CHEMICAL COMPOSITION EVALUATION OF SOME FLOUR MIXTURES WITH HIGH NUTRITIONAL VALUE

Stoin Daniela, Jianu Calin, Velciov Ariana – Bianca, Negrea Monica, Pintilie Sofia, Cozma Antoanela, Trasca Teodor

University of Agricultural Sciences and Veterinary Medicine of Banat "King Mihai I of Romania" Timisoara
Faculty of Food Processing Technology Food Science Department 300645, Timisoara, Calea Aradului, nr. 119, Roumania
author's email address: danielastoin@yahoo.com

Abstract
Cereals, fruits and vegetables have interesting nutritional properties and their inclusion in the diet is encouraged, their incorporation in bakery products could be a good way to increase consumption. In this study, the influence of the partial replacement of wheat flour (WF) with four types of flour: rye flour (RF), whole rye flour (WRF), quinoa flour (QF), buckwheat flour (BF) and goji fruit GFr) in eight mixtures obtained therefrom, was analyzed. The wheat flour was blended with rye flour, whole rye flour, quinoa flour, buckwheat flour and goji fruit in the ratios of 25:25:25:25 and 25:50:25. The studied samples were subjected to the following analyzes: determination of moisture, protein content, ash content, fat content, fiber content and total carbohydrate content. The resulting mixtures had high protein content (12.35% at M7 and 13.30% at M2), fiber (4.11% at M5 and 7.76% at M4), ash (1.79% at M8 and 2.15% at M1) fat (1.63% at M8 and 3.57% at M1) and low carbohydrates (62.35% at M2 and 65.68% at M7) and moisture ranged between 11.20% at M7 and 12.37% at M2. This study determined the optimum proportions to form these high nutritional flour mixtures. Centralizing the data obtained in this study, the high nutrient intake of the analyzed mixtures can be seen, and on the basis of these, we can recommend their use on the industrial scale in the recipes for the production of finely produced products with superior nutritional value.

Introduction
In recent decades, there has been growing concern about diversification in the production and renewal of the range of products in the food industry and an increase in the consumption of high nutritional food by the population. Obtaining foods with high nutritional value means either restoring the natural concentration of the ingredients or supplementing with nutrients above the natural concentration of the product [1]. Food pyramid is a graphical representation of nutritional recommendations, quantities and types of foods to be consumed daily in order to maintain health and reduce the risk of developing various dietary diseases [1, 2]. Indications are expressed in portions of food, whose daily consumption will provide all the essential nutrients. Cereals, vegetables and fruits are best represented in the food pyramid as the basis of balanced nutrition, calling them the "basis" for proper nutrition and health, noting that they can reduce the risk of chronic disease [2].
In this context, the importance of rye flour, quinoa and buckwheat derives from their complex chemical composition, implicitly from their food value, but also from the fact that in some countries they are considered basic foods [3, 4]. High content in proteins, some essential amino acids and mineral substances of pseudo-cereals leads to improvement of the nutritional

composition of the products obtained after their processing and of their food value, respectively [5, 6].
Goji fruits have the highest concentration of antioxidants, they have a high content of vitamins, minerals, polysaccharides, amino acids, essential oils that strengthen the immune system and keep the body healthy [7]. Starting from the described premises, this work aimed at optimizing some blends of high nutritional flours.

Experimental

Materials

Flours and goji fruits analyzed in this study have been purchased from hypermarkets and specialized stores.

Steps in the preparation of flour mixtures

In determining the proportion of each flour assortment that formed a mixture, was taken account of both the physical and chemical characteristics of these flours. For example, because rye flour, buckwheat flour and quinoa flour are gluten-free, to ensure the formation of the three-dimensional gluten skeleton of the dough, 25% wheat flour has been added. In the formation of the 8 mixtures, rye flour, whole rye flour and pseudocereal flour (buckwheat and quinoa flour) were used, as it is known that these flour assortments have a high nutritional value, being rich in essential amino acids, antioxidants, minerals and vitamins [3, 4, 5]. It is worth mentioning that out of the 8 mixtures, 4 of them contain only mixed flour according to the established proportions (25WF:50RF:25QF; 25WF:50WRF:25QF; 25WF:50RF:25BF; 25WF:25WRF:25BF) and the other 4 blends, contain 25% goji fruit beside the established flour mixtures (25WF:25RF:25QF:25GFr; 25WF:25WRF:25QF:25GFr; 25WF:25RF:25BF:25GFr; 25WF:25WRF:25BF:25 GFr). Goji fruit has been added in a proportion of 25%, taking into consideration that goji fruit has a high nutritional value due to the significant content of antioxidants, vitamins and minerals [7].

Analytical procedures

Proximate composition of flours, flour mixtures and goji fruit

For determining the average chemical composition of flours, flour mixtures and goji fruit, respectively, the following chemical characteristics were determined: moisture, acidity, fat content, ash content, fiber content and carbohydrate content- according to standard method A.O.A.C. 1995 [8] and protein content by the Kjeldahl method- according to standard method A.A.C.C. 2000, No. 46-10 [9]. All determinations were performed in triplicate, calculating their arithmetic mean of three separate determinations. The data were statistically analyzed using the program Microsoft Excel.

Results and discussion

The results obtained from the proximate analysis of flours and goji fruit are shown in Table 1.
The results obtained with regard to the chemical composition of the four types of flour analyzed and GFr compared to wheat flour highlight their nutritional potential as a result of the higher protein, fiber, fat and ash content. RF showed high levels of fat - 1.92% compared to 1.62% in WF, fiber - 3.99% compared to 1.56% in WF, ash - 2.60% compared to 0.65% in WF and lower protein level - 11.77% compared to 12.65% in WF and carbohydrates - 65.50% compared to 69.25% in WF [3]. Regarding the chemical composition of whole rye flour, quinoa flour and buckwheat flour, this was superior for all constituents analyzed as compared

to wheat flour. Fat content ranged from 1.74% to WRF to 6.24% at QF compared to 1.62; protein content ranged from 12.92% in WRF to 13.93% in QF compared to 12.65% in WF; fiber content ranged from 5.09% in WRF to 8.21% in BF compared to 1.56% in WF; ash content ranged from 1.94% in BF to 2.42% in QF compared to 0.65% in WF [3, 4, 5, 6]. Compared with other studies [3, 4, 5, 7], the carbohydrate content is lower for the four types of flour and GFr in comparison with WF, ranging from 56.85% in GFr to 65.50% in RF compared to 69.25% in WF, which contributes to the lowering of the glycemic index of the products obtained from these flours. The moisture of all four types of flour was lower than that of WF, ranging from 11.69% in BF to 14.02% in RF compared to 14.27% in WF. The chemical composition of GFr was superior to that of WF, too, exhibiting a protein content of 13.72%, fat content of 4.52%, fiber content of 16.18% and ash of 2.89%, respectively [3,4,5,6].

Table 1. Chemical composition of flours and goji fruit

Analysis (%)	**Wheat flour (WF)**	**Rye flour (RF)**	**Whole rye flour (WRF)**	**Quinoa flour (QF)**	**Buckwheat flour (BF)**	**Goji fruit (GFr)**
Moisture	14.27±0.36	14.02±0.21	13.82±0.08	11.88±0.67	11.69±0.16	5.84±0.14
Fat	1.62±0.31	1.92±0.14	1.74±0.20	6.24±0.26	2.43±0.19	4.52±0.21
Protein	12.65±0.3	11.77±0.38	12.92±0.15	13.93±0.11	13.24±0.13	13.72±0.09
Fiber	1.56±0.16	3.99±0.25	5.09±0.11	6.86±0.19	8.21±0.14	16.18±0.08
Carbohydrates	69.25±0.13	65.50±0.22	64.63±0.33	58.67±0.23	62.49±0.24	56.85±0.16
Ash	0.65±0.36	2.60±0.32	2.30±0.21	2.42±0.14	1.94±0.16	2.89±0.20

The flour mixtures were marked as:
M1 - 25%WF + 25%RF + 25%QF + 25%GFr; **M2** - 25%WF + 25%WRF + 25%QF + 25%GFr; **M3** - 25%WF + 25%RF + 25%BF + 25%GFr; **M4** - 25%WF + 25%WRF + 25%BF + 25%GFr; **M5** - 25%WF + 50% RF + 25%QF; **M6** - 25%WF + 50%WRF + 25%QF; **M7** - 25%WF + 50%RF + 25%BF; **M8** - 25%WF + 50%WRF + 25%BF.

Table 2. Chemical composition of the studied flour mixtures

Mixtures	Moisture (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrates (%)	Ash (%)
M1	11.92±0.36	3.57±0.11	13.01±0.06	7.14±0.57	62.56±0.10	2.15±0.12
M2	12.37±0.31	3.40±0.12	13.30±0.40	7.42±0.23	62.35±0.19	2.11±0.21
M3	11.65±0.33	2.52±0.28	12.84±0.25	7.48±0.14	63.52±0.03	1.98±0.01
M4	12.15±0.16	2.45±0.15	13.13±0.12	7.76±0.19	63.30±0.24	1.94±0.08
M5	11.52±0.13	2.92±0.32	12.47±0.33	4.11±0.41	64.73±0.24	2.06±0.16
M6	12.25±0.36	2.58±0.02	13.05±0.11	4.65±0.14	64.29±0.16	2.07±0.20
M7	11.20±0.16	1.97±0.52	12.35±0.41	4.43±0.19	65.68±0.08	1.94±0.12
M8	12.01±0.22	1.63±0.12	12.93±0.11	4.98±0.16	65.25±0.19	1.79±0.26

Comparing the moisture values (Table 2) corresponding to the eight analyzed mixtures of flour, it can be seen that the moisture ranged between 11.20% (**M7**) and 12.37% (**M2**). It can also be noticed that the moisture of RF and BF blends is lower (11.65% for **M3** and 11.20% for **M7**) than for blends with WRF and QF (11.92 % for **M1** and 11.52% for **M5**), which makes the use of RF and BF blends in bread making technology, to prolong the freshness of the products [3, 4, 5, 6].

The fat content of the analyzed samples varies between 1.63% (**M8**) and 3.57% (**M1**), and it can also be observed that for QF mixtures the fat content is higher (3.57% for **M1** and 2.92% for **M7**) than in the case of blends with BF (2.45% for **M4** and 1.63% for **M8**) [3, 4, 5, 6, 7]. According to the results presented in table 2, the studied mixtures (**M1** ÷ **M8**) can be considered as important "protein sources", "fiber sources" and "mineral sources", thus, the protein content varies between 12.35% for **M7** and 13.30% for **M2**, the fiber content between 4.11% for **M5** and 7.76% for **M4** and the ash content between 1.79% for **M8** and 2.15% for **M1**, results that are consistent with those obtained by Hansen, (2004), Vojtiskova (2012), Faizullah (2013) and Filho (2017) [3, 4, 5, 6].

The addition of GFr increases the nutritional value of mixtures, namely the mineral content (1.94% ÷ 2.15%), compared to the mixtures that do not contain these fruits (1.79 ÷ 2.07%). Regarding the carbohydrate content of the analyzed mixtures (**M1** ÷ **M8**) (Table 2), it can be observed that mixtures not containing GFr exhibit higher values (64.29% for **M6** and 65.68% for **M7**) compared to mixtures containing GFr (62.35% for **M2** and 63.52% for **M3**) [3, 4, 5, 6, 7].

Conclusions

This study showed that rye flour, whole rye flour, quinoa flour, buckwheat flour and goji fruit are important sources of protein, fiber, minerals and fat compared to wheat flour. Based on the results obtained in this study we can assume that the proportions established for each

assortment of flour and goji fruit lead to the obtaining of some flour mixtures that comply with the quality standards provided by the specialized STAS. Also based on these results, the following recommendation can be made, namely, the use of these blends in both the biscuit production technology and the technology of other pastry and bakery products. The results in this research confirm that this mixture is a good source of many important nutrients that appear to have a very positive effect on human health and could be used to obtain potentially functional foods.

References

[1] Chwang, L. C., "Nutrition and dietics in aged care". Nutrition and Dietics, vol. 69 (3), pp 203–207. doi:10.1111/j.1747-0080.2012.01617.x. Retrieved March 31, 2015.
[2] Vitamin and mineral requirements in human nutrition: report of a joint FAO/WHO Expert Consultation, Bangkok, Thailand, 1998.
[3] Hansen H., Moller B., Andersen S., Jorgensen J., Hansen A., Grain Characteristics, Chemical Composition, and Functional Properties of Rye (Secale cereale L.) As Influenced by Genotype and Harvest Year, J. Agric. Food Chem., vol. 52, pp 2282−229, 2004.
[4] Vojtiskova P., Kmentova K., Kuban V., Kracmar S., Chemical composition of buckwheat plant (Fagopyrum esculentum) and selected buckwheat products, Journal of Microbiology Biotechnology and Food Sciences, vol. 1 (February Special issue), pp 1011-1019, 2012.
[5] Filho A.M., Pirozi M.R., Borges J.T., Pinheiro Sant'Ana H.M., Chaves J.B., Coimbra J.S., Quinoa: Nutritional, functional, and antinutritional aspects, Crit Rev Food Sci Nutr., vol. 57(8), pp 1618-1630, 2017.
[6] Faizullah K., Muhammad A., Tariq Umar K., Muhammad I. K., Javed A. B., Nutritional evaluation of common buckwheat of four different villages of Gilgit-Baltistan, ARPN Journal of Agricultural and Biological Science, vol. 8, no. 3, 2013.
[7] Niro S., Fratianni A., Panfili G., Falasca L., Cinquanta L., Rizvi Alam M.D., Nutritional evaluation of fresh and dried goji berries cultivated in Italy, Ital. J. Food Sci., vol. 29, pp 398 - 408, 2017.
[8] A.O.A.C., "Official Methods of Analysis" Association Official Analytical Chemists of the 16" Ed. International, Washington, D.C., U.S.A., 1995.
[9] AOAC (Association of Official Analytical Chemists) Official Methods of Analysis International. 17th, Ed. Washington, DC: AOAC, 2000.