



## STUDIES ON THE INFLUENCE OF QUINOA FLOUR ADDITION ON BREAD QUALITY

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**Abstract:** *The aim of this research was to investigate the effect of quinoa flour addition to wheat flour on bread quality. A part of wheat flour type 000 was replaced by red and white quinoa flour in various proportions from 0% to 20% as follows: 0%, 5%, 10%, 15% and 20% respectively. Once this prototype was established, we wanted to study the influence of the quinoa flour on physical, colour, and crumb cell, textural and sensory characteristics of the bread products. For this purpose Motic stereo microscope, Konica Minolta CR-700 Spectrophotometer and Mark-10-ESM301 texture analyzer were used. The experimental data showed statistically significant differences between samples. Increasing amounts of quinoa flour both white and red, lead to stronger and less extensible doughs. The volume as well as the elasticity of samples decreased with a higher percentage of quinoa flour addition. The porosity decreased as well. The results also showed that blends containing either 5 or 10% white or red quinoa flour presented better physical properties than those with higher proportions of quinoa flour. The colour of samples was visibly modified with the increasing amounts of quinoa flour, the most evident being in red quinoa samples especially from the L\* parameter point of view of CIE Lab method.*

*The obtained results were statistically interpreted. The statistical analysis was done using two-factor ANOVA without replication and Microsoft Excel 2007 software. The tasters appreciated the samples with 5 and 10% quinoa flour, the overall acceptance score being close to that of control or even higher.*

**Key words:** *wheat flour, quinoa flour, bread quality, colour profile, crumb structure*

### 1. Introduction

Bread and bakery products represent an important sector of the food industry. They are known and consumed throughout the world for thousands of years. However, we can say that their production is relatively new only thinking of how fast the technology evolves from year to year. Lately, the bread can be considered an exceptional product, and so is, considering the continued growth of its market.

Bread is a source of vitamins and minerals, especially phosphorus and copper [1]. However, from the nutritional point of

view, the bread has a low content of essential amino acids, e.g. lysine, tryptophan, threonine [2]. Also, A, C, D and B<sub>12</sub> found in a low content in bread decrease the nutritional quality of it [3]. Adding other types of flour in bread helps to improve its nutritional properties. Bread with composite flour maybe made from other types of flour than wheat flour or may be made from flours derived from pseudo-cereals mixed with wheat flour [4]. El-Soukkary F. A. H. (2001) shows that the addition of flour from pseudo-cereals can increase the protein content of bread

and therefore can improve its nutritional quality, particularly by increasing the lysine content in which bread is deficient [5]. On the other hand, the addition of pseudo-cereal flour increased the soluble fiber content of the product. There are two reasons for which the adding of fibers to bread is essential: fibers contribute to the decrease of caloric value of the product and help in increasing there commended intake of soluble fiber [6].

Making bread and bakery products using composite flour have been developed in recent years, attracting the attention of many researchers. After many years of studying in this area, they found that products made with mixture of several types of flour have the same characteristics with products made entirely of wheat flour. The use of composite flour has direct impact on the finished products in terms of physical and chemical effects on the human being health [7]. In addition, bread-making using composite flour is a new approach to the use of cereals that are lesser used or known and have higher nutritional characteristics.

In order to make composite flour, many other types of flour can be used with wheat flour. These include: corn and chickpea flour [8–10], pumpkin flour [11], lupine flour [12–13], quinoa and amaranth flour [14–18] e.g.

Quinoa (*Chenopodium quinoa Willd.*) is a pseudo-cereal found at high altitudes in regions of South America. It belongs to the *Dicotyledons* class, the *Chenopodiaceae* family, genus *Chenopodium*, species quinoa.

Quinoa is known for its high protein content. More exactly it contains all essential amino acids with large amounts of lysine and methionine [19]. It contains significant amounts of fiber, minerals, especially calcium and iron [20] and antioxidants [21]. Moreover, it doesn't contain gluten protein, so products made exclusively from this type of flour can be

consumed by people with gluten intolerance or those allergic to wheat [22]. With these characteristics, quinoa is distinguished from other conventional grain which makes it appreciate worldwide.

Quinoa seeds are small (about 350 grains weight a gram), round, slightly flattened, colour ranging from pale yellow to pink or even black. Quinoa, like other Andean grain, is consumed in different ways, today presenting numerous innovations at the industry level. Thus, it can be eaten cooked, milled or extruded.

In the present study, composite flour bread was prepared using wheat flour type 000 and whole quinoa flour both white and red. The objective of this work was to investigate the effect of different ratios of quinoa flour addition to wheat flour on bread quality.

## 2. Materials and methods

### 2.1. Materials

#### 2.1.1. Wheat flour

The research study has been carried on 000 flour type obtained from a local hypermarket. The flour used in this study presents the following characteristics: moisture content 14.2%, ash content 0.48%, wet gluten content 27%, gluten deformation index 6 mm and 3.3 acidity. The flour chemical composition was determined according to Romanian standard methods: moisture (SR EN ISO 712:2010), ash content (SR EN ISO2171:2010), wet gluten content, gluten deformation index (SR 90:2007), acidity (SR 90:2007).

#### 2.1.2. Quinoa flour

Red quinoa seeds (Bolivia origin) and white seeds (Ecuador origin) were purchased from specialized shops and then were grounded separately with a laboratory grinder in order to obtain flour. Prior to grinding, the grains were washed with cold water to remove the layer of saponins.

The process was repeated several times until water clarification and disappearance of foam. The seeds were dried and then grounded.

## 2.2. Methods

### 2.2.1. Preparation of composite quinoa-wheat flour bread

The bread samples (fig. 2) were made using direct method for preparation of the dough. The ingredients were mixed in a mixer for about 15 minutes. Yeast and salt were added in doses of 3% respectively 1.5% reported to the mass of the wheat-quinoa flour and water up to 56% wheat flour hydration capacity. The doughs obtained were manually moulded into pieces of 250 grams each. Samples were then put into special trays and left to rise for some time until the samples have doubled their volume before being baked in an electric oven with thermo humidification and ventilation (Piron Caboto PF8004 D, Italy) 30 minutes at 180°C. After taking out of the trays, bread samples were cooled for analysis.

### 2.2.2. Physical and quality parameters of bread

For assessing the influence of the characteristics of quinoa flour, bread samples were evaluated to determine elasticity, volume, porosity and other characteristics. Measurements were performed for all samples under the same conditions and according to the same parameters. The analysis was performing in proper time so that not to exceed the shelf life of the product.

**Bread volume, elasticity and porosity** were determined according to SR 91:2007.

**Photometric analysis of bread samples** was made using Konica Minolta CR – 700 (Japan) portable colorimeter from the Food Safety Research Laboratory of the Faculty of Food Engineering of Suceava. The measurement of colour was carried out by colour system method CIE Lab, where L\*

indicates the brightness of the colour, measured in a range from 0 (black - light minimum) to 100 (maximum brightness), a\* denotes the position of the colour on a scale ranging from pure green (-) to pure red (+) and b\* coordinate indicates the colour position on a scale ranging from pure blue (-) to yellow pure (+). The parameters of this method, L\* (Hunter lightness), a\* (redness), b\* (yellowness), offered concrete results on the effectiveness and sensitivity of colorimetric sensor, absorption of electromagnetic radiation being achieved in the UV-VIS range. The readings for each sample separately were carried out under laboratory conditions, after device calibration by targeting its light path on a specific area of white (obtaining white spectrum,  $\Delta_{65}$ ).

To appreciate the **texture of bread samples** we used a texture analyzer (Mark-10-ESM301) in order to obtain primary and secondary texture parameters resulting from a mechanical action applied to the product. The electronic texture analyzer is equipped with a sensor that measures the force, displacement and analysis time. Texture parameters analyzed were: hardness, gumminess, cohesiveness, elasticity and chewiness. Bread samples have passed through a double compression between the discs of texture analyzer (aluminium disk of 50 mm diameter), compression being carried out on half of the thickness of the bread slice. The samples were analysed for 2.5 to 4 minutes depending on composition and structure. Interpretation of the data obtained was performed using a Mesur Gauge software of Mark 10 texture analyzer.

In order to establish their relevance, it was also emphasized the relation between primary and secondary texture parameters analysed. On this line, we used Data Analysis package provided by MS Excel.

To study the **microstructure of bread samples** binocular stereo microscope

Motic SMZ-140 was used. Bread sample slices of 8 mm thick were placed on the special board of microscope. For analysis, a 20x objective was used. The captured images were sent to an external hard drive and then were saved in jpg format using colour model Blue at a resolution of 2048x1536 pixels.

The most effective way we can appreciate the quality of bread is *sensory analysis*. For this method bread samples with different levels of quinoa flour addition were cut into small pieces and placed on plastic dishes to be tasted. The tasters were 20 semi-trained judges, students of the Faculty of Food Engineering of Ștefancel Mare University (representative sample given multiple students' knowledge in this area). Assessing the value of the product was done with a scale score of 1 (I dislike very much) to 9 (I like very much), pursuing the following characteristics: appearance, colour, taste, smell, flavour, firmness and overall acceptance.

For a better appreciation of the influence of quinoa flour on bread samples, the results of this analysis were statistically interpreted, results being expressed as means.

### *2.2.3. Statistical analysis*

To calculate the mean values and standard deviations of then analysis results, Microsoft Office Excel software was used. To determine the significance of these obtained results, the two-factors without replication ANOVA was used, and Fisher's test was used to assess significant differences ( $p < 0.05$ ) among samples. The significance level for all tests was 0.05. It was calculated Pearson's coefficient ( $r$ ) to measure the linear relationship existing between two variables.

## **3. Results and discussion**

### *3.1. Physical and chemical properties of wheat flour*

The results obtained from the flour analysis correspond to standards. White flour 000 type is of a very good quality for bread making. Due to its low nutrients content we chose to mix it with quinoa flour more rich in nutrients.

### *3.2. Bread volume*

Quinoa flour significantly influences the volume of the bread sample in which is added. According to the results from Figure 1, we can note that the relation between the variation of quinoa flour percentage and bread volume is described by a regression line with descending slope. The correlation coefficient,  $r = 0.985$  for white quinoa and  $r = 0.966$  for red quinoa indicates a strong inverse connection between these parameters. Small amounts of flour did not significantly affect the volume of bread, samples having similar characteristics to that of the control one. Quinoa, both white and red has a slightly amylase activity which may lead to an increase in the production of gas and thus the volume of bread [23].

However, samples with the addition of quinoa flour over 15% have a smaller volume compared to the control sample. The results corresponded with those of Morita, N. et al. (2001) [24]. This can be attributed to gluten reduction in the product the dough couldn't retain so well the fermentation gases. Park, H.S. et al. (2005) [15] studied under a microscope samples of wheat flour bread mixed with 30% quinoa flour and observed that structured gluten matrix encompassing aggregate grains starch which retain gases was missing. As we can see in Figures 1 and 2 compared to the control, samples loaf bread volume decreases with increasing concentration of quinoa flour added.

Analysis of variance shown no significantly differences ( $p < 0.5$ ) between the two types of quinoa flour regarding the bread samples volume ( $F = 3.47 < F_{crit} = 7.7$ ).

From this results we can conclude that the type of quinoa flour, white or red, does not influence the decreasing of bread volume, but the percentage of flour added ( $F = 65.46 > F_{crit} = 6.38$ ).

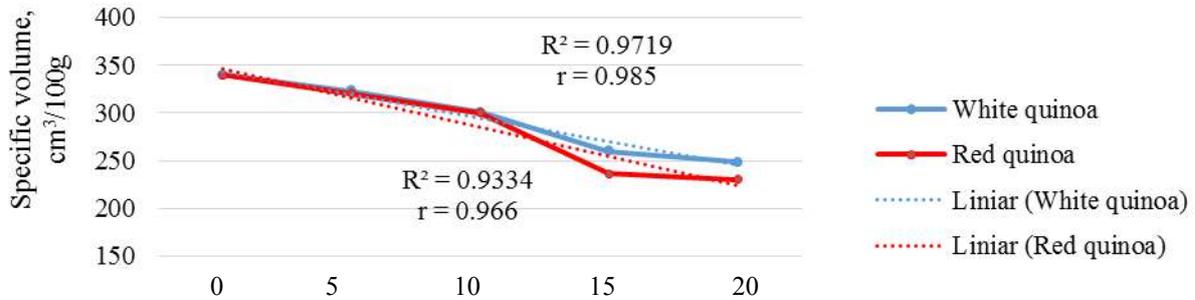


Fig. 1. Loaf volume of bread samples with different levels of quinoa flour addition

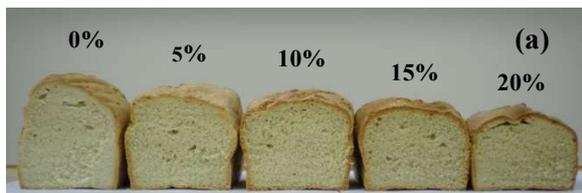


Fig. 2. Bread samples with white quinoa flour



Fig. 3. Bread samples with red quinoa flour

### 3.3. Elasticity and porosity

The quinoa flour influence on the elasticity and porosity of the bread is shown in Figure 3. As seen, bread samples of 5% and 10% quinoa flour, both white and red, have elasticity close to that of control (0% quinoa flour added). Higher concentrations of quinoa flour resulted in a less elastic crumb. Correlation coefficients obtained in both cases,  $r = 0.973$  for white quinoa flour and  $r = 0.948$  for red quinoa flour indicate strong inverse connections between samples, both quinoa white flour samples elasticity and red quinoa flour samples elasticity decreasing ( $p < 0.05$ ) with the increasing amount of flour added. This is explained by mechanical damage of gluten by fibers in quinoa flour.

Samples porosity significantly differs from the control sample. Regression lines obtained in both cases indicate strong inverse connections between samples. Following statistical analysis of variance (ANOVA) we can note a decreasing samples porosity ( $p < 0.05$ ) with increasing amounts of quinoa flour added, both white and red ( $F = 65.46 < F_{crit} = 6.38$ ). This is explained by mechanical damage of gluten by fibers in quinoa flour.

### 3.4. Colour samples

The colour of the crumb has been also an important parameter for characterising quinoa-wheat flour bread. Colour values of bread crumb samples are presented in Table 1. Lower  $L^*$  value indicates darker crumb,  $a^*$  positive value is associated with crumb redness, whereas  $b^*$  positive value indicates yellow colour.

Control sample has the greatest lightness. In general, the brightness values  $L^*$  decrease ( $p < 0.05$ ) with increasing concentration of quinoa flour added to

bread. This dark colour is owed to the darker quinoa flour colour, both white and red, compared to white wheat flour.

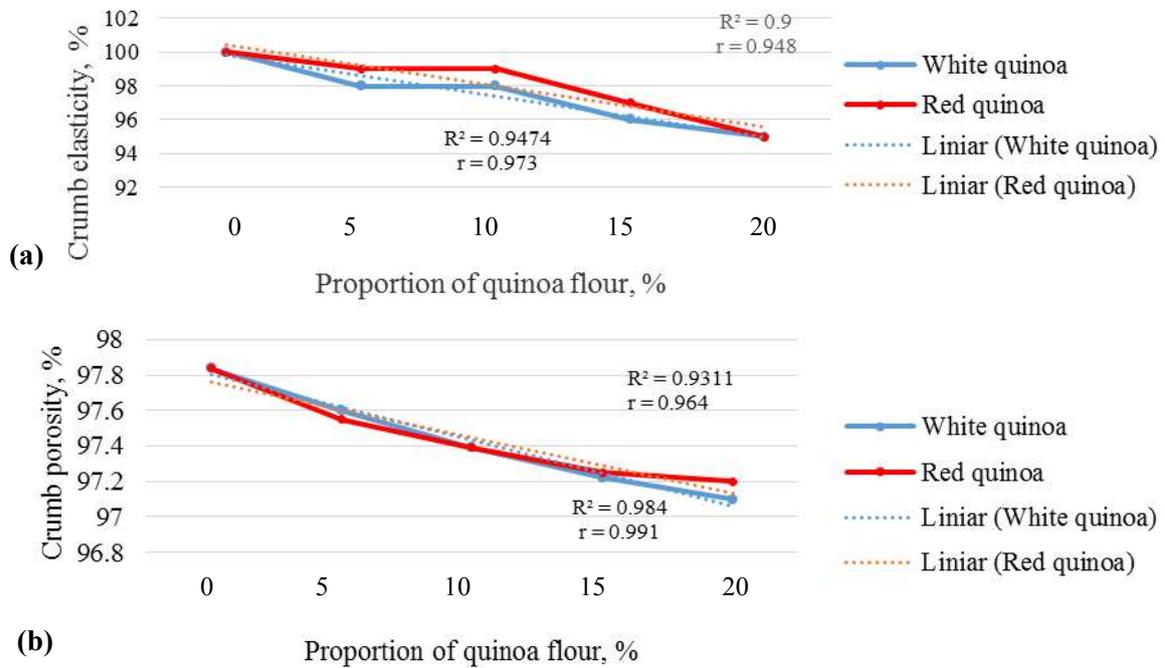


Fig. 3. Effect of quinoa flour addition on bread elasticity (a) and porosity (b)

The darkest colour presents the sample with highest concentration of red quinoa flour. Compared with the control, coordinate  $a^*$  indicates lower values of white quinoa bread samples, whereas in case of red quinoa bread samples, the values turn to the positive area, that is red colour. Coordinate  $b^*$  of the CIE Lab colour system method indicates close and positive values of the samples colour.

### 3.5. Bread texture

Primary (hardness, cohesivity, elasticity) and secondary (gumminess, chewiness) texture parameters of samples are presented in Table 2. Quinoa flour in different concentrations has significant effects on the bread samples texture profile. For example, the hardness of the bread increases to a certain level of quinoa

flour added. Above this concentration (15% for white quinoa and 10% for red) hardness begins to decrease. Bread samples cohesivity is largely of interest, with a preference for a high cohesivity so during mastication product not disintegrate. In our case, control sample has the highest cohesivity and compared to it, the other samples cohesiveness is relatively low ( $p < 0.05$ ), due to the reduction of the wheat flour amount in the product. As for chewiness, the things remain the same as in the case of hardness. Up to 15% quinoa white flour and 10% red quinoa flour added, chewiness (less than in case of control) increases. Over these values it begins to fall.

To establish links between texture parameters, a Pearson correlation was established, Table 3. As seen, the correlation coefficients obtained indicate

the presence of close and statistically significant links between some parameters.

### 3.7. Sensory analysis

Attributes that have the greatest influence on the reaction of tasters were colour and

overall acceptance. Tasters prefer samples of bread with the addition of 5 and 10% quinoa flour, both white and red, overall acceptance score exceeded that of the control.

**Table 1.**

**Colour values of bread samples with quinoa flour addition**

Sample \ Parameters	L*	a*	b*	ΔL	Δa	Δb	ΔE
Control sample	74.46	-1.87	13.35	38.64	-15.22	-0.87	41.54
5% WQF	69.39	-2.23	14.8	33.57	-15.58	0.58	37.01
10% WQF	65.84	-2.07	13.24	30.02	-15.42	-0.99	33.76
15% WQF	61.46	-1.33	15.17	25.64	-14.69	0.94	29.67
20% WQF	67.11	-1.4	16.82	31.29	-14.75	2.6	34.69
5% RQF	68.41	-0.22	12.02	32.59	-13.57	-2.2	35.37
10% RQF	62.21	0.99	13.19	26.39	-12.36	-1.03	29.16
15% RQF	59.16	1.79	12.34	23.34	-11.56	-1.88	26.11
20% RQF	55.2	3.02	12.74	19.38	-10.33	-1.48	22.01

WQF – White quinoa flour; RQF – Red quinoa flour

**Table 2.**

**Texture profile analysis for quinoa-wheat flour composite bread**

TPA parameters \ Sample	Hardness (N)	Cohesivity (dimensionless)	Elasticity (dimensionless)	Gumminess (N)	Chewiness (N)
Control	16.22	0.69	0.86	11.19	9.62
5% WQF	16.78	0.54	0.80	9.06	7.25
10% WQF	18.48	0.61	0.84	11.27	9.47
15% WQF	54.62	0.57	0.84	31.13	26.15
20% WQF	31.16	0.67	0.36	20.88	7.52
5% RQF	18.80	0.63	0.82	11.84	9.71
10% RQF	32.72	0.56	0.84	18.32	15.39
15% RQF	28.42	0.64	0.83	18.19	15.10
20% RQF	15.38	0.68	0.85	10.46	8.89

**Table 3.**

**Pearson correlation for primary and secondary texture parameters**

	Hardness	Cohesivity	Elasticity	Gumminess	Chewiness
Hardness	1				
Cohesivity	-0.377	1			
Elasticity	-0.146	-0.266	1		
Gumminess	<b>0.986</b>	-0.229	-0.248	1	
Chewiness	<b>0.892</b>	-0.395	0.305	<b>0.846</b>	1

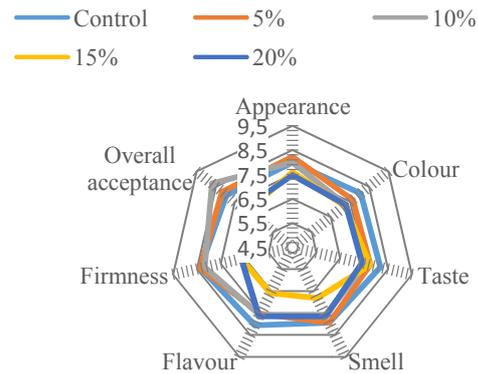
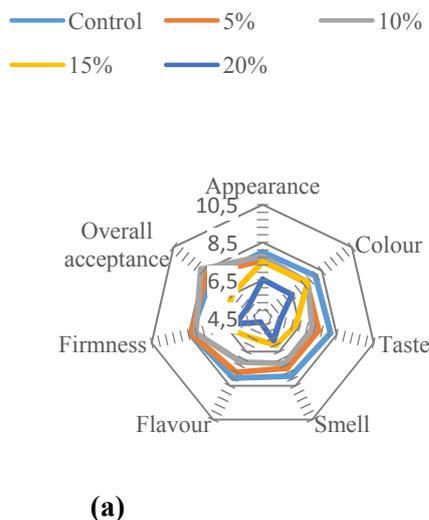
Correlation is significant at the 0.05 level

These samples were analysed for differences between them regarding the influence of the percentage of quinoa flour added on the overall acceptance of the final product. The averages scores of the 5 samples were 7.94 (for control) 8.29, 8.76 (for 5% and 10% white quinoa), 8.17 and 8.41 respectively (for bread with 5% and 10% red quinoa flour).

The two-factor without replication ANOVA revealed a significant difference between these averages,  $F = 1.84$  (higher than  $F_{crit} = 1.64$ ),  $p < 0.05$  for type of flour, white or red, and  $F = 8.35$  (greater than  $F_{crit} = 3.13$ ),  $p < 0.05$  for the concentration of the quinoa flour.

There are statistically significant differences between samples made with white and red quinoa flour. The two influencing factors were type of quinoa flour (independent variable) and percentage of quinoa flour added, 0, 5, 10, 15 and 20% (dependent variable). For  $p < 0.05$ ,  $F = 2.17 > F_{crit} = 1.52$  (for the type of flour), and  $F = 9.99 > F_{crit} = 2.44$  (for the percentage of the flour added).

As for both of these factors  $F$  is greater than  $F_{crit}$ , it is clear that both white flour or red and their percentage significant statistically influence the taste of the product.



(b)

Fig. 4. Sensory profile of wheat-quinoa white bread (a) and (b) wheat- quinoa red bread

### 3.6. Bread microstructure

The analysis of microstructure of bread samples is shown in Figure 5.

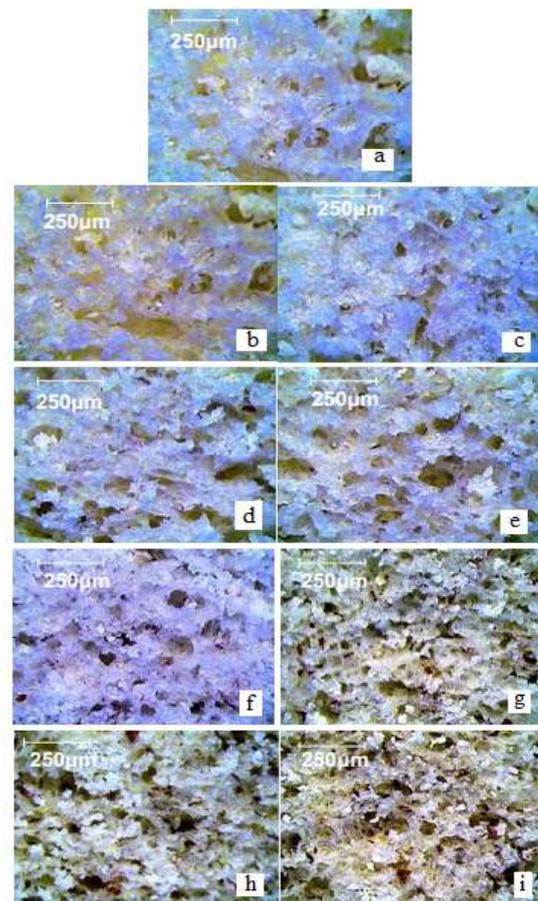


Fig. 5. Crumb structure of bread samples  
 a - Control; b - 5% WQF; c - 10% WQF;  
 d - 15% WQF; e - 20% WQF; f - 5% RQF;  
 g - 10% RQF; h - 15% RQF; i - 20% RQF;

It is noticed that the bread samples with higher concentrations of quinoa flour presents a crumb structure made up of thin films and filaments, absent to the control sample. This may be due to the destruction of gluten protein network by quinoa flour fibers. The results are in agreement to those obtained by others [25–26].

#### 4. Conclusions

The addition of rich-in-fiber quinoa integral flour to wheat flour causes a number of changes to bread technological parameters, changes that have direct impact on the quality of the finished products.

Thus, the volume, elasticity and porosity of the bread samples decrease with increasing amount of quinoa seed flour addition, regression lines obtained in all cases indicating very strong intensity reverse link.

The two-factor without replication ANOVA showed no statistically significant difference ( $p < 0.05$ ) in what concerns the type of quinoa flour added on texture and physical parameters analysed. The colour of bread with quinoa flour white or red, the volume, elasticity and porosity are influenced in especially by the percentages of quinoa flour mixed with wheat flour type 000.

A percent of 5-10% quinoa flour mixed with wheat flour type 000 of a very good quality for bread making has beneficial influence on the bread quality, firstly by the obtained values, values close to those of the control sample, and secondly by the improving sensory characteristics of bread or increasing its nutrient content.

#### 5. References

- [1]. STEER T., THANE C., STEPHEN A., JEBB S., Bread in the diet: consumption and contribution to nutrient intakes of British adults, *Proceedings of the Nutrition Society*, 67: E363, (2008)
- [2]. DHINGRA, S., JOOD, S., Organoleptic and nutritional evaluation of wheat breads supplemented with soybean and barley flour, *Journal of Food Chemistry*, 77: 479-488, (2001)
- [3]. HOSENEY R.C., Principles of Cereal Science and Technology, 2<sup>nd</sup> ed., AACC International: St. Paul, MN, (1992)
- [4]. AGHAMIRZAEI, M., HEYDARI-DALFARD, A., KARAMI, F., FATHI, M., Pseudo-cereals as a functional ingredient: effects on bread nutritional and physiological properties-Review, *Intl J Agri Crop Sci.*, 5(14): 1574-1580, (2013)
- [5]. EL-SOUKKARY, F. A. H., Evaluation of pumpkin seed products for bread fortification, *Plant Foods Hum Nutr*, 56: 365-384, (2001)
- [6]. STAUFFER, C. E., Functional additives for bakery foods. Van Nostrand Reinhold, New York; 1990
- [7]. NOORFARAHZILAH, M., LEE, J. S., SHARIFUDIN, M. S., MOHD FADZELLY, A. B., HASMADI, M., Applications of composite flour in development of food products, *International Food Research Journal*, 21(6):2061-2074, (2014)
- [8]. HUSSEIN, A. M. S., KAMIL M. M., HEGAZY, N. A., EL-NOR, A. S. A. H., Effect of wheat flour supplemented with barely and/or corn flour on balady bread quality, *Pol. J. Food Nutr. Sci.*, 63(1):11-18, (2013)
- [9]. MAN, S., PĂUCEAN, A., MUSTE, S., POP, A., Effect of the chickpea (*Cicerarietinum L.*) flour addition on physicochemical properties of wheat bread, *Bulletin UASVM Food Science and Technology*, 72(1): 41-49, (2015)
- [10]. WANI, I. A., SOGI, D. S., SHARMA, P., SINGH GILL, B., Physicochemical and pasting properties of unleavened wheat flat bread (Chapatti) as affected by addition of pulse flour, *Cogent Food & Agriculture*, 2: 1-9, (2016)
- [11]. WONGSAGONSUP, R., KITTISUBAN, P., YAOWALAK, A., SUPHANTHARIKA, M., Physical and sensory qualities of composite wheat-pumpkin flour bread with addition of hydrocolloids, *International Food Research Journal*, 22(2): 745-752, (2015)
- [12]. AHMED, H. F., Effect of fortification pan bread with lupine flour on the chemical, rheological and nutritional properties, *J. Food and Dairy Sci., Mansoura Univ.*, 4 (3): 65-75, (2013)
- [13]. CORREIA, P. M. R., GONZAGA, M., BATISTA, L. M., BEIRÃO-COSTA, L., GUINÉ,

- R. F. P., Development and characterization of wheat bread with lupin flour, *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering*, 9(10): 923-927, (2015)
- [14]. ENRIQUEZ, N., PELTZER, M., RAIMUNDI, A., TOSI, V., POLLIO, M. L., Characterization of wheat and quinoa flour blends in relation to their breadmaking quality, *The Journal of the Argentine Chemical Society*, 91(4/6): 47-54, (2003)
- [15]. PARK, S. H., MORITA, N., Dough and breadmaking properties of wheat flour substituted by 10% with germinated quinoa flour, *Food Sci. Technol. Int.*, 11: 471-476, (2005)
- [16]. ROSELL, C. M., CORTEZ, G., REPO-CARRASCO, R., Breadmaking use of andean crops quinoa, kañiwa, kiwicha, and tarwi, *Cereal Chem.*, 86(4): 386-392, (2009)
- [17]. BERGHOFER, E., SCHONLECHNER, R., Utilization of amaranth and quinoa in Europe, *Ernahrung*, 24: 303-308, (2000)
- [18]. KONG, X., BAO, J., CORKE, H., Physical properties of Amaranthus starch, *Food Chem.*, 113: 371-376, (2009)
- [19]. ABUGOCH JAMES, L. E., Quinoa (*Chenopodium quinoa Willd.*): Composition, Chemistry, Nutritional, and Functional Properties, *Advances in Food and Nutrition Research*, 59: 1-31, (2009)
- [20]. ANDO, H., CHEN Y. C., TANG, H., SHIMIZU, M., WATANABE, K., MITSUNAGA, T., Food components in fractions of quinoa seed, *Food Science and Technology Research*, 8(1): 80-84, (2002)
- [21]. HIROSE, Y., FUJITA, T., ISHII, T., UENO, N., Antioxidative properties and flavonoid composition of Chenopodium quinoa seeds cultivated in Japan, *Food Chemistry*, 119(4): 1300-1306, (2010)
- [22]. CAPERUTO, L. C., AMAYA-FARFAN, J., CAMARGO, C. R. O., Performance of quinoa (*Chenopodium quinoa Willd*) flour in the manufacture of gluten-free spaghetti, *Journal of the Science of Food and Agriculture*, 81(1): 95-101, (2001)
- [23]. LORENZ, K., ROEWE-SMITH, P., KULP, K., BATES, L., Preharvest Sprouting of Winter Wheat. II. Amino Acid Composition and Functionality of Flour and Flour Fractions, *Cereal Chem*, 60: 360-366, (1983)
- [24]. MORITA, N., HIRATA, C., PARK, S. H., MITSUNAGA, T., Quinoa flour as a new food stuff for improving dough and bread, *J. Appl. Glycosci.*, 48: 263-270, (2001)
- [25]. BORDEI, D., BURLUC, R. M., Technology and quality control in the bakery industry, Dunărea de Jos University Foundation Publishing, Galați, (2003)
- [25]. FARCAȘ, A. C., Research on the identification and recovery of biologically active compounds from biomass resulting as a byproduct from brewing, Cluj-Napoca, (2014)
- [26]. SR ISO, Standardization Association of Romania (ASRO), Bucharest, Romania: 90, 91, 11036, (2007)
- [27]. SR ISO, Standardization Association of Romania (ASRO), Bucharest, Romania: 712, 2171, (2010)