Bread Quality Improvement with Special Novel Additives

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***Abstract*—**Presently a significant portion of the Earth's population does not have access to healthy food. Either because they cannot afford it or because they do not know which one are they. The aim of the VII th Framework Chance project (Nr. 266331) supported by the European Union has been to develop relatively cheap food with favourable nutritional value and it should have acceptable quality for consumers. As one task of the project we manufactured bread products as a basic food. We examined the enrichment of bread products with four kinds of bran, with a special milling product of grain industry (aleurone-rich flour) and with a soy-based sprouted additive. The applied concentration of the six mentioned additives has been optimized and the physical properties of the bread products were monitored. The weight/density of the enriched breads increased a bit, however the volume and height decreased slightly compared to the corresponding data of the control bread. The optimized composition of the final product is favourably affected by these additives having highly preferred composition from nutritional point of view.

***Keywords*—**Aleurone-rich flour, Brans, Bread products, Sprouted soybean, YASO.

I. Introduction

DUE to the growing population of the World and due to the modern, accelerated life style more attention should be paid to sufficient food supply. It is necessary to raise the number and variety of healthy and affordable food products. Besides the affordable price a healthier product has to provide with acceptable quality as well. Within the frame of the EC funded project "CHANCE - Low cost technologies and traditional ingredients for the production of affordable, nutritionally correct foods improving health in population groups at risk of poverty" new, outstanding nutritional composition products have been developed meeting the mentioned requirements [1].

Although there are nations typically with high bread consumption, annually plenty of bread and bread products are consumed worldwide. According to a survey in 2010 the average consumption in the EU countries was 50 kg of bread per person per year. This number can vary slightly over the years but significant changes are not expected since bread is eaten in nearly every household [2]. Our aim was to enhance the nutrition composition of the widely consumed bread products. Thus we increased the nutritional value of bread with incorporation of different additives.

As the healthy eating habits in the developed countries are getting more popular the customers are seeking more and more the nutritionally favourable products instead of the conventional ones. On the other hand many people are living in poor financial circumstances and looking for affordable, nutritionally sufficient, healthy products. In accordance with these requirements the levels of dietary fibre, protein and mineral content of bread products have been increased. Six different additives (four kinds of bran, a special milling product of grain industry (aleurone-rich flour) and a soy-based sprouted additive) were used in different concentrations to reach the most valuable nutritional composition of breads without deteriorating the quality of the product.

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II. Materials and Methods

A. Materials

The four kinds of bran differing in particle size were provided by VTT Technical Research Centre of Finland Ltd., Finland. 50; 160; 400 and 750 µm were the particle sizes of the used brans. The special milling product of wheat industry (aleurone fraction) was prepared by Gyermelyi Zrt., Hungary. The sprouted soy-based additive was produced by Fitorex Ltd., Hungary. In breadmaking the used wheat flour was provided by Gyermelyi Zrt., Hungary. It meets the requirements of Codex Alimentarius Hungaricus [3]. The flour is commercially available its ash content is 0.61-0.88% of dry matter, acidity is at most 3.0, moisture content is at most 15.0% and wet gluten content is at least 28%. The particle size distribution of the wheat flour corresponds to the regulation, namely 100% of the particles pass throw 315µm and at least 95% of the particles pass throw 250µm size. The other used ingredients (salt, sugar and yeast) were obtained in commercial quality.

B. Bread Baking

The baking procedure was carried out according to the ICC Standard Method 131 with slight modification. The standard was adapted to our circumstances in the laboratory. The standard procedure was designed to highlight the differences among the different types of flour. Six additives were used in different concentrations in the bread products. The control product is made of 1kg wheat flour, 25g fresh yeast, 15g salt and 18.6g sugar. The homogenous dough was ensured with a mixing/kneading step, carried out with a Kitchen Aid Professional Mixer (Model 5KPM5, St. Joseph, Michigan, USA) equipped with a flat beater, using a mixing speed of 84rpm (speed 2) and a mixing time of 5min. After mixing the dough was leavened for 30min at 31°C. Then, the dough was divided into four portions and formed into loafs. After moulding the dough was leavened again for 50min at 31°C. Finally, the bread was baked for 30min at a temperature of 210°C in an electrical oven (Model Minimat 2 IS 500 links, Wiesheu Wolfen Gmbh, Germany). After cooling down samples were stored in sealed plastic pots at room temperature until analysing.

C. Physical Characterization

Three physical properties of the products have been measured. These physical parameters are height, volume and weight data of the breads. Three parallel measurements were done in each case. The measurement of volume has been done by using mustard seed on the principle of displacement.

III. Results and Discussion

A. Nutritional Composition and Beneficial Properties of Wheat Bran

Wheat bran is produced in a significant amount as by-product of milling during the production of refined grains. It is obtained from the outer layers of cereal grain. The bran fractions consist of the pericarp, seed coat, nucellar epidermis and aleurone layers. Bran is particularly rich in dietary fibre, proteins and nutritional molecules [4]. Wheat bran contains 46% non-starch polysaccharides mainly arabinoxylan, cellulose and beta-glucan. The concentration of soluble fibre in wheat is low compared to other cereals. Bran is a good source of essential fatty acids, minerals and vitamins. Additionally it contains antioxidant substances such as phenolic compounds and alkylresorcinols [5]. It has higher antioxidant activity than other milled fractions [6]. Wheat bran has several health benefits: it promotes the prevention of diseases such as colon and breast cancers, cardiovascular disease, obesity and gastrointestinal diseases. These beneficial properties are due to the nutritional composition of bran and due to its fibre content which causes mechanical effects mainly in the gastrointestinal tract [5]. Some research shows that the consumption of bran in case of type 2 diabetes mellitus reduces the occurrence of cardiovascular diseases and mortality [7]. Although bran can negatively alter food quality it is worth to deal with its use as food additive duo to its high nutritional value.

Four kinds of wheat bran differ in particle size have been incorporated in bread products. 750; 400; 160 and 50 µm were the applied particle sizes. The composition of brans is summarized in Table I. The moisture content of the brans increased with growing particle size. The total fat and energy content decreased with the growing particle size as well as the protein, ash, dietary fibre, soluble fibre fraction and insoluble fibre fraction increased slightly.

The addition of bran can influence protein functionality and water absorption capacities of the dough. The appearance and the physical properties of the product may differ depending on the particle size. The dosage of all kinds of bran has been examined in three different concentrations (10; 30 and 50%).

TABLE I
Composition of Brans with Four Particle Sizes

Constituent	750µm bran	400µm bran	160µm bran	50µm bran
moisture [m/m%]	11.9	10.5	8.6	6.6
protein [m/m%]	17.5	17.6	17.8	18.3
total fat [m/m%]	3.8	3.9	4.8	5.3
crude fibre [m/m%]	19.3	21.2	18.6	17.9
ash [m/m%]	5.3	5.5	5.6	5.6
dietary fibre [m/m%]	42.3	42.9	43.2	45.4
soluble fibre fraction [m/m%]	2.4	2.3	2.8	3.2
insoluble fibre fraction [m/m%]	39.9	40.6	40.4	42.2
energy content [kJ/100g product]	725.9	707.5	765.0	793.1

B. Nutritional Composition and Beneficial Properties of Soy-based Sprouted Additive

The widely grown soybean has an outstanding composition from nutritional point of view. Its protein content is high and its carbohydrate content is low compared to the other legumes. In details the mature soybean consists of approximately 38% protein, 30% carbohydrate and 18% high quality oil. Soybean is a complete protein source; its essential amino acid content meets the human demands. In addition it is reach in vitamins, in minerals and in bioactive components and has high polyunsaturated fatty acid content [8].

The nutritional value of soybean can be effectively increased by a natural, holistic biological process by germination. In the early phase of germination (0-48h) the release of the reserved nutrient starts. Sprouted seeds have a higher nutritional value than the mature seeds. They contain nutrients in an easily accessible and easily processed form for the human body. A further advantage of germination is that due to the degradation processes the harmful components of seeds are also partly degraded. They are allergens and the anti-nutritive substances, such as enzyme inhibitors and stachyose [9].

A unique, high quality raw material/ food/ additive has been produced with short-term (48h) germination of soybean. The strictly controlled germination process led to a product that is a source of highly digestible complete protein and a good source of dietary fibre, omega-3 and omega-6 fatty acids combined with no cholesterol and low carbohydrate content [10]. The brand product under the name of YASO [9] is suitable to increase the variety of healthy food products. Table II shows its nutritional composition.

YASO has already been used as additive in several types of food [10]. Considering its beneficial properties we incorporated YASO into breads in three different concentrations (10; 30 and 50%).

C. Nutritional Composition and Beneficial Properties of Aleurone-Rich Flour

It is well known that the nutritionally outstanding valuable components of the whole-grain can be found partly in the germ and in the outer layers of the grain. As the utilization of these grain constituents have end-product with disliked quality, therefore several researchers are looking for new methods to take advantage of the valuable components without decrease the product quality. The most valuable parts of wheat are in the aleurone layer and in the subaleurone cells since they contain high amount of bioactive components and proteins [11], [12]. Therefore a fractionation method have been developed resulting in an aleurone layer rich milling fraction. The technology producing aleurone-rich flour (ARF) has been developed at Germely Zrt., Hungary [13].

The aleurone layer differs in composition from the other parts of wheat bran thus its contribution to product properties is also different. The comparison of the composition of aleurone-rich flour to the composition of three commercially available wheat flours can be seen in Table III. The aleurone-rich flour has extremely high protein, dietary fibre and ash content and its water absorption capacity is also outstanding. Researcher [13] studied the incorporation of ARF in dry semolina egg pasta matrix and examined its available carbohydrate content. In addition to other advantageous properties the available carbohydrate content is much lower in the new product compared to the control one. They found that the particle size distribution of the aleurone-rich flour is similar to the conventional wheat flour which facilitates the processing operations. The main carbohydrates of the aleurone layer are pentosans, mostly arabinoxylans in contrast to the other parts of the bran which contains mainly cellulose [14]. This difference can led to the difference effect on rheological properties of wheat dough in ARF and in other fibre-rich milling products. Namely arabinoxylans are able to interact with the gluten system thus it is involved in the construction of dough [13]. As a new nutritionally valuable component we examined its effect to our bread product using it in two different concentrations (25 and 50%).

TABLE II
COMPOSITION OF YASO

moisture [m/m%]	62.4	minerals [m/m%]	
protein [m/m%]	16.3	calcium [m/m%]	0.09
total fat [m/m%]	8.7	magnesium [m/m%]	0.08
from which ω-3, ω-6 [m/m%]	5.7	phosphorus [m/m%]	0.19
dietary fibre [m/m%]	8.3	potassium [m/m%]	0.26
carbohydrates [m/m%]	2.9	sodium [m/m%]	0.07
		vitamin C [μg/g]	140
		vitamin E [μg/g]	32
		vitamin B3 [μg/g]	5.1

TABLE III
COMPOSITION OF ALEURONE-RICH FLOUR AND THREE COMMERCIAL WHEAT FLOURS

Constituent	ARF	BL 55	BL 80	BL 112
Protein [m/m%]	21.3	11.8	12.9	15.8
Ash [m/m%]	3.0	0.4	0.7	1.3
Dietary fibre [m/m%]	15.7	5.3	5.3	4.2
Soluble fibre fraction [m/m%]	2.0	1.9	1.7	2.7
Water absorption [%]	71.0	57.0	59.0	63.0

D. Composition of the Prepared Bread Products

Wheat brans with four different particle sizes and YASO were added in three different concentrations to the prepared breads. These concentrations were 10; 30 and 50% substitution of the wheat flour. The aleurone-rich flour was used in two different concentrations, namely in 25 and 50% addition.

E. Physical Properties of the Baked Breads

In case of the breads enriched with different kinds of bran and with soy-based sprouted additive the height and volume values of the products were measured. Fig. 1 shows the height data, Fig. 2 the volume data of the prepared products.

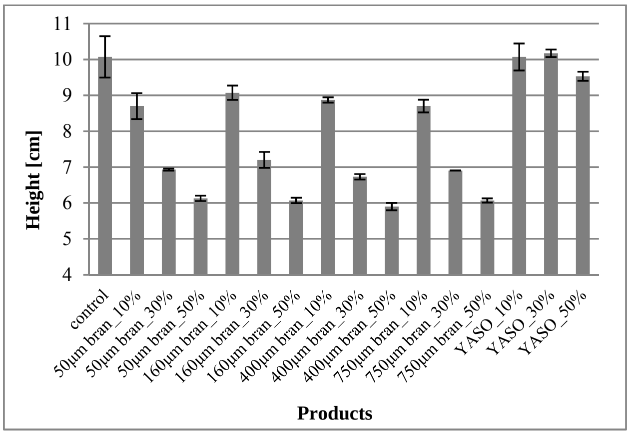

Fig. 1 Height data of breads enriched with different kinds of bran and with YASO

It can be stated that in case of breads containing brans as the concentration of brans are increasing the height of the breads are decreasing. With 10% addition of brans with different particle sizes the height data approaches the height of the control bread but none of them reaches it. Bread products containing soy-based sprouted additive (YASO) have a different behaviour. About the same height of the product is reached by 10; 30 and 50 percent dosage, compared to the control bread. Just the height of the bread with 50% addition of YASO decreased slightly.

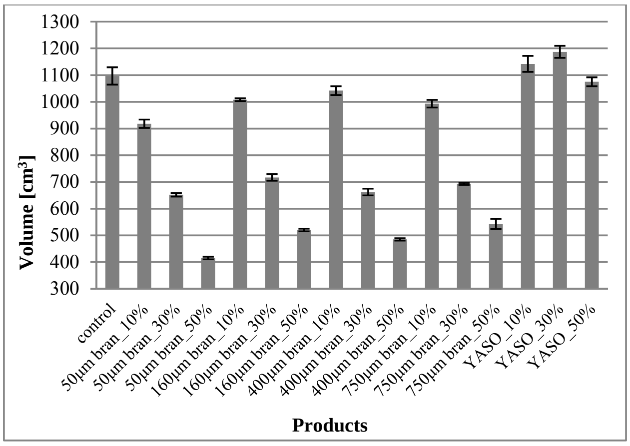

Fig. 2 Volume data of breads enriched with different kinds of bran and with YASO

The effect of the used additives in different concentrations to the volume data are similar as what we observed at the height data. The addition of brans and YASO resulted in different volume data. Increasing the concentration of each kind of bran reduces the volume of the bread products. In case of 10% addition of bran the 400μm particle size bran gave the smallest decrease in the volume. At 10 and 30 percent addition of YASO a slight increase can be observed compared to the control product. In fact 10 and 50 percent addition of YASO has no significant effect on the volume values of the bread products, only 30% addition of soy-based sprouted additive increase significantly the volume of breads.

In case of the breads enriched with aleurone-rich fraction (ARF) three physical properties have been measured. This additive was used in 25 and 50% concentrations so these two breads were compared with a control one. Fig. 3 shows the height data, Fig. 4 the volume data and Fig. 5 the weight data of the prepared products.

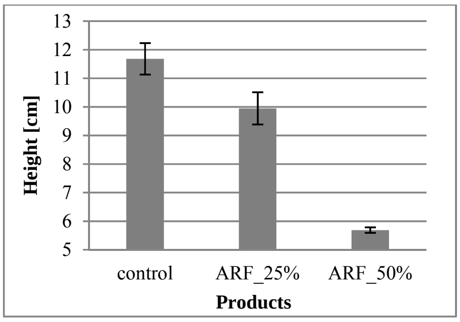

Fig. 3 Height data of breads enriched with aleurone-rich flour (ARF)

Addition of aleurone-rich flour affects the height of the end-product. 25% addition results almost 15 percent decrease in the height compared to the control one whereas 50% addition results circa 50 percent decrease in the height.

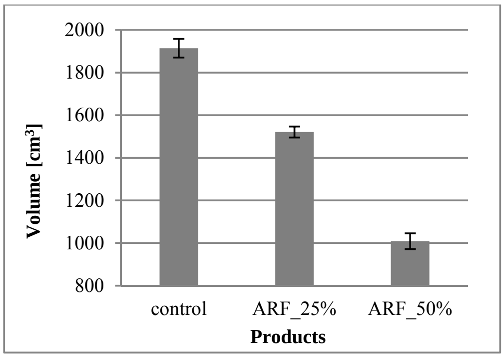

Fig. 4 Volume data of breads enriched with aleurone-rich flour (ARF)

The effect of the ARF enriched breads to the volume values is similar to the height values. As the concentration of added ARF is growing the volume of the baked breads is continuously decreasing.

The weight values of the breads are growing with the addition of aleurone-rich flour. Both the 25 and 50 percent additions resulted in higher weight values compared to the weight value of the control bread. 25% addition of ARF led to a 7.2 percent increase whereas 50% addition led only to 3.6 percent increase in weight.

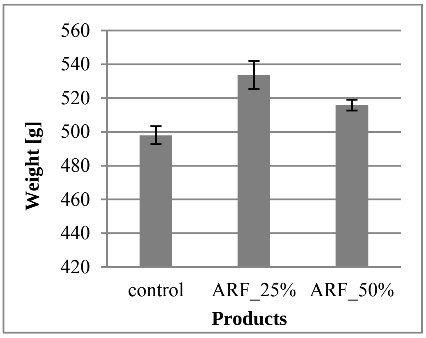

Fig. 5 Weight data of breads enriched with aleurone-rich flour (ARF)

IV. Conclusion

The effects of six different additives using in different concentrations to the physical properties of bread products have been examined. Results confirmed that the cereal based and soy-based novel additive with low price can improve the composition (higher protein content) and nutritional quality (higher dietary fibre content) of bread products without significant reduction of sensory quality. Bread enriched with different particle size brans are smaller in height and smaller in volume compared to the corresponding data of the control bread. Among the bran containing breads the bread with 400μm particle size using 10% addition has the best quality. Breads enriched with YASO have approximately the same height and a bit bigger volume compare to the control bread. Considering the effect of the additive on the physical properties of the product, YASO can be used in 30 or even in 50 percent addition in breads. Breads enriched with aleurone-rich flour are smaller in height and smaller in volume but a bit bigger in weight compared to the corresponding data of the control bread. According to these measurements maximum 25 percent addition of ARF can be recommended. The concentrations which were selected as the best ones do not reduce significantly the properties of the breads in case of certain additives. In subsequent experiments we are planning to examine in details the sensory properties of the new products and to realize the experiment in industrial scale.

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