ISSN (Print) : 2319-8613
ISSN (Online) : 0975-4024

Effect of adding Chenopodium Quinoa Willd flour on the chemical properties of bulk bread

FATEMEH RAOUFIANBANADAKI
Master's degree in Food science and technology engineer,
Islamic Azad University, Yazd Branch

Abstract: Since bread is the essential food of the people, increasing its nutritional value can lead to enhancing the health of society and taking advantage of its nutritional properties. This study investigated the effect of adding quinoa flour on different properties of bulk bread. By replacing wheat flour (0-30%) with quinoa flour, bulky bread has been baked. Rheological tests of dough, including extensograph and farinograph and tests of texture, color, and sensory evaluation) were performed on the bulk bread. Using one-way analysis of variance and at 95% confidence level, the average test results were evaluated. By adding quinoa flour, the hardness of the dough increased, its brightness decreased, and indices *a* and *b* increased. By adding 10% quinoa flour, the sensory properties of bread were improved. But adding higher amounts, there was a significant reduction in overall acceptance, smell, taste, and texture of the product. In general, the results show that the best treatment is to add 10% quinoa flour.

Keywords: Quinoa flour, Sensory properties, Bulk bread,

Introduction*:*

In most countries of the world, bread is the main food and has a large portion in obtaining energy, protein, minerals, and B vitamins needed daily for people (Moharrami et al., 2011). According to the FAO, the consumption of bread and other wheat products accounts for 70% of the daily energy of the people of the Middle East. Besides, the lack of good quality in traditional bread is a parameter that has caused more than 30% of them to be wasted (Movahed et al., 2014). In Iran, by consuming bread, 60-65% of protein and calories, as well as 2-3 grams of required mineral salts and a large part of the required daily salt obtained (Rajabzadeh, 2001). The polysaccharide in starch is the most important part of carbohydrates received in the body. By chewing and contact of the enzyme with the polysaccharide, its enzymatic decomposition begins and as soon as stomach acid encounters the polysaccharide, the breakdown stops. By contact with duodenal alkaline and pancreatic enzyme amylase activity, starch degraded to glucose and absorbed via the intestinal wall. Of course, starch must be hydrolyzed before being absorbed by the gut, which is done in the stomach (Cabarello, 2007). Via different flours in a different region of the world, bread is produced in a variety of shapes. Wheat belongs to the genus of cereals, is one of the monocotyledonous plants, and is located under the genus of wheat. Bakery wheat (Triticum aestium) consists of three parts: germ, endosperm, and shell. Cereal membranes, such as wheat, are a deformed form of the leaves called straw.

There is a layer on the shell that is one cell thick and covers all the endosperm and bud and is the outer layer of the endosperm (Payan, 2001). The aleurone layer contains ash, protein, cellulose, phosphates, phytates, fats, niacin, thiamine, and riboflavin. The endosperm is cellulose-free and the starches are large, small, and lenticular.

Quinoa (Chenopodium quinoa wild) is a grain-like seed and native of South America. This grain has long been considered a product of the American continent. Archaeologists have found that quinoa was consumed in South America around 3,000 BC. This seed was known among the Incas as the mother of seeds and was also a sacred seed. In Inca times, quinoa was a popular agricultural product in Latin America. After the Spanish took control of the area, the use, consumption, and cultivation of this seed ceased and remained only as small farms. Also, the food habits and traditional foods of the natives changed and were replaced by non-native products such as wheat and barley. In this way, quinoa was grown on small fields in rural areas for animal feed or as a border for crops such as potatoes and corn. Since then, the grain has been considered the food of the poor, and its consumption has gradually declined among the people.

Quinoa seeds have an outer layer that contains the poisonous and bitter substance saponin. This layer must be removed before eating or processing during food production. Besides, this layer plays a role in protecting the grain against pests.

Research has reported an average of 12-23% protein for quinoa seeds (Abugoch et al, 2009). This amount of protein is higher than common grains such as rice, barley, or wheat, but less than legumes. Methionine and histidine are higher in quinoa seed protein than in barley, soy, or wheat. The high content of these compounds shows that quinoa can be used as a supplement for legumes, as most legumes are low in methionine and cysteine (Demir & Kilinc, 2017).

Quinoa is higher in minerals, especially potassium, magnesium, and calcium than other grains, such as rye and barley) (except phosphorus). Kunishi et al. (2004) found that grinding quinoa seeds (to remove saponin compounds) had a significant effect on reducing calcium levels. Quinoa is also very rich in vitamins, it has high amounts of vitamin B6 and total folate, which is 100 grams can meet the needs of children and adults for vitamins (Table 1-9). In addition to the mentioned benefits, quinoa seed also contains important micronutrients such as minerals and vitamins. This seed has effective antioxidant properties due to the presence of sufficient amounts of bioactive compounds such as polyphenols. (Alvarez-Jubete et al., 2010). Other research has shown that quinoa is a wealthy source of dietary fiber (1.1 to 16.3%), which is greatly higher than rice (0.4%), wheat (2.7%), and corn (1/7%) Alvarez-Jubete et al. 2010). This plays an important role for the celiac patient because these patients have gluten-free diets, which cause insufficient absorption of fiber in the body, so the implementation of quinoa seeds in their diet can compensate for this problem of fiber absorption. Alvarez-Jubete et al., 2010).

The colorimetric properties of the crust, kernel, and quality characteristics of Barbari bread enriched with whole quinoa flour were studied by Jeldani et al. (2017). They used a ratio of 0.1.5% xanthan gum and 0-15% quinoa flour in this experiment. The data showed that increasing quinoa flour in the formulation reduced the L index in the crust and kernel, index a in the brain, and b in the crust are also reduced. Also, in the produced bread, due to the increase in the percentage of quinoa, weight loss occurs, and the index an in the crust and b of the brain increase. Ultimately, they suggested that these components be added to the bread formulation to enhance the nutritional value of the bread.

Ebrahimzadeh et al, (2015) substituted wheat quinoa flour for wheat flour at three levels of 10, 20, and 30% and then examined the rheological properties of the resulting Barbari bread dough. Farinograph test data showed no significant difference between control and other samples, but there was a significant difference in the rheological results obtained from the extensograph between the control and other samples in resistance to extension, tensile strength, and energy required for extension dough was observed. In the colorimetric test, a considerable difference was observed between the color of the control sample and the samples with quinoa flour.

Jeldani et al. (2017) added xanthan gum and whole quinoa flour to Barbari bread and then studied its chemical and sensory properties. Xanthan gum (0-1.5%) and whole quinoa flour (0-15%) were considered as independent variables in this study. Dependent variables included chemical properties (moisture, ash, fat, protein) and sensory properties of Barbary bread. Adding whole quinoa flour to Barbary bread increased the amount of ash, protein, and fat in the bread, and with the addition of xanthan gum, the amount of moisture in the bread samples increased. Their findings showed that the optimal formulation could be 84.9% whole quinoa flour and 1.5% xanthan.

Soika et al. (2014) examined bread enriched with quinoa leaves and its effect on the set of protein-phenolic reactions on nutritional and antioxidant attributes. This addition led to a change in the textural properties of the dough and a 5% increase was observed linearly in the dough firmness, adhesion, and chewability. The results showed that there is an inverse relationship between starch digestibility and the amount of quinoa added.

Milovavik et al. (2014) examined the quality characteristics of wheat bread made with quinoa, buckwheat, and pumpkin seeds in their research. In this study, wheat flour up to 40% was replaced with a mixture of quinoa (15%), buckwheat (15%), and pumpkin seeds (10%), and its impact on nutritional value, sensory quality, and energy was tested. Compared to the control sample, the amount of protein, crude fiber, and oil in the replaced samples was increased. The sensory properties of bread, including specific volume, appearance, crust and texture, aroma, smell, and color were also enhanced in this experiment.

Johar et al. (2016) used biological tests to determine the functional characteristics of bread prepared with quinoa flakes. The results of this study showed that the preparation process affects the nutritional properties of bread because it increases the amount of dietary fiber, instead reduces the soluble fiber. Increasing fiber does not change the amount of food absorbed. Also, with the addition of quinoa, all tocopherols showed an increasing trend.

Demir and Klink (2017) conducted a study on cookie production using quinoa flour. They used ratios of 0, 10, 20, 30, 40, and 50% of quinoa flour. The results showed that the use of quinoa flour can slightly increase the thickness and diameter of the product. Also, increasing the amount of quinoa in flour, indices a and b increased but index L decreased. With the addition of quinoa flour, an upward trend was observed in indicators such as ash, crude protein, crude fat, the amount of total phenolic compounds in the cake samples. Also, increasing the amount of phytic acid in the samples was the result of increasing quinoa flour. The addition of quinoa enhanced properties such as color, taste, crispness, and overall acceptability, but hurt odor. Eventually, results showed that the implementation of quinoa flour had a positive impact on the chemical, nutritional, and sensory properties of the cake.

Nowadays, there is an increasing trend in the use of bulk bread, because this bread is processed and baked in a way that leads to less waste, increase the shelf life of the bread, as well as its vitamins and proteins preserved. Baguette bread is a popular and widely consumed bulk bread (4%) in the country (Adili et al., 2015). Due to the type of soil and climatic conditions that exist in most parts of Iran, cultivated wheat does not have the desired quality for flour production. Since controlling atmospheric conditions and other parameters affecting the quality of wheat is difficult and often impossible, as a result, the quality of the flour obtained is not very acceptable and causes deficiencies in bread production (Shafi Soltani, 2014). By mentioning these cases, it seems necessary to improve the characteristics of wheat as well as alter the quality of bread. Hence, in this study, the effect of Chenopodium Quinoa Willd flour on the chemical properties of bulk bread was studied.

Research Methods:

Materials: Special star wheat flour with a bran content of 21% was used in this study. Quinoa seeds were purchased from the local market and xanthan gum was prepared from Avijeh Farjud Parsi Company. All chemicals used in the test were analytical.

Preparing the dough*:* 95% star flour, 2% salt, enough water to achieve the desired dough consistency, 2% dry yeast dough and 1% curing(Flour treatment agent), and quinoa seed flour in the amount specified in the treatments were used to produce the dough. After preparing the dough, the relevant tests were performed on it. The formulation used is shown in Table 3-3.

Samples: Table 1 shows the treatments used in this study. Numbers are expressed as a percentage by weight. First, the above treatments were prepared, and then the steps of performing tests and preparing dough and baking were performed.

Baking bread*:* After performing the necessary tests, the dough was placed at 40-38 °C for 40 minutes to ferment. Then it entered the cooking stage. The bread was baked at 250 °C for 15 minutes. After cooking, they were cooled and packed in polyethylene bags to prevent drying and making undesirable changes until the test. Finally, other tests were performed on bulk bread.

Table 1: Formulation of treatments used in the experiment (numbers are given as a weight percentage).

Treatment	Quinoa flour	Xanthan gum	salt	Flour treatment agent	dry yeast dough	Star flour
T_0	0	0	2	1	2	95
T_1	10	10/	2	1	2	84/9
T_2	20	10/	2	1	2	74/9
T_3	30	10/	2	1	2	64/9

Moisture: to measure the moisture content, 4-5 grams of the sample was weighed in a plate that had already reached a constant weight. The plate was then dried in an oven at 130 ± 5°c for 120 minutes (about 2 hours). The plate was then taken out of the oven and cooled in a desiccator and weighed again. A scale with an accuracy of 0.001 was used for the experiment. According to the formula in (National Standard of Iran 2705, 1389, method of measuring the moisture content of cereals and its products by a conventional method, with some changes) the amount of moisture was measured.

Formula (1):

$$= \frac{\text{initial weight of plate and sample in gram} - \text{secondary weight in gram}}{\text{weight of sample}} * 100 \text{ - moisture}$$

Flour protein: Using the Kjeldahl method, the amount of protein in flour samples was measured. This method includes three stages of digestion, distillation, and titration. In the first step (digestion), 1 g of flour sample was weighed with a digital scale with an accuracy of 0.001 g. The sample was then transferred to a digestion balloon and 5-6 g of protein catalyst (which contained 1.1 g of selenium oxide, 0.5 g of copper sulfate powder, and 5 g of potassium sulfate) and 20 ml of concentrated sulfuric acid was added to it. The system was closed and heated for digestion. After this stage and the clarification of the liquid inside the Kajeldal balloon, it was heated in the same position for half an hour and then removed from the heat. The balloon was cooled and the distillation system was closed. In the end, 50 ml of boric acid 4%(M/V), accompany methyl red reagent poured into an Erlenmeyer flask and place the refrigerant end under the liquid. Then 200 ml of water and also 50 ml of caustic soda of 40% (M/V) were slowly added to the digestion balloon. The system was heated with refrigerant. This step is completed when the volume of boric acid in Erlenmeyer reaches 150 ml. Titration was performed with 0.1 N sulfuric acid. The volume of sulfuric acid consumption was recorded. After titration, the amount of protein in the flour sample was calculated from the following formula (2014, Iranian National Standard 19052, measuring the amount of nitrogen and calculating the amount of crude protein - Kajeldal method, with some changes).

Formula *(2):*

$$\text{Nitrogen} = \frac{V*0.0014*10000}{w*100}$$

V is the volume of sulfuric acid consumed during titration(ml), W = Flour sample weight(g), After determining the amount of nitrogen, the resulting number was multiplied by the protein conversion ratio of wheat flour (5.7) and the number obtained was reported as protein.

Dough tests:

Farinograph:

A pharyngeographic device with specifications (Yojesh Bash, Turkey) and method No. ACC54-21 was used to measure the treatments added on dough characteristics such as (weight dough, stability, and flour water content). Before performing the test, the water tank of the device was turned on until the water reached 30 ° C. Then the burette of the device was filled with this water. The impurities in the flour were removed and aerated evenly. Then we weighed 300 (g) of it and poured 5 (g) of salt and the amounts used in the treatments into the tank of the machine and the machine started operating. Mixing was performed for 1 minute to achieve a uniform mixture. After this step, gently add water to the flour using a burette and a water absorption diagram began to be drawn. Water was added to the dough until the graph reached the 500 FU line. The chart should be kept on this line for three minutes, which is possible by adjusting the amount of water added. After 5 minutes, the device was turned off and the amount of water added could be read from the device burette. This test was performed to determine the water absorption in the dough and the obtained dough was used for the extensograph test. To draw a farinograph diagram, 300 g of unsalted flour was added to the machine again. The previous test was repeated and the water obtained from the previous step, which indicates the absorption of water in the flour, was drained at once. After 20 minutes, the curve was drawn by the device. We used this chart to interpret the farinograph results.

Extensograph:

Analysis of texture and properties of the dough, such as strength, tensile strength, and energy of the dough was performed using an extensograph at three times (45, 90, and 135 minutes) according to (ICC standard method number 140). The dough prepared in the farinograph stage was used for the extensography test. The dough was divided into two parts of 150 g and each part was first rotated in the rounding part of the machine for 20 seconds at 20 rpm. Then it was rolled and placed in the greenhouse of the machine so that the dough could sleep at a temperature of 25°c at a certain time.

After a certain period (30, 90, and 135 minutes) the dough was placed in the part containing the holder, then by pressing the desired key, the hook of the machine started to come down and by pulling the dough down, the extensograph curve was drawn. Eventually, when the dough broke, the drawing stopped and the hook stopped at the end of the path and then moved upwards. The extensograph-related results were analyzed by examining the graph obtained at this stage.

Color evaluation experiment

The color of bread samples was measured using a Minolta colorimeter (Minolta, C360, Japan), and the L, a, and b indices were determined. Bread crust color analysis was carried out 2 days after baking using three indicators a *, b *, and L *. The L* index indicates the brightness of the sample and its range varies from zero (pure black) to 100 (pure white). a* description of the similarity of the sample color to green and red and varies from -120 (pure green) to +120 (pure red). Index b * display the degree of proximity of the sample color to blue and yellow colors and its range varies from -120 (pure blue) to +120 (pure yellow). These indices were measured by making an incision measuring 2 x 2 cm from the bread and then scanning it.

Findings*:*

Chemical analysis of quinoa flour and star flour:

Table 2 display the results of the chemical analysis of quinoa flour and star flour used in the preparation of fancy bread. As reported, the ingredients in quinoa flour such as fat, protein, fiber, and ash are high, which these parameters affects the fancy bread produced. Comparison of the two flours shows that quinoa seed flour has a higher amount of protein and ash than star flour, and ash is in the standard range of star and terms of gluten and gluten index has a good quality for making fancy bread.

Table 2: the results of chemical analysis of quinoa flour and star flour

number	Chemical factors	Rate (%)
Quinoa flour		
1	moisture	031/6
2	fat	767/6
3	protein	364/14
4	starch	177/36
5	ash	534/2
6	fiber	39/1
star flour		
1	moisture	11/14
2	Wet gluten	27
3	protein	5/12
4	Gluten index	75
5	ash	70/0

Dough water absorption

Figure 1 shows a comparison of changes in water absorption in dough due to the addition of different amounts of quinoa flour. Also in this figure, the comparison of the control sample against the sample containing quinoa flour is shown. Water absorption in samples containing quinoa flour had a significant increase, the highest water uptake was related to the treatment containing 30% quinoa flour (57%) and the lowest water uptake was observed in the control sample, which did not contain quinoa flour (52.4). There was no difference between water absorption in the control sample and the sample containing 10% quinoa flour ($P < 0.05$). Therefore, the results showed that quinoa flour has a positive effect on increasing the water absorption of the dough.

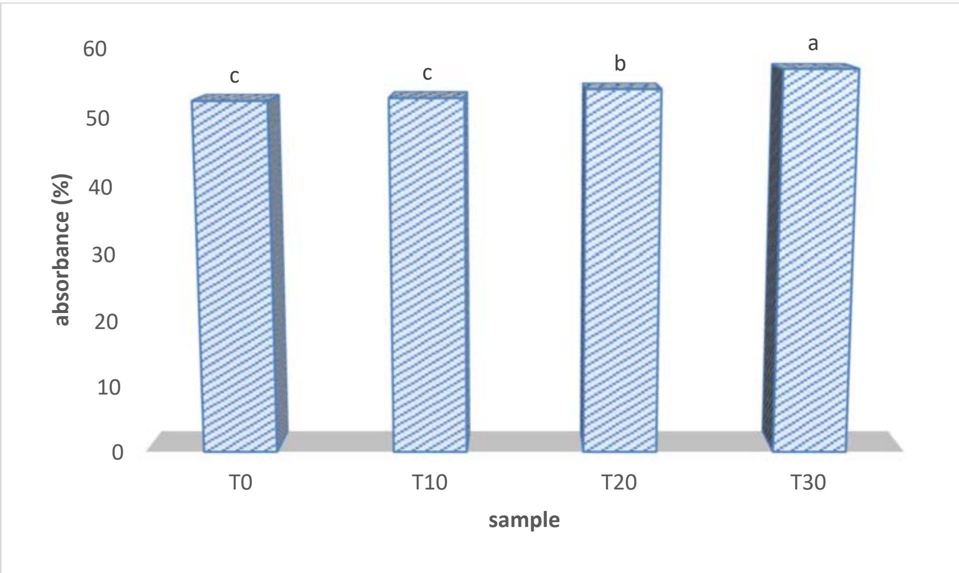

Figure 1- changes in water absorption in fancy bread dough containing different amounts of quinoa flour. Different letters indicate a significant difference between the results ($P < 0.05$).

The color of bread

To evaluate the color of bread, three indices of light (L), green-red (a), and yellow-blue (b) were measured in bulk bread samples, and then the results were compared. You can see the results in Table 4-5. Also, the changes in these color indicators in the presence of different amounts of quinoa flour are shown in Figure 2, respectively.

Table 3: Color indices (L, a, and b) different bread samples in the presence of different amounts of quinoa flour. Different letters indicate a significant difference between the results

L	a	b	
53/15^{a}	9/79^{d}	21/97^{d}	**T0**
50/45^{b}	11/34^{c}	23/48^{c}	**T10**
43/12^{c}	14/12^{b}	26/21^{b}	**T20**
40/9^{d}	18^{a}	28^{a}	**T30**

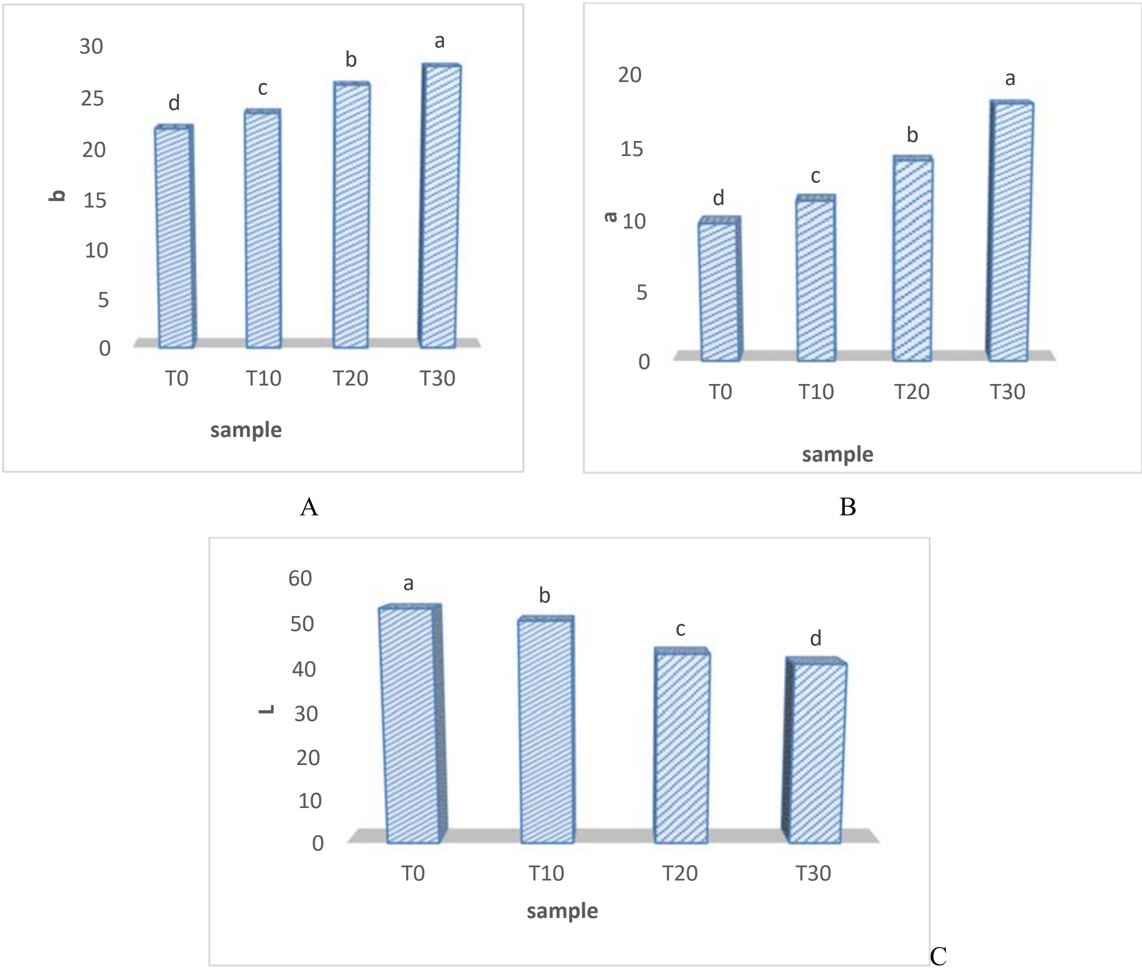

Figure 3 - a) changes in the index (a) in the color of bulk bread after adding different amounts of quinoa flour. Different letters indicate a significant difference between the results (P <0.05), B) Adding different amounts of quinoa flour and changes in the index b in the color of bulk bread. Different letters indicate a significant difference between the results (P <0.05), C) different in the amount of L index in the color of bulk bread in the presence of quinoa flour. Different letters indicate a significant difference between the results (P <0.05).

The results obtained from the color characteristics show that by increasing quinoa flour, the amount of (a) and b indices in all samples increases, but the amount of L index decreased. These changes and their differences are statistically significant at the 95% confidence level (P <0.05). It was found that the control treatment had the lowest index (a) and b (9.79, 97, and 21, respectively) and the highest index L (53.15). With increasing quinoa flour, the brightness index (L) decreased and the amount of two green-red (a) and yellow-blue (b) indices increased. By adding the highest amount of quinoa flour (30%), the highest amount of index (a) and b (18 and 28, respectively) was obtained and the lowest amount of index L was 9.40. As shown, all differences in these indicators were statistically significant (P <0.05).

Conclusion

In this study, the effect of adding different values of quinoa flour on different characteristics of bulk bread was studied. For this purpose, quinoa flour was replaced by wheat flour at a rate of 0-30%. Then, the bread dough was prepared and the rheological properties of the dough were analyzed using extensograph and farinograph devices. In determining the properties of the dough, water absorption properties, dough stability, development time, energy, strength, and extension time of the dough were evaluated and compared. Then the bread was prepared and textural characteristics, color, and sensory evaluation were performed. Mean results were obtained using a one-way analysis of variance (ANOVA) with a 95% confidence level. In farinograph examination, the results showed that the addition of quinoa flour increases water absorption. Water absorption percentage indicates the amount of moisture that flour absorbs during the conversion into the dough. The amount of water absorption depends on several factors. In this study, it was found that the higher the ratio of increasing the amount of quinoa flour, cause increases the water absorption. This seems to be due to the high percentage of fiber in quinoa seeds.

Fiber absorbs a lot of water and as a result, in samples containing the higher value of quinoa, water absorption will be higher. In terms of color characteristics, the results declare that with increasing the percentage of quinoa flour, the brightness index of the dough decreased, and at the same time the a and b index of bread increased, which display the negative effect of this flour on the whiteness and brightness of the resulting bread. The obtained results are by the finding of Jaldani et al. (2017) who examined the colorimetric properties of the crust, kernel, and quality characteristics of Barbari bread enriched with quinoa whole flour. Their results showed that increasing the percentage of quinoa flour in the formulation decreases the L-crust and kernel index, a kernel and b-crust index, and weight loss, and increases the a-crust and b-kernel index in the produced bread. The reason for these results can be found in the use of quinoa flour and also the different colors of quinoa flour compared to wheat flour, which was accompanied by whole bran and fiber. In terms of sensory characteristics, the results showed that by adding quinoa flour up to 10% Acceptability has increased, but with increasing levels, all sensory characteristics have decreased significantly. The smell and taste of quinoa flour compared to wheat flour can be the reason for this decrease in acceptance.

The results are consistent with the results of Morales and Alancar (2017), which matched the sensory properties of gluten-free bread containing quinoa flour and amaranth and sweetener. 100% quinoa flour replaced wheat flour and was tested for celiac disease. Their results showed that the brown color of the crust and the special taste and aroma of quinoa harmed consumer acceptance. In general, according to the obtained results, it seems that the optimal amount of quinoa flour to determine the best texture, sensory and color characteristics is to add 10% of this flour and replace it with wheat flour in the preparation of bulk bread.

References

[1] Payan, R, (2001), Introduction to Cereal Products Technology, Aize Publishing, Tehran, 420 p.

[2] Abugoch, J., (2009). Quinoa (chenopodium quinoa Willd.): composition, chemistry, nutritional and functional properties. Advances in Food and Nutrition Research, 58,1-31.

[3] Wang, S., Opassathavorn, A& Zhu, F. (2015). Influence of quinoa flour on quality characteristics of cookie, bread and Chinese steamed bread. Journal of Texture Studies, 46(4), 281-292.

[4] Gewehr, M. F., Pagno, C. H., Danelli, D., Melo, L. M. D., Flôres, S. H., & Jong, E. V. D. (2016). Evaluation of the functionality of bread loaves prepared with quinoa flakes through biological tests. Brazilian Journal of Pharmaceutical Sciences, 52(2), 337-346.

[5] Alencar, N. M. M., Morais, E. C., Steel, C. J., & Bolini, H. M. A. (2017).Sensory characterisation of gluten-free bread with addition of quinoa, amaranth flour and sweeteners as an alternative for coeliac patients. International Journal of Food Science & Technology, 52(4), 872-879.

[6] Rajabzadeh N., 1989.Fundamentals of Cereal Technology, Volume II, University of Tehran Press.

[7] Movahedi, Khalatbari Mohseni, G, Ahmadi Chenarban H, 2014. Evaluation of the use of xanthan gum and potato flour on the rheological properties of dough and the quality of toast, Journal of Modern Food Science and Technology, 1 (3:) 48-39.

[8] Cabarello,. (2007). Effect of hydrocolloids on dough rheology and bread quality parameters in gluten-free formulations. Journal of food Engineering. 79 ,1033-1047.

[9] Koanishi, (2004).

[10] Different hydrocolloids as bread improvers and antistaling agents. Food Hydrocolloids, 18, 241–247.

[11] L. Alvarez-Jubete, Eimear Gallagher, Elke K Arendt" Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients",February 2010,Trends in Food Science & Technology 21(2):106-113,DOI: 10.1016/j.tifs.2009.10.014.

[12] Jaldani Sh, Nasehi B, Barzegar M and Sepahvand N, 2016.study of colorimetric characteristics of crust, kernel and quality of Barbari bread enriched with quinoa flour, the first international congress and the fourth national congress of Iranian food science and industry, Tarbiat University Modares, Tehran.

[13] Jaldani Sh, Nasehi B, Barzegar M and Sepahvand N, 2017.Impact of adding whole quinoa flour and xanthan gum on the chemical and sensory properties of Barbari bread by response surface method, Journal of Food Science and Industry, 70, 79-89.

[14] Soeeca et al., Coelho I, Gueifão S, Santos M, Matos AS, Gimenez A, Lobo M, Samman N. and Castanheira I, 2014. Characterisation of nutrient profile of quinoa (Chenopodium quinoa), amaranth (Amaranthus caudatus), and purple corn (Zea mays L.) consumed in the North of Argentina ‹proximates, minerals and trace elements. Food chemistry 148: 420–426

[15] Milovanovic, Rosell CM and Gomez M, 2014. Effect of water content and flour particle size on gluten–free bread quality and digestibility. Food Chemistry 151: 526–531

[16] The effect of using lipase enzyme on the quality characteristics of baguette bread, Mania Salehifar, Leila Adili, Babak Ghiasi Tarz, Hossein Bakhoda, Journal of Food Science and Technology, No. 49, Volume 12, Winter 2015.

[17] Shafi Soltani, Mahsa, Salehifar, Mani, Hashemi Maryam. The role of alpha-amylase enzyme obtained from fungi on the quality characteristics of dough and toast, Innovation in food science and technology (Food Science and Technology, Summer 2014, Volume 6, Number 2; Page 43 to Page 54

[18] National Standard of Iran 19052, Measurement of Nitrogen and Calculation of Crude Protein - Kajeldal Method, 2014.

[19] Ebrahimzadeh A, 2015. Study of chemical, physical and rheological properties of Barbari bread enriched with quinoa flour, Master Thesis, Islamic Azad University of Ghods.

[20] M.K. Demir, Utilization of quinoa flour in cookie production, December 2017.International Food Research Journal 24(6):2394-2401.

[21] Buehler E .2006. Bread Science: the Chemistry and Craft of Making Bread,USA, Durham Herald Company, 247p.