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The Adaptation of a Bread Recipe to Quinoa Seeds Addition

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Abstract

Quinoa (*Chenopodium quinoa* Willd.) originated in the Andean region of northwestern South America and was domesticated 3,000 to 4,000 years ago for human consumption. It is a pseudocereal with a high nutrient content which is increasingly used in foods such as breads with or without gluten, salads, main courses, desserts and beverages. Quinoa seeds represent a rich source of polyphenol compounds with antioxidant potential, fats, high quality proteins, calcium, magnesium and manganese, good levels of several B vitamins, vitamin E and dietary fiber.

In this study we adapted a classical recipe of bread and added quinoa seeds. We established the optimal quantity of quinoa seeds to be added to the dough which does not have deleterious effects on the quality of the bread. We observed that by increasing the amount of quinoa we also had to increase the amount of water, in order to preserve the quality of bread. By adding up to 16% quinoa seeds (calculated as weight of quinoa divided by weight of flour x 100) the quality of bread didn't change. Adding above 16% quinoa seeds, the quality of bread decreased progressively. At more than 24% quinoa seeds the bread becomes unfit for consumption

Keywords: bread, recipe, quinoa seeds, bread quality

1. Introduction

For many of us, quinoa (*Chenopodium quinoa* Willd.) is a very nutritional food that has recently appeared in many stores and in our daily diet, but quinoa was and remains a very important food crop in South America. It is a cereal with high-quality protein, high levels of essential fatty acids and phenolic compounds, no gluten and a source of dietary fiber and vitamins. The macro-nutrient contents of quinoa and other selected foods are given in **Table 1**.

Table 1. Macro-nutrient contents, per 100g dry weight [1]

	Quinoa	Bean	Maize	Rice	Wheat
Energy (kcal/100g)	399	367	408	372	392
Protein (g/100g)	16.5	28.0	10.2	7.6	14.3
Fat (g/100g)	6.3	1.1	4.7	2.2	2.3
Total carbohydrate (g/100g)	69.0	61.2	81.1	80.4	78.4

The protein quality of quinoa exceeds the FAO recommendation scoring pattern for 3 to 10 year old children regarding all eight essential amino acids contrasting with the other grains which are low in lysine and have a lower content in methionine and cysteine than quinoa [2].

The dietary fiber content of quinoa is generally higher than that of most grains: 13.6 - 16.0 grams per 100 grams dry weight, most of it insoluble: 12.0 - 14.4 grams compared to 1.4 - 1.6 grams of soluble fiber per 100 grams dry weight [3].

The essential polyunsaturated linoleic and linolenic fatty acids represent over 50 percent of the total fat content of quinoa and maintain their quality due to a high content of vitamin E with antioxidant properties [4].

As Koziol reported, quinoa is a better source of minerals than most grains, especially calcium, iron, magnesium, potassium and zinc [1], but is also rich

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in oxalate, which can bind calcium and magnesium, reducing their absorption in the body [5].

The vitamin content of quinoa is comparable with the vitamin content of wheat, but the quantity of niacin is lower in quinoa [1].

Quinoa is a very good source of polyphenols with beneficial effects on health, possibly due to antioxidant and anti-inflammatory properties. Hirose *et al.* (2010) found that quinoa seeds possess a large amount of quercitin and kaempferol glycosides and that the amount of quercitin in quinoa seeds from Japan is higher than those grown in South America [6]. The amount of quercitin and kaempferol glycosides can be increased by sprouting quinoa seeds [7].

Due to its high nutritional value, quinoa seeds can be a very precious raw material for various foods, including ordinary bread or gluten-free bread [8]. Caldarelli *et al.* (2010) found that bread with about 13% quinoa flour was well accepted by consumers and it had a functional quality due to its good ratio between the polyunsaturated and saturated fatty acids and a low level of trans fatty acids [9]. It seems that processing affects the nutritional characteristics of bread with quinoa flour or flakes (presumably the baking): there was a significant increase in dietary fiber content but a reduction in soluble fiber and in polyphenols [10,11]. Yet, the bread with quinoa flour still contained polyphenols in significant quantity [11].

To find out the percentage of additional quinoa seeds for which the obtained bread has acceptable organoleptic properties for the Romanian consumer, we used a common recipe of whole wheat bread to which we added increasing quantities of quinoa seeds. The results we obtained are given below.

2. Materials and Methods

2.1. Materials

We used a whole wheat flour with following characteristics: protein 12.4%, ash 2%, water absorption 58.87%, and quinoa seeds whose water content was 12%.

2.2. Baking test

For a 1kg bread loaf we used: 620g whole wheat flour, 10g yeast – 1.6%, 10g salt – 1.6%, 365ml water – 58.87%, and increasing quantities of quinoa seeds:

sample S1 – 0g
sample S2 – 50g (8%)
sample S3 – 100g (16%)
sample S4 – 150g (24%)
sample S5 – 200g (32%)

The dough was mixed for 8 minutes and allowed 60 minutes of fermentation time at 25-30ºC, then dough pieces were moulded and proofed for 75 minutes at 30-35ºC in rectangular pans. The loaves were baked 45 minutes at 250ºC.

2.3. Analysis

The flour analysis was made according to SR 90/2007. The bread quality analysis was made according to SR 91/2007 [12].

3. Results and Discussions

By increasing the quantity of quinoa seeds by multiples of 8% of the quantity of flour we had to proportionally increase the amount of water by 5.5% each time in order to maintain the quality of the bread. Without this increase the resulting dough consistency was very high and the obtained bread didn't have either the proper volume or the proper crumb porosity. The additional water was absorbed by the added quinoa seeds.

We determined the main qualitative parameters – specific volume, crumb porosity and crumb elasticity – of the samples. Only the significant results are presented in **Table 2** and processed in **Figures 1, 2** and **3**.

Table 2. Qualitative parameters of breads with different levels of quinoa seeds

Level of quinoa seeds [g/100g flour]	Level of water [g/100g flour]	Specific volume [cm3/100g]	Crumb porosity [%]	Crumb elasticity [%]
S1 – 0	58.87	283	77.2	94
S2 – 8	62.1	282	76.8	94
S3 – 16	65.32	283	76.6	93
S4 – 24	68.54	252	63.4	81
S5 – 32	71.76	209	47.1	59

We noticed that adding up to 8% quinoa seeds the qualitative parameters of the samples remained virtually unchanged. We also carried out an organoleptic analysis (results not shown here) that showed consistency with the results obtained by Chopicka *et al*., 2012 and Stikic *et al.*, 2012, that is, an improvement in the taste of bread when adding quinoa seeds [13, 14].

However, adding over 16% of quinoa seeds worsened the quality of the bread: the specific volume decreased with 11%, the crumb porosity decreased by 15% and crumb elasticity decreased by 16%. With the addition of 32% of quinoa seeds bread became totally unattractive for consumption: the specific volume decreased by 26%, the crumb porosity decreased by 38%, and crumb elasticity decreased by 40%.

Stikic et al., 2012 added up to 20% dehulled quinoa seeds, devoid of saponins into white wheat flour and found that the rheological characteristics of dough and the sensory characteristics of bread were excellent. Codină *et al*., 2016 added up to 20% quinoa flour to white wheat flour and found that 5-10% of quinoa flour has a beneficial influence on bread quality (both on the physical and sensorial properties) [15]. The differences in the percentage of added quinoa between our results and those quoted may have occurred due to the form in which quinoa - seeds or flour, peeled or not peeled - was added and also due to the type of wheat flour that was used - white or whole.

4. Conclusions

As shown above the addition of quinoa seeds does not change the process of making bread but it does modify the recipe by requiring that for every 8 grams of seeds added to 100 grams of flour, the amount of added water must be increased by 5.5% of the initial water. The main qualitative parameters – specific volume, crumb porosity, and crumb elasticity – of the samples remain virtually unchanged up to an additional 8% of quinoa seeds. An addition of 16% quinoa seeds resulted in a worsening of the quality of the bread, while an addition of 32% quinoa seeds renders the bread totally unattractive for consumption, especially taking into account that the Romanian consumer prefers bread with high volume, high porosity and high elasticity of crumb.

Quinoa seeds, as such, can be used as an ingredient in the manufacturing of bread with functional properties without modifying the expected character of the bread as long as the percentage of 16% quinoa seed (relative to flour) is not exceeded.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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