CHEMICAL COMPOSITION OF SOME FLOUR MIXTURES WITH HIGH NUTRITIONAL VALUE

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Abstract

The objectives of this study were to optimize high nutritional blends obtained by partial substitution of white wheat flour 550 (WWF) with rye flour (RF), oat flour (OF), quinoa flour (CF) and maize flour, respectively, and assessing the impact of using these mixtures on the sensory qualities of multigrain bread. WWF has been substituted by 5%, 10%, 15%, 20% and 25% RF, OF, QF and MF, respectively. As for flours and flours mixtures, the following determinations were carried out: moisture, protein content, ash content, fat content, fiber content, and total carbohydrate content. The resulting mixtures had high protein content (11.23% at M6 and 11.91% at M3), fiber (2.71% at M6 and 3.68% at M1), ash (1.28% at M6 and 1.70% at M3) fat (2.61% at M6 and 3.42% at M1) and low carbohydrates (65.74% at M1 and 68.02% at M6) and moisture ranged between 13.77% at M1 and 14.15% at M6.
Based on the obtained results regarding the physic-chemical composition of the M1 ÷ M6 mixtures, it can be appreciated that all these mixtures are suitable for being used in obtaining bakery products (multigrain bread) according to the established substitution amounts, because all the results obtained for the nutritional and quality parameters had the values closest to the daily nutritional needs of the human body for good development and function.

Introduction

Current concerns both at national and international level in the food sector are directed towards product quality, diversification of production and the renewal of the range of products, thus aiming at obtaining high nutritional products without additives, preservatives or other compounds with a negative impact on the human organism [1, 2, 3].
The food pyramid reflects the nutritional recommendations, the quantities and types of foods to be consumed daily to maintain health and reduce the risk of developing various dietary diseases [4, 5]. The most important foods that make up the food pyramid are cereals, vegetables, and fruits as the foundation of balanced nutrition, calling them the "basis" for proper nutrition and health [5].
The flours used in this study to obtain functional multigrain bread were: white wheat flour 550 (WWF), rye flour (RF), oat flour (OF), quinoa flour (QF) and maize flour (MF). The use of these different types of flour in various amounts (RF, OF, QF, MF) in the production of multigrain bread by the partial substitution of WWF is justified on the basis of their complex chemical composition, implicitly for their food and biological value [6, 7, 8, 9, 10, 11].
The beneficial effects of rye on health are due to the high intake of fiber, protein, mineral salts (iron, calcium, phosphorus, magnesium, potassium), nitrates, starch carbohydrates, cellulose, essential amino acids, vitamins A, C, E , K, complex B, and very few fats (cholesterol free) [6, 7].
The superior nutritional value of oats is given by the high content of proteins, lipids, minerals, fibers, various other phyto-constituents such as flavonoids, flavonolignans, saponins, sterols and triterpenoids [8].

Quinoa is very rich in proteins and essential amino acids (isoleucine, methionine, lysine, thiozine, valine); vitamins A, B, C and E; calcium, iron, magnesium, omega 3; manganese, copper, magnesium, phosphorus; soluble fibers as well as insoluble fibers [9, 10].
Corn contains proteins, sugars, fats, essential fatty acids omega-3 and omega-6, vitamins (B1, B2, B3, B5, B6, B9, C, E, K), mineral salts (sodium, magnesium, phosphorus, iron, zinc, calcium, copper, selenium), antioxidants (carotene, lutein, cryptoxanthin) [11].
Starting from these observations, the purpose of this study was to optimizing some blends of high nutritional flours, establishing the optimum manufacturing recipe, and the optimal doses of RF, OF, QF and MF that can be added to the multigrain bread without affecting its quality.

Experimental

Materials

The flours analyzed in this study have been purchased from hypermarkets and specialized stores.

Steps in the preparation of flour mixtures

When determining the proportion of each flour assortment to form a mixture, account was taken of the physical, chemical and technological characteristics of these flours. Thus, due to the fact that both RF and OF, QF and MF do not contain gluten, in order to ensure the formation of the three-dimensional gluten skeleton of the dough, 40% and 60% of WWF were added.
In the obtaining of the 6 blends RF, OF, QF and MF were used in variable proportions (5%, 10%, 15%, 20% and 25%) because it is known that these flours have a high nutritional value, rich in proteins, fibers, essential amino acids, antioxidants, minerals and vitamins [6, 7, 8, 9, 10, 11].
The 6 mixtures of flours to be used in making multigrain bread are:
Mixture (M1): 40%WWF:10%RF25%OF:20%QF:5%MF;
Mixture (M2): 40%WWF:15%RF:20%OF:20%QF:5%MF;
Mixture (M3): 40%WWF:20%RF:15%OF:20%QF:5%MF;
Mixture (M4): 60%WWF:10%RF10%OF:15%QF:5%MF;
Mixture (M5): 60%WWF:10%RF:15%OF:10%QF:5%MF;
Mixture (M6): 60%WWF:10%RF:20%OF:5%QF:5%MF.

Analytical procedures

Proximate composition of flours and flour mixtures

For determining the average chemical composition of flours and flour mixtures, were determined: moisture, acidity, fat content, ash content, fiber content and carbohydrate content was determined according to standard method A.O.A.C. 1995 [12]; protein content was determined by the Kjeldahl method according to standard method A.A.C.C. 2000, No. 46-10 [13].
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

Proximate composition of flours and flour mixtures

Table 1 presents the results obtained from the proximate analysis of flours. The results obtained regarding the composition of the four flours (RF, OF, QF and MF) analyzed compared to WWF, highlights their nutritional potential as a result of the higher protein content, raw fiber, fats and ash. RF showed high protein levels - 12.82% compared to 10.72%

in WWF, fiber - 3.84% vs. 1.36% in WWF, ash - 2.72% vs. 0.69% in WWF, fat - 1.98% in WWF and lower carbohydrate levels - 64.42% vs. 71.24% in WWF [6, 7].
Also, the composition of OF, QF and MF was superior for all analyzed constituents compared to WWF, and confirmed by Lea J. (2009), Singh, R. et. al. (2013), Qamar S. et al. (2017) and Filho A.M. et. al. (2017). Thus, fat content ranged between 4.46% in OF and 6.16% in QF versus 1.65 in WWF; protein content ranged between 11.12% in MF and 11.36% in OF and 14.13% in QF versus 10.72% in WWF; fiber content ranged between 2.55% in MF and 5.42% in OF and 6.46% in QF vs. 1.56% in WWF; ash content ranged between 1.85% in OF and 2.62% in QF vs. 0.69% in WWF [8, 9, 10, 11].

Table 1. Proximate composition of flours studied

Analysis (%)	White wheat flour 550 (WWF)	Rye flour (RF)	Oat flour (OF)	Quinoa flour (QF)	Maize flour (MF)
Moisture	14.34±0.29	14.22±0.09	13.98±0.60	11.94±0.25	15.07±0.06
Fat	1.65±0.21	1.98±0.24	4.46±0.21	6.16±0.20	4.76±0.20
Protein	10.72±0.35	12.82±0.42	11.36±0.13	14.13±0.18	11.12±0.19
Fiber	1.36±0.16	3.84±0.15	5.42±0.19	6.46±0.41	2.55±0.21
Carbohydrates	71.24±0.23	64.42±0.41	62.93±0.32	58.69±0.33	66.44±0.18
Ash	0.69±0.27	2.72±0.22	1.85±0.24	2.62±0.16	2.06±0.21

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

The flour mixtures were marked as: **M1, M2, M3, M4, M5, M6.**

Table 2. Proximate composition of flour mixtures studied

Mixtures	Moisture (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrates (%)	Ash (%)
M1	13.77±0.21	3.42±0.06	11.77±0.20	3.68±0.20	65.74±0.16	1.62±0.21
M2	13.78±0.24	3.31±0.18	11.84±0.45	3.60±0.14	65.81±0.08	1.66±0.08
M3	13.79±0.11	3.18±0.24	11.91±0.12	3.52±0.19	65.90±0.24	1.70±0.28
M4	13.95±0.32	2.78±0.47	11.50±0.33	2.81±0.41	67.61±0.28	1.35±0.22
M5	14.05±0.14	2.69±0.36	11.37±0.11	2.76±0.19	67.82±0.27	1.31±0.20
M6	14.15±0.13	2.61±0.52	11.23±0.21	2.71±0.19	68.02±0.11	1.28±0.14

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

In contrast, carbohydrate content is lower for all four flours compared to WWF, ranging between 58.69% in QF and 66.44% in MF compared to 71.24% in WWF, which contributes to lowering the glycemic index of the products obtained from these flours [8, 9, 10, 11, 14, 15]. As for the moisture content of the analyzed flour samples, it was lower in the case of QF (11.94%), OF (13.98%) and RF (14.22%) than that of WWF (14.34%), while moisture content in MF was 15.07% [16].
Analyzing the moisture values (Table 2) corresponding to the six mixtures of analyzed flour, it can be seen that it varied between 13.77% (M1) and 14.15% (M6), which makes the use of these blends in multigrain bread manufacturing, to require a smaller amount of water to be added to the dough [14]. It can also be noticed that the humidity of the mixtures M1 ÷ M3 (13.77 ÷ 13.79%) was lower than that for the M4 ÷ M6 mixtures (13.95 ÷ 14.15%) which makes the use of M1 ÷ M3 blends in the manufacturing technology of the multigrain bread to cause a slight extension of its freshness [14, 15].
The fat content of the analyzed mixtures varied between 2.61% (M6) and 3.42% (M1), observing that with the increase of the WWF percentage from 40% to 60% and the decrease of the QF percentage from 20% at 5% and the percentage of OF from 25% to 10%, the fat

content of the mixtures decreases linearly, thus avoiding the risk of increasing acidity of these mixtures [16].

According to the results presented in Table 2, the studied mixtures (M1 ÷ M6) can be considered important "sources of proteins, fibers and minerals", thus the protein content ranges between 11.23% in M6 and 11.77% in M1, the fiber between 2.71% in M6 and 3.68% in M1 and the ash rate between 1.28% in M6 and 1.62% in M1, results that are consistent with those obtained by Lea J. (2009), Singh, R. *et. al*. (2013), Qamar S. *et al*. (2017) and Filho A.M. *e*t. *al* (2017) [8, 9, 11]. Regarding the carbohydrate content of the analyzed mixtures (M1 ÷ M6) (Table 2), it can be observed that it increases linearly from M1 (65.74%) to M6 (68.02%) with the increase of the WWF percentage from 40% to 60% [8, 9, 11, 15].

Conclusions

Mixtures M1 ÷ M6 can be successfully incorporated into the multigrain bread obtaining recipe, resulting in a value-added functional product due to the superior protein, fiber, mineral and fat content compared to WWF.

Based on these results, we can formulate the following recommendation, namely, the use of these blends in both multigrain bread technology and in other pastry and bakery products technology. The use of RF, OF, QF and MF for the purpose of obtaining bakery products does not raise technological problems and can be processed following the model of classic production lines existing in bakery units.

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.

The recipe for multigrain bread recommended following the observations from this study is: flour mixture (60% WWF: 10% RF: 15% OF: 10% QF: 5% MF), water - 57%, yeast – 2.5%, salt – 2%.

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