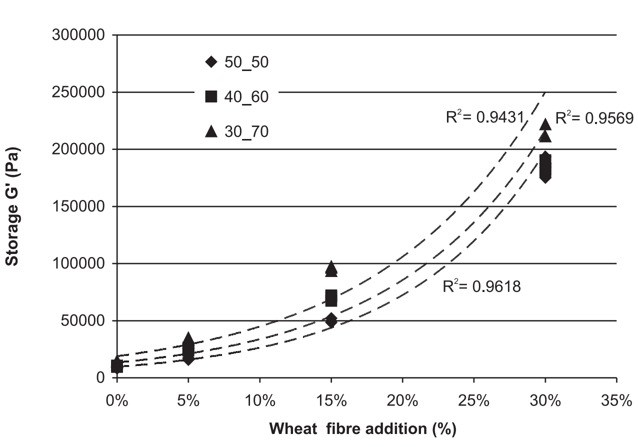

FIGURE 2. Changes in storage modulus (G') of adhesive-resilient structures represented by dough with different ratios of wheat and rye flour, depending on wheat fibre addition.

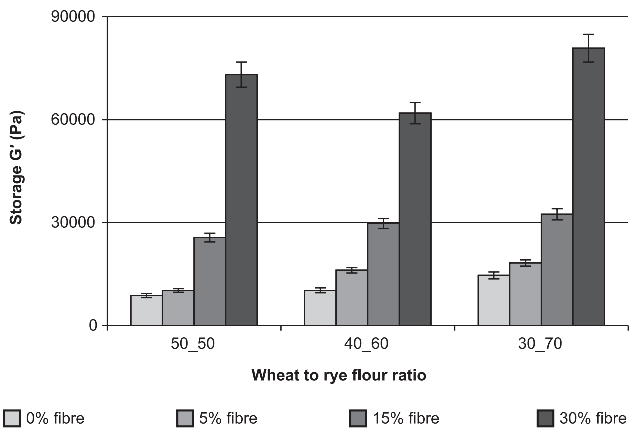

FIGURE 3. Changes in storage modulus (G') of adhesive-resilient structures represented by dough with different contents of oat fibre, depending on wheat to rye flour ratio.

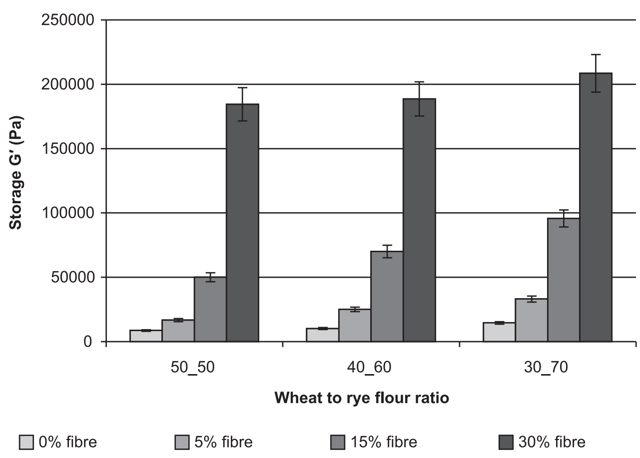

FIGURE 4. Changes in storage modulus (G') of adhesive-resilient structures represented by dough with different contents of wheat fibre, depending on wheat to rye flour ratio.

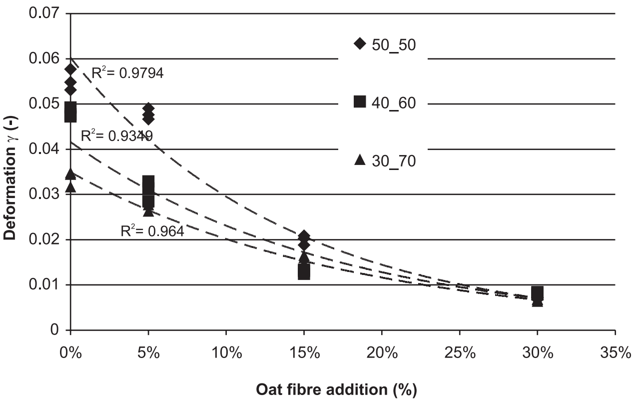

FIGURE 5. Changes in deformation γ (-) in dough with different ratios of wheat and rye flour, depending on oat fibre addition.

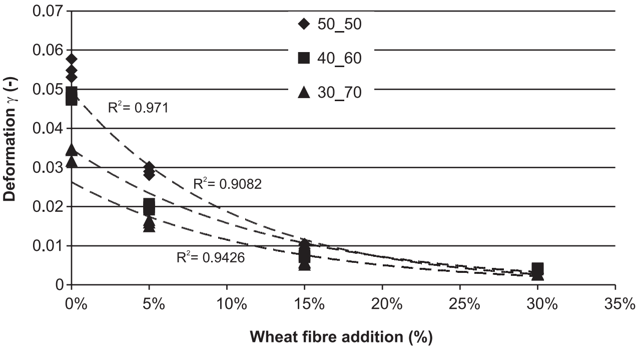

FIGURE 6. Changes in deformation γ (-) in dough with different ratios of wheat and rye flour, depending on wheat fibre addition.

ratio of 30% to 70% with the 30% addition of wheat fibre in relation to the amount of flour. The average value of this modulus was 221.9 kPa (Figure 4). The highest percentage decrease of this modulus was observed for dough with flour proportion of 50% to 50%. A decrease was observed in G' value from 184.4 kPa for wheat fibre content of 30% to 16.7 kPa for 5% fibre content.

Addition of oat and wheat fibre in dough resulted in a decrease of distortion values for each of the samples differing in the content of wheat and rye flour (Figures 5 and 6).

It was observed that the dough made from flour with the proportion of 50% to 50% (wheat flour to ray flour) with 5% addition of fibre was giving the highest values of deformation Figure 7). The value of this distortion was 0.0477. The greatest changes of distortion were observed in samples with flour content of 50% to 50%, *i.e.* from 0.0477 for 5% addition of oat fibre to 0.0071 for 30% addition of fibre. It is easy to observe that deformation values for 30% content of oat fibre in each type of dough resulted in a similar value of 0.0075.

The highest values of distortion (Figure 7) for dough with the addition of fibre was observed for a sample with 5% addition of wheat fibre with flour proportion 50% to 50%. The value of this distortion was 0.029. Addition of wheat fibre to dough resulted in a decrease of deformation values for each sample with different wheat and rye flour contents (Figure 8). It is worth noticing that distortion values for each type of dough with 30% content of wheat fibre resulted in a similar value of 0.003.

A decrease in distortion values was observed for dough with wheat fibre addition in comparison to dough with oat fibre addition. The greatest decrease was observed for dough with flour proportion from 30% to 70%, *i.e.* from 0.033 to 0.0027 for 30% fibre content.

The study showed a decrease in elasticity of bread with an increasing addition of oat fibre (Figure 9).

The smallest value of this parameter (6.23 mm) was observed for bread with flour proportion of 30% to 70% and fibre content of 30% in both cases (oat and wheat fibre addition).

The bread with wheat fibre addition showed a decrease in elasticity with decreasing amounts of added fibre during penetration tests. The highest value of elasticity (16.92 mm) was observed for bread with flour proportion from 40% to 60% and fibre content of 5% (Figure 10). It is worth emphasizing that the elasticity values for bread with oat fibre addition had higher values than those for bread with wheat fibre addition (Figure 9 and 10). This can be caused by a threefold higher water binding capacity of wheat fibre as compared to oat fibre.

For a bread with wheat fibre addition, the highest values were observed upon 30% fibre addition to all types of bread. The value of this parameter reached *ca*. 0.021 kN. Bread with 30% addition of wheat fibre showed higher hardness(by *ca.* 38%) than that with 30% addition of oat fibre (Figure 11).

A decrease in bread hardness was observed for bread with flour content of 50% to 50% and 30% to 70%, respectively to

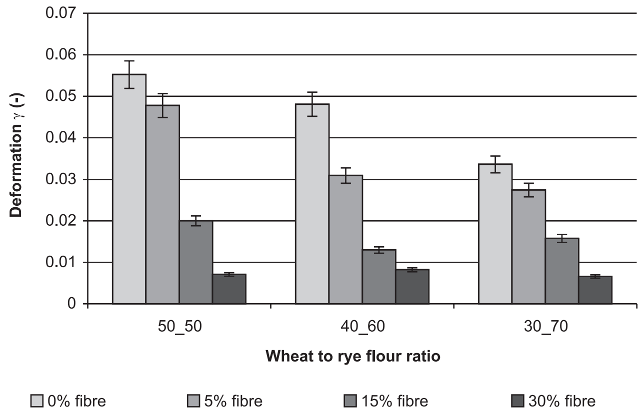

FIGURE 7. Changes in deformation γ (-) in dough with different oat fibre contents, depending on wheat to rye flour ratio.

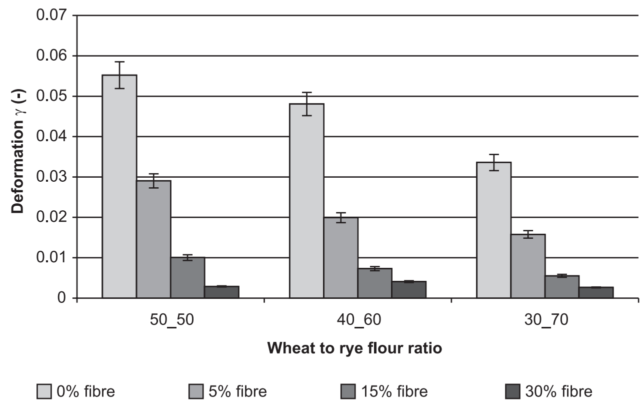

FIGURE 8. Changes in deformation γ (-) in dough with different wheat fibre contents, depending on wheat to rye flour ratio.

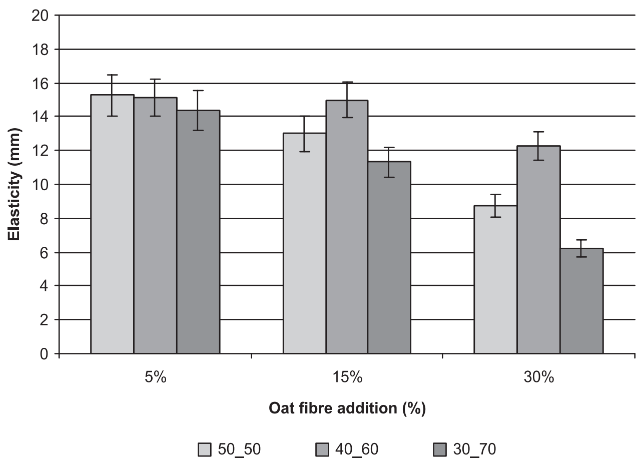

FIGURE 9. Changes of elasticity of wheat-rye bread depending on the addition of oat fibre with a soluble fraction.

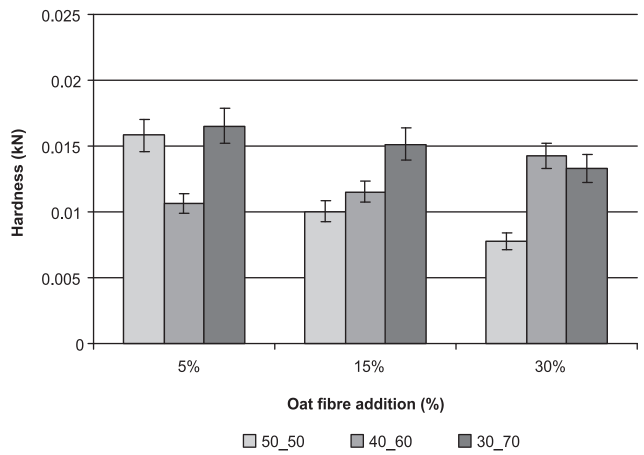

FIGURE 11. Changes in hardness of wheat-rye bread depending on the addition of oat fibre with a soluble fraction.

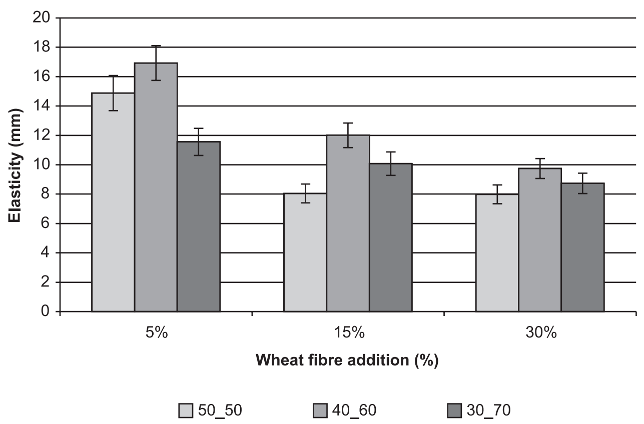

FIGURE 10. Changes of elasticity of wheat-rye bread depending on the addition of wheat fibre with a soluble fraction.

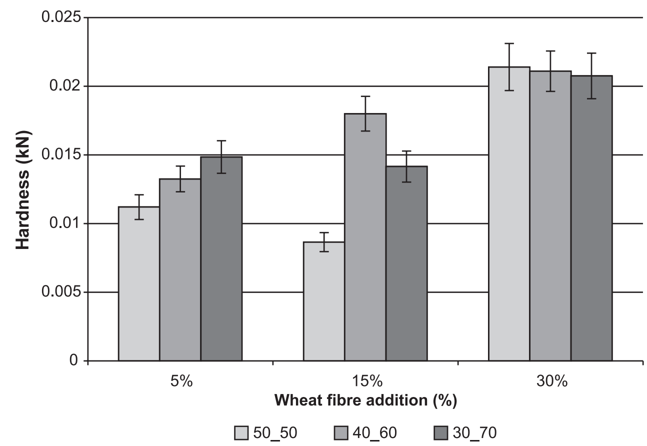

FIGURE 12. Changes in hardness of wheat-rye bread depending on the addition of wheat fibre with a soluble fraction.

the values of 0.0261 kN to 0.0078 kN and from 0.0187 kN to 0.0133 kN. In the case of bread with wheat and rye flour content of 40% to 60%, an increase in this parameter was observed from 0.01235 kN to 0.01425 kN (Figure 12).

CONCLUSIONS

1. Addition of fibre to bread results in a decrease in distortion, hence it has no destructive influence upon dough structure.

2. Elasticity and hardness of bread with wheat fibre addition was higher than that of bread with oat fibre addition.

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WPŁYW WYBRANYCH BŁONNIKÓW ROŚLINNYCH NA FIZYCZNE WŁAŚCIWOŚCI PÓŁPRODUKTÓW I PRODUKTÓW PIEKARSKICH

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W artykule prezentowane są wyniki badań wpływu wybranych błonników roślinnych (w różnym stopniu rozpuszczalnych w wodzie) na właściwości fizyczne półproduktów i końcowych produktów piekarskich. Badano wpływ dodatku błonnik różnego pochodzenia na właściwości reologiczne ciasta chlebowego wykorzystując reometr rotacyjny HAAKE RT20 z systemem pomiarowym płyta-płytka oraz metodą pomiarową OCS. Analizowano również wpływ błonnika różnego pochodzenia na teksturę i barwę pieczywa. Do pomiarów tekstury wykorzystano maszynę wytrzymałościową INSTRON4301 (test penetracji).