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Development and Application of Novel Additives in Bread-Making

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Abstract

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There is a great need for good quality and low-cost food since. A large proportion of the population does not have access to food with adequate quality from the nutritional point of view. This paper deals with the increasing of the nutritional value of widely consumed bread products. The development and incorporation of seven different food additives prepared with simple physical or physiological/biotechnological modifications have been studied in bread model. Bran with four different particle sizes and soy-based sprouted additive were applied in the experiment carried out in laboratory scale. These additives are rich in vitamins, bioactive components, dietary fibre and other health-beneficial compounds. A few of them have been selected for further examination. Aleurone-rich flour and wheat bran sourdough were supplemented to the selected additives and the experiment was carried out in industrial scale. The quality of the baked products was examined by analysing physical and sensory properties. The quality of the prepared bread products having limited amount of each additive does not decrease compared to the commercially available products, nevertheless their nutritional value increased. Four new bread products rich in dietary fibre, in vitamins and in minerals have been developed during the experiment carried out in industrial scale. They are relatively cheap comparing commercially available products so they are accessible for the population with low income. These new products can be labelled as fibre rich products and are applicable in several diets.

Keywords: aleurone-rich flour; bread-making; fermented bran; physical properties; sensory characterisation; soy-based sprouted additive; wheat bran

Food-products prepared from wheat flour are staple food worldwide. Although the traditions, favourable flavours and baking as well as cooking methods differ from country to country. Different kind of bread, pita bread, biscuits, pizza bases and similar products are the most abundantly consumed products worldwide. These products are cheap, thus they are consumed in a definitely high ratio in the low-income part of population. Due to the relative high carbohydrate intake the nutrient supply of the poor population is not well-balanced Gilland (2002). However, as products baked from flour can be enriched in many ways with other food components such as different seeds, pulses, vegetables, etc. (Dhinda *et al*. 2012; Kteniodaki & Gallagher 2012).

Food supply problems resulting from the growth of the world's population have already been recognized. The majority of people do not have access to good quality food from nutritional point of view either because of price or other reasons. As a re-

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sult of it the European Commission has launched a research program. EC funded a project to reach 'Low-cost technologies and traditional ingredients for the production of affordable, nutritionally correct food improving health in population groups at risk of poverty' with the acronym Chance (Bruce 2014). The aim has been to create new food additives and products with increased nutritional value but with still low price. The adding of useful nutrients had to be achieved without deteriorating the quality of the products compared to the quality of similar commercially available products (Bruce 2014; Glicerina *et al*. 2017).

This paper deals with the improvement of the nutrient-composition of widely consumed bread products. The dietary fibre, protein and mineral content of the products have been increased (Dhinda *et al*. 2012). Taking into consideration the nutrition habits of people especially the poor populations and their increased nutritional demand in low cost bread, seven different additives (four kinds of bran, a special milling product of grain industry (aleurone-rich flour), a fermented bran namely wheat bran sourdough and a soy-based sprouted additive (YASO) were used. The additives were used in different concentrations in order to reach the best nutritional composition without deteriorating the quality of the product. The appropriate evaluation of the quality during the development of the new products is important (Tuorila 2007), so the physical and organoleptic properties of the products were monitored.

MATERIAL AND METHODS

Material. The four kinds of bran differing in particle size and the wheat bran sourdough were provided by VTT Technical Research Centre (Finland Ltd., Finland). The sprouted soy-based additive (YASO) was prepared by Fitorex Ltd. (Hungary). A special milling product of wheat industry (aleurone-rich flour (ARF)) and the standard refined wheat flour (*Triticum aestivum* L.) was produced by Gyermelyi Zrt. (Hungary). These raw materials with outstanding nutritional properties and their composition, has been presented earlier Bartalné-Berceli *et al*. (2015).

Bread baking in laboratory scale. The baking procedure was carried out according to the ICC Standard Method No. 131 (1980). The parameters of the control product and the features of the baking process has been presented earlier Bartalné-Berceli *et al*. (2015).

Physical and sensory characterisation. Three physical properties (height, volume and weight) of the products were measured. The measurement methods are described in the standards (AACCI 2000; method 10-05.01. and MSZ 20501-3:1982v.).

To analyse the sensory properties of the product is based on a standard scoring evaluation method (MSZ ISO 6658:2007). For all typical attributions (colour and appearance, odour, texture and taste) possible defects have been presented and it has been declared what was expected from the products with respect to each attribution. So a method was developed with multiple factors to create a maximum score of 20 for a perfect bread. According to this scoring system the bread products are ranked into five quality categories. The scoring system has been done by trained sensory evaluators, number of panellists was 10.

Nutrient composition and beneficial properties of aleurone-rich flour, wheat bran and soy-based sprouted additive. A fractionation method has been developed resulting an aleurone layer rich milling fraction. The technology producing aleurone-rich flour has been developed at Germely Zrt., Hungary (Bagdi *et al*. 2014). Four kinds of wheat bran, differing in particle size (750; 400; 160 and 50 μm) were examined during incorporation in bread products. The nutritional value of soybean was increased by germination (Bartalné-Berceli *et al*. 2016) which was carried out according to patent of Fitorex (Fitorex Engineering and Trading Ltd. 2008). The composition of these additives has been presented in details earlier (Bartalné-Berceli *et al*. 2015).

Nutrient composition and beneficial properties of wheat bran sourdough (fermented bran). A novel, bioprocessed wheat bran has been produced at VTT Technical Research Centre of Finland Ltd. (Espoo, Finland). This bioprocessed bran can also be called 'fermented bran' or 'bran sourdough' which refers to the microbes they are helping processing. Wheat bran sourdough was bioprocessed with yeast and lactic acid bacteria (*Lactobacillus brevis* and *Kazahstania exigua*) further on with commercial carbohydrates enzyme mixtures. It is a slurry containing 80% of water and 20% of wheat bran with the average particle size of 400 μm. To produce fermented bran the ingredients (3.4 kg wheat bran, 13.4 kg water, and appropriate amount of microbial starter cultures and enzymes) were mixed and then incubated without continuous stirring. Finally the product was cooled down to 4°C. The bioprocessed bran was transferred to Hungary immediately because fermented bran is storable for

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up to one day if its temperature does not exceed 4°C. The enriched bread was baked within 24 h in industrial bakery (Lipóti Bakery, Hungary).

Composition of prepared bread products. A lab-scale experiment was carried out, with the aim to study the effect of additives using wide dosing levels where the following additives were used: four kinds of bran differing in particle size and YASO. These additives were used in 10, 30 and 50% addition i.e. 10, 30 and 50% replacement of wheat flour. Based on the above mentioned lab experiments additional measurements were carried out in industrial scale. Nutritionally valuable additives the ARF and the wheat bran sourdough have been used additionally in tests. The aleurone-rich flour was applied in 25 and in 50% addition in the baked bread. The fermented bran and selected bran fraction – based on the observations of the lab-scale experiment – were used in 14% addition and the soy-based sprouted additive was used in 30% addition.

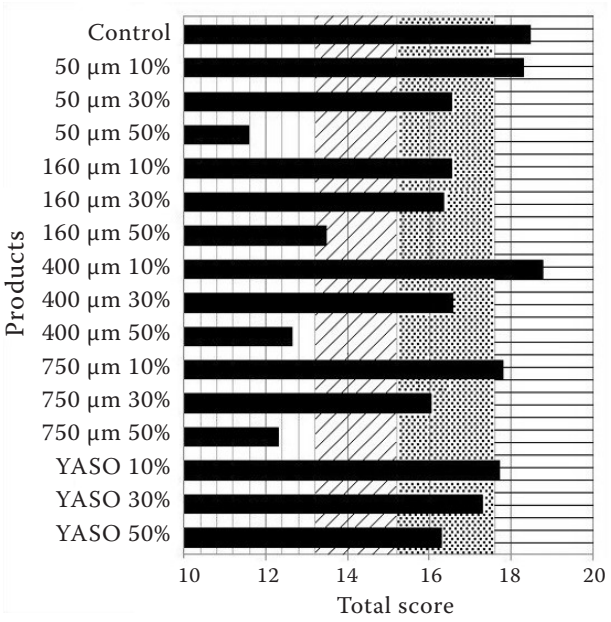

Figure 1. Sensory properties of bread enriched with different kinds of bran and with YASO

under 8 – inadequate; 13.1–8 – correspond; 15.1–13.2 – medium; 17.5–15.2 – good; 20–17.6 – excellent

RESULTS AND DISCUSSION

Sensory properties of the baked bread prepared in the experiment carried out in laboratory scale. The sensory characterisation was carried out with a scoring evaluation method. The maximum available score was 20. The scores of each bread are shown on Figure 1., with the relating quality categories.

A fifty percent addition of any kind of bran gave a week sensory quality, so these bread products are not recommended to consume. Each kind of bran using 30% addition in the products got a good but not an excellent classification from the sensory assessors. The utility and upgradeability of these loaves of bread should be taken into consideration. The best i.e. the excellent quality category has been reached by 10% addition of bran with 50, 400 and 750 µm particle size. The bread with 400 µm particle size achieved the best score. In case of the addition of YASO none of the applied dosage results in such a big quality reduction as bran addition results. The bread with 10% addition of YASO got an excellent classification from the sensory assessors. Bread containing 30% of YASO is in the good quality category. Moreover with its relatively high score point it almost reaches the excellent quality category. Bread containing 50% of YASO has a little lower quality but its score point is still in the middle of the range of the good quality category.

Physical properties of baked bread prepared in the experiment carried out in industrial scale. An addition of 14% of native bran with 400 µm particle size and 30% of addition of YASO have been chosen for further studies based on the results of the experiment realized in laboratory scale. In addition two new food additives having outstanding properties from nutritional point of view have been added to bread products. Fourteen percent of wheat bran sourdough was applied in the baked bread. The aleurone-rich flour was used in 25 and in 50%. Figure 2 shows the height, Figure 3 the volume and Figure 4 the weight data of the baked bread.

Among six baked loaves of bread, including the control bread the one with 50% addition of ARF has the lowest height. Its height is approximately the half of the height of the control bread. The low height refers to a dense texture which is a consequence of higher non-gluten protein and higher lipid level. The bread containing 14% sourdough is the highest among the enriched bread, its height almost reaches the height of the control bread. 25% addition of ARF or 14% addition of native bran results around the same height loss, while 30% addition of YASO results a bit bigger height loss.

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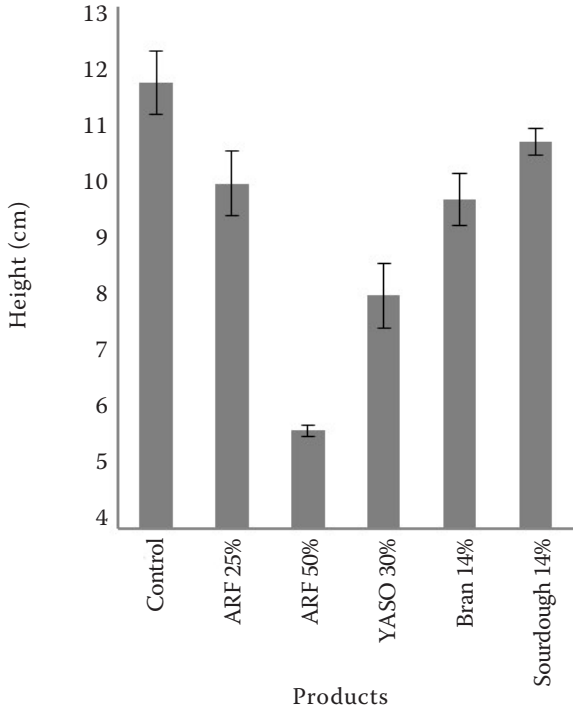

Figure 2. Height data of bread prepared in the experiment carried out in industrial scale

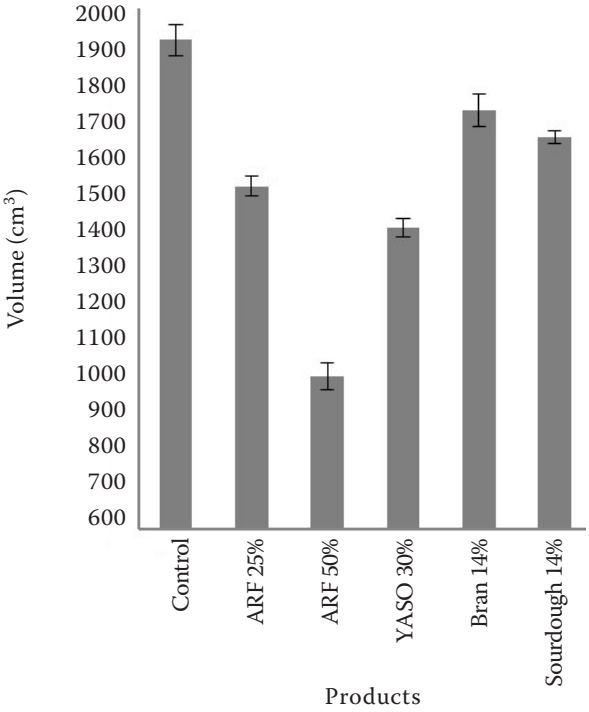

Figure 3. Volume data of bread prepared in the experiment carried out in industrial scale

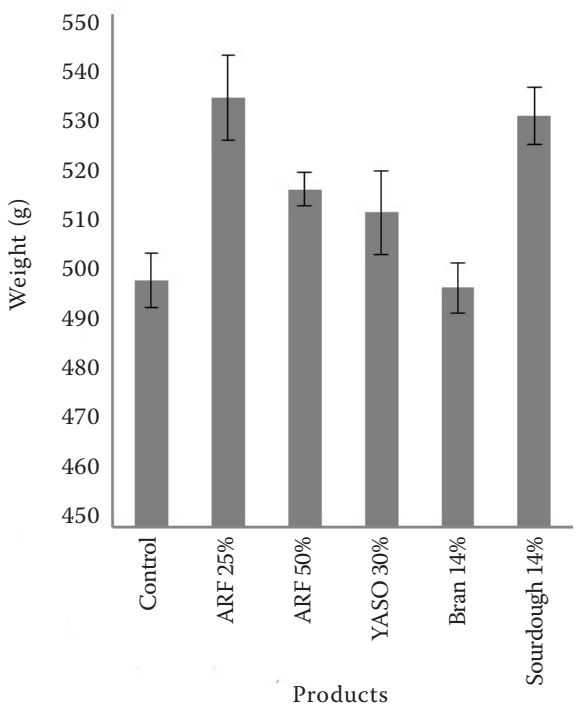

Figure 4. Weight data of bread prepared in the experiment carried out in industrial scale

In case of 50% addition of ARF the result is similar as it can be observed at the height data. The volume of this bread is approximately the half of the volume of the control bread which also indicates a really dense texture. The volumes of bread enriched with native bran and sourdough are 86–90% of the volume of the control bread. The volume of bread with adding 25% ARF is a bit smaller than these. The volume of the bread with adding 30% YASO is even smaller than the volume value of the bread with 25% ARF.

Different observations can be made with weight data of the products. Bread with 14% bran addition has almost the same height as the control bread has. However, all the other enriched loaves of bread have bigger weight. The weight of the loaves of bread containing 25% ARF and 14% sourdough have 106–108% of the weight of the control bread. The bread products with 50% ARF addition and with 30% YASO addition have just a bit higher weight value than the control bread has.

Sensory properties of the baked bread prepared in the experiment carried out in industrial scale. The sensory characterisation of the baked loaves of bread was carried out with the same scoring evaluation method as it was used previously. The sensory

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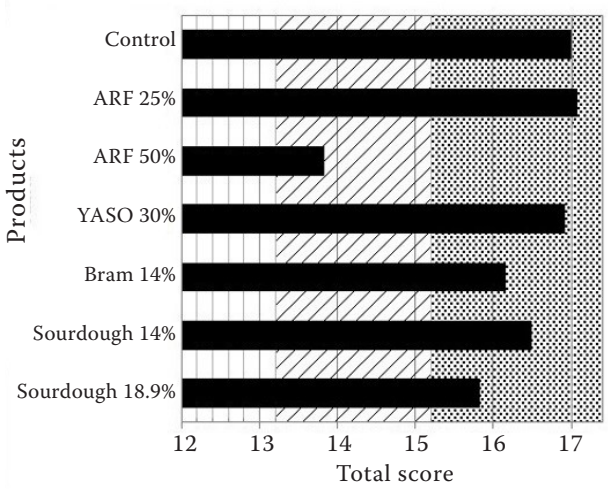

Figure 5. Sensory properties of bread prepared in industrial scale

under 8 – inadequate; 13.1–8 – correspond; 15.1–13.2 – medium; 17.5–15.2 – good; 20–17.6 – excellent

evaluation of bread products prepared in the industrial experiment can be seen on Figure 5.

All of the baked loaves of bread have reached a good quality category except the bread containing 50% aleuron-rich flour. Bread enriched with 50% ARF is not recommended to consume. The best sensory quality was reached by the loaves of bread enriched with 25% ARF and with 30% YASO. These two kinds of bread got almost the same score as the control bread got. Bread products containing native wheat bran and wheat bran sourdough have also good but slightly lower scores. The scores are about 95–97% of the score of the control bread.

Nutritional properties of the baked bread prepared in the experiment carried out in industrial scale. As it was presented in the materials and methods section the used additives are valuable from the nutritional point of view. The level of minerals and bioactive compounds are increased in the prepared bread products. Moreover they have higher protein and dietary fibre content compare to the control bread. Bran and sourdough addition results products rich in Cu, Fe, Mg, Mn, Zn and P and has higher levels of sterol, alkylresorcinol and arabinoxylan. Since wheat bran and sourdough are containing numerous mineral components and other bioactive compounds in significant amount (Poutanen *et al*. 2009; Stevenson *et al*. 2012). In case of ARF addition the amount of P, Mg, Mn and Fe and even the amount of phenolic acids, antioxidants, phytoestrogens and sterols has been increased owning to the beneficial composition of ARF (Bucsella *et al*. 2016). Products enriched with YASO have higher Ca, Mg, P and K levels over and above increased phytoestrogen levels due to high levels of these trace elements and phytoestrogens (Bartalné-Berceli *et al*. 2016). The dietary fibre and protein content of each prepared bread are calculated based on stoichiometry. These values are presented in Table 1.

Discussing the effects of additives on sensory and physical quality attributes in bread products using lab-scale and industrial-scale it can be stated that the

Table 1. Dietary fibre and protein content of bread prepared in industrial scale

	Dietary fiber		Protein	
Raw materials				
Flour		5.27		12.9
Bran		42.85		17.6
Sourdough		42.85		17.6
ARF		15.71		21.3
YASO		8.30		16.3
Enriched breads				
Control	1 × 5.27	5.27	1 × 12.9	12.9
ARF 25%	0.25 × 15.71 + 0.75 × 5.27	7.88	0.25 × 21.3 + 0.75 × 12.9	15.0
ARF 50%	0.5 × 15.71 + 0.5 × 5.27	10.49	0.5 × 21.3 + 0.5 × 12.9	17.1
YASO 30%	0.3 × 8.3 + 0.7 × 5.27	6.18	0.3 × 16.3 + 0.7 × 12.9	13.9
Bran 14%	0.14 × 42.85 + 0.86 × 5.27	10.53	0.14 × 17.6 + 0.86 × 12.9	13.6
Sourdough 14%	0.14 × 42.85 + 0.86 × 5.27	10.53	0.14 × 17.6 + 0.86 × 12.9	13.6

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selected levels of addition (refined bran 14%, ARF 25%, YASO 30% and sourdough 14% respectively) did not negatively influenced the sensory quality while the elevated dietary fibre and protein content and bioactive components resulted an improvement in the nutritional quality.

In case of addition of refined bran and ARF the substitution of wheat flour resulted in a significant reduction in production costs.

CONCLUSIONS

The main aim of this paper was to enhance the nutritional value of widely consumed bread products. Novel, value added products were developed with improved nutritional value without reducing the quality by studying the incorporation of seven different food additives in bread. Bran with 400 μm particle size in10% dosage and soy-based sprouted additive in 30% dosage were selected as optimum levels of addition. In industrial scale experiment two more novel food additives rich in vitamins and other health-beneficial compounds were studied (aleurone-rich flour and wheat bran sourdough). The composition of bread products should meet the requirements for labelling them as fibre rich products. Thus four new bread products have been developed which are rich in dietary fibre, in vitamins and in minerals. The protein content increased with approximately 0.5% and the dietary fibre content increased more than 5% in the enriched loaves of bread. Reduced cost bread products having good quality were produced. Consumers will accept them and they are advantageous for population having low income. According to the beneficial composition of novel additives they can be used in several diets. The novel additives can be applied successfully in several other bakery products based on wheat or on other cereal.

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