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Investigating the physicochemical and textural characteristics of semi-volume Barbari bread containing whole meal flour and malt flour of cereal and pseudo cereal

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ABSTRACT

Food security is always under threat due to the limited production resources in agriculture and dependence on a single product such as wheat. Sustainable agriculture requires that in the production of agricultural products, one-sided and single products should not be used. So, the aim of this study was replacement of 10% of the wheat flour in the semi-volume Barbari bread formulation by the whole meal flour and malt flour of barley, oats, quinoa and amaranth. The results showed the sample containing 10% whole oat flour had the highest amount of moisture, specific volume and porosity. While the use of malt decreased the amount of the mentioned parameters. Regarding the evaluation of the firmness of the texture, the results showed that the sample containing whole oat had the lowest firmness in 2 h and 3 days after baking, and it should be mentioned that the use of the malt of the studied grains compared to the grain increased the firmness. Also, the analysis of the results showed that the amount of protein in the samples containing oat, amaranth and quinoa flour was higher than other samples. Examining the crust color of the product, showed a decrease in the amount of the L* value and an increase in the amount of the a* value with the addition of malt flour. During the sensory evaluation, the panelists assigned the highest overall acceptance score to the sample containing 10% whole oat flour. Therefore, the producers can enrich their products with oat flour without reducing the quality.

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1. Introduction

Being aware of the problem of drought and water crisis in many regions, researchers are looking for solutions to reduce water consumption, especially in the agricultural sector. In fact, due to the limited water and soil resources, the amount of wheat production in Iran does not exceed 15 million tons with the existing agricultural methods in the best climatic and weather conditions, and this is while the population is more than 80 million people. Iran needs about 15 million tons of wheat. Therefore, the fluctuations of wheat production and the wars that the world's major producing countries are currently involved in can be a crisis. This issue directs our attention to other parts of the world, in some regions of the world, sources of carbohydrates and plant protein are not provided only from wheat, and other grains, legumes and pseudo-cereals are the best providers of carbohydrates or protein. 1 and 2 [.

On the other hand, the malt obtained from these sources can also be used in the production of baking products, especially bread. In the baking industry, malt is added to flour as an enzyme source to prepare dough. In general, the most important effects of adding malt as an enzyme source are increasing the fermentation speed, improving the consistency of the dough, increasing the volume of bread, browning the crust and swelling and gelatinization of starch. In general, malting is one of the oldest biotechnology operations, and it means the process of limited and controlled germination of seeds, after drying, the product has desirable nutritional properties [3]. In the meantime, choosing the type of grain for malting is very important. In the present study, wholemeal flour as well as malt obtained from cereal grains (barley and joduser) and semi-cereals (quinoa and amaranth) were used in the formulation of semi-bulky Berber bread.

Barley is one of the most important sources of malt production worldwide and has unique nutritional properties. This cereal has a lot of dietary fiber (especially soluble fiber). Soluble fiber contains beta-glucans that lower blood cholesterol. Also, this compound is a hydroscopic substance and has the ability to retain water, which helps intestinal digestion. Today, the role of fiber in human diet and its effect on health and prevention of chronic diseases such as obesity, cardiovascular diseases, diabetes and gastrointestinal cancers are important [4]. Oatmeal or oats is a plant from the wheat family, which is quite narrow and elongated and is the same on both sides, that's why it is called oats. Its shell contains betaglugan, which increases the nutritional value of this seed. Oatmeal is a very good source of soluble and insoluble fiber, and the presence of complex carbohydrates reduces the risk of various types of cancer. Whole oat grain has unsaturated fatty acids such as oleic and linoleic acid, and the ratio of polyunsaturated fatty acids to saturated fatty acids is very favorable (2:2). Also, oats contain a high amount of protein that includes various amino acids. The protein in this grain is different from many grains. For example, the main protein in oats is globulin soluble in salt solutions, and this is one of the reasons for the high nutritional value of this grain [5].

On the other hand, it is worth mentioning that pseudo-cereals are not from the wheat family, but they are very similar to cereals, and in this study, quinoa and amaranth seeds, which are included in this category, were used. Quinoa plant is one of the plants that produces under dry and low water conditions. The nutritional quality of this plant is higher than grains and it is

very favorable in terms of amino acid balance [6]. The amount of lysine in the seeds of this plant is higher than that of wheat and it is favorable for human nutritional balance. Quinoa is poor in terms of sodium, but it is superior in terms of calcium, phosphorus, magnesium, potassium, iron, copper and manganese compared to wheat, barley and corn [7]. It is also richer than wheat in terms of fat, carbohydrates and vitamins [8]. Amaranth is one of the fodder plants in the pseudo-cereal category, which has recently been proposed as human, livestock and poultry feed. Due to its nutritional and adaptability, this plant can have the potential to enter crop rotation. Amaranth's adaptability to poor soils and its response to drought stress have made it possible to use it as a crop in semi-arid regions. Observations and dry conditions show that the drought tolerance of this plant is similar to sorghum and it is suitable for areas where sorghum and millet are grown [8 and 9]. In this regard, Miranda Vila et al. (2018) investigated the effect of adding quinoa flour and malt flour from it (up to 30% replacement in the formulation) on the quality of gluten-free muffins based on rice and the results showed that with Adding quinoa flour increased the amount of protein and minerals in the product. Also, the samples containing quinoa malt flour had the same level of moisture, height, volume and firmness as the test sample [10]. Al-Hadari et al. (2018) also investigated the effect of replacing barley malt with wheat flour in the biscuit formulation on the characteristics of the final product and stated that by increasing the amount of barley malt in the formulation, the L* component of the product decreased [11]. In addition, Ikomola et al. (2017) also investigated the characteristics of cookies prepared from wheat flour and barley bran malt and found that by increasing the amount of barley bran malt to the level of 10% in the formulation, the final moisture level of the samples increased [12]. Therefore, according to the mentioned materials, the purpose of this research was to investigate the possibility of replacing 10% of the wheat flour in the semi-bulky Berber bread formulation with wholemeal flour and malt prepared from barley, judser, quinoa and amaranth flour.

2- Materials and methods

2-1- Materials

Wheat flour (star flour) used in the formulation of Berber semi-bulky bread samples was purchased from Tehran Bakhtar factory (Tehran, Iran). Barley, judo head, quinoa and amaranth seeds were also obtained from the Research Institute of Plant Breeding and Seed Preparation and stored at 4 degrees Celsius. Other materials needed in the experiments include salt, oil and sugar purchased from a reputable store and dry and instant yeast from Razavi Yeast Factory (Mashhad, Iran) and improver also prepared from Nan Sahar Industrial Unit (Tehran, Iran) and refrigerated (The temperature was kept at 4 degrees Celsius. All chemicals were obtained from Merck, Germany.

2-2- Methods

2-2-1- Evaluation of the physicochemical properties of wheat flour and the seeds used

Barley, jujube, quinoa and amaranth seeds, after being cleaned and removing thorns and other waste materials, were ground into whole flour using a laboratory hammer mill and passed through a sieve with 100 mesh in order to control the size of the granules. became It is important to mention that regarding quinoa seeds due to the presence of saponin (a glycosidic compound with a bitter taste and

it is soluble in water, which is located in the outer shell of quinoa seeds), washed with water and after drying at room temperature, they were ground**]8[**. Then, in order to control the size of the granules, it was passed through a sieve with 100 mesh. In the following, the physicochemical characteristics of flours such as moisture, protein, ash and fat are based on the standard methods developed in the American Association of Cereal Chemists (AACC).[1]) (2000) was measured. The amount of moisture was evaluated according to standard number 44-16, protein 46-10, ash 01-08, fat 10-30 [13]. The amount of fiber was also determined according to the method of Ranganayaki et al. (2012) [14]. The amount of carbohydrates in the samples was also obtained by subtracting the sum of constituent compounds from 100 [15].

2-2-2- Preparation of malt from cereals and semi-cereals

To produce quinoa and amaranth malt, soak 2 kilos of seeds for 2 hours at a temperature of 20 degrees Celsius, then remove the excess water by using a net and keep the seeds closed on one side for 24 hours at a temperature of 25 degrees Celsius. for quinoa and 48 hours at 37 degrees Celsius for amaranth in a single layer and away from sunlight until the germination process is done [10 and 16]. Also, in order to produce barley and joduser malt, 2 kilos of seeds were soaked for 48 and 4 hours respectively at room temperature, then the excess water was removed by using a net and the seeds were kept on one side of the door closed for 5 days. Barley seeds and 4 days for barley seeds in a single layer and away from sunlight at a temperature of 18 degrees Celsius until the germination process is done [17 and 18]. Finally, the germinated seeds were dried by an oven and gradually with an upward temperature gradient until reaching the final humidity of 4% in order to maintain the enzymatic activity of the seeds. Before use, the protruding roots and cotyledons were separated and ground by hand. At the end of the process, they were passed through a sieve with a mesh of 0.25 mm [19].

2-2-3- Evaluation of the properties of malt produced from cereals and semi-cereals

The amount of reducing sugar in the produced malt samples was measured using the Linn anion volumetric method [20]. The amount of nitrogen in the malt extract samples was measured using the Kjeldahl apparatus [13]. The pH of the malt samples and the color of the malt extract produced according to the AOAC method were measured as 945-29 and 972-13, respectively [21].

2-2-4- Preparation of semi-bulky Berber bread samples

In order to prepare semi-bulky Berber bread dough, first dry ingredients including 100% wheat flour, 1% dry yeast, 1% salt, 1% sugar and 0.5% improver for 2 minutes with slow rotation in the mixing tank (Disona, manufactured Germany) were combined. In the next step, the required water (55-60%) was added and it was stirred again for 2 minutes and then it was stirred for 8 minutes with high speed. It is worth noting that 1% oil and 1% salt were added to the formulation in the sixth minute. At the end of the mixing stage, the dough (after 6 minutes of initial rest in a mass in the mixing tank and at ambient temperature) was weighed to a weight of 350 grams, then after an intermediate rest at ambient temperature for 12 minutes, forming And it was placed in a tray. The final fermentation was done for 45 minutes at a temperature of 37 degrees Celsius in a relative humidity of 80% in a greenhouse, and then the dough inside the oven was cooked with hot air and steam (Miwe, made in Germany) at a temperature of 240 degrees Celsius for 13 minutes. became. At the end, the trays were

[1]- American Association of Cereal Chemists (AACC)

emptied and the products were cooled for 1 hour at room temperature and packed in polyethylene bags (control sample) [22]. It is worth mentioning that whole flour and malt obtained from barley, jujube, quinoa and amaranth seeds were individually substituted for wheat flour in the formulation at 10% levels.

2-2-5- Evaluation of quantitative and qualitative characteristics of semi-bulky Berber bread samples

2-2-5-1- Measurement of moisture and protein

In order to measure the moisture and protein of the production samples, AACC (2000) test Nos. 44-16 and 46-10 were used respectively [13].

2-2-5-2- Measurement of specific volume

To measure specific volume of manufactured bread samples, using the volume replacement method with rapeseed[2] It was used in accordance with AACC standard No. 10-72. For this purpose, a cube-shaped piece of 25 mm was separated from each sample using a saw knife and weighed, and then it was placed in a cylinder with a certain volume of rapeseed and the increase in volume was recorded. At the end, the amount of specific volume was reported by dividing the volume by the weight of the samples [13].

2-2-5-3- Measurement of porosity and shell color

Evaluation of porosity and bread crust color was done using image processing technique. At first, in order to evaluate the porosity, a 25 mm sample piece was separated by a saw knife and images were taken from all three sections using a scanner (model: HP Scanjet G3010) with a resolution of 600 pixels. Image J software was installed and the porosity of the samples was estimated by calculating the ratio of light to dark points. Finally, the average porosity calculated for all three sections of the sample was reported as the final number of porosity [23]. Next, in order to determine the three indexes L*, a* and b*, images were taken from the shell using a scanner, and the above indexes were calculated in the Plugins section of AfazaLAB software [24].

2-2-5-4- Tissue evaluation test

The firmness of the bread texture was evaluated at intervals of two hours and three days after baking, using a texture tester (model XT plus, made in England). The maximum force required to penetrate a cylindrical probe with a flat end (2 cm diameter x 2.3 cm height) at a speed of 30 mm/min into the sample, as an index of stiffness.[3] Was calculated.

2-2-5-5- evaluation of sensory characteristics

In order to evaluate the sensory characteristics such as form and shape, shell characteristics, porosity and porosity, firmness and softness of texture and flavor (taste and aroma) which had a rank coefficient of 4, 3, 2, 3 and 3, respectively, from the 5-point hedonic method. (1: very unfavorable, 2: unfavorable and ... 5: very favorable) was used. Each of the bread samples was evaluated by at least 10 judges. Having this information, the overall acceptance (number of bread quality) was calculated using equation 1.

Relationship 1:

$$Q=\frac{\Sigma(P\times L)}{\Sigma P}$$

where: Q = overall acceptance, P = rating coefficient of attributes and G = evaluation coefficient of attributes.

2-2-5- Statistical plan and results analysis method

The results obtained from this research were evaluated using SPSS version 16 software. For this purpose, from a completely random design with factorial arrangement of two factors

[2]- Rape seed displacement

[3]- Hardness

The first factor was the type of substitute source of wheat flour in four levels of barley, jujube, quinoa and amaranth, and the second factor was the method of using these sources in two cases: whole flour or malt, each at a rate of 10% as a substitute for wheat flour. The samples were prepared in three replicates and the averages were compared using Duncan's test at a significance level of 5% (P<0.05). Finally, Excel software was used to draw graphs.

3. Results and Discussion

3-1- Physicochemical properties of flours

The results of the evaluation of the physicochemical properties of wheat flour and whole flour obtained from barley, jojoba, quinoa and amaranth used in the semi-bulky Berber bread formulation are given in Table 1.

Table 1. Physicochemical properties of different flour

Physicochemical properties (%)	Wheat flour	Barley flour	Oat flour	Quinoa flour	Amaranth flour
Moisture	12.10±0.32	10.8±0.25	10.61±0.32	10.2±0.03	13.9±0.24
Protein	12.0±0.41	11.0±0.12	15.9±0.61	15.3±0.53	14.2±0.39
Ash	0.69±0.01	2.69±0.10	1.83±0.03	2.17±0.36	1.97±0.00
Fat	1.60±0.01	2.51±0.08	4.65±0.05	3.15±0.01	3.70±0.12
Fibre	1.20±0.00	4.23±0.02	6.16±0.01	6.11±0.16	1/03±0.03
Carbohydrate	72.21±1.25	69.03±1.25	61.56±1.36	62.77±1.66	56.59±1.08

2-3- Physicochemical properties of malt

The results of evaluating the physicochemical properties of malt flour obtained from barley, jujube, quinoa and amaranth seeds are given in Table 2.

Table 2. Physicochemical properties of malt

Physicochemical properties	Barley	Oat	Quinoa	Amaranth
Reducing sugar (%)	1.3±0.0	1.1±1.2	1.2±0.1	1.2±0.0
Total nitrogen (%)	2.8±0.2	4.9±0.1	4.4±0.0	4.8±0.1
pH (-)	5.9±0.0	6.5±0.2	6.2±0.3	6.7±0.2
Color (ASBC)	11.5±1.1	9.5±0.3	9.7±0.4	9.6±0.2

3-3- Evaluation of quantitative and qualitative characteristics of semi-bulky Berber bread samples

3-3-1- Humidity

The results of the effect of the type of flour replaced with wheat flour on the moisture level of semi-bulky Berber bread are shown in Table 3. By examining the results, it was observed that the type of flour replaced with wheat flour had a significant effect on the moisture content of the bread (P<0.05). So that among the examined grains, oat grain had more ability to retain moisture in the final product. On the other hand, the samples containing malt of one grain had less moisture than the whole flour samples of that grain, so that the samples containing whole oat flour and the samples containing amaranth malt had the highest and lowest moisture levels, respectively. In relation to increasing the moisture level of the product using oat flour, it seems that, probably because the mentioned composition has a high amount of protein (according to Figure 1) and fibrous compounds that retain moisture such as beta-glucan [25], they have a greater ability to retain moisture. . In this regard, Chohan et al. (2018) investigated the effect of replacing whole oat flour (at levels of 0, 10, 15, 20 and 25%) with wheat flour on the nutritional and sensory characteristics of bread and noodles and stated that the moisture content of bread increased The amount of oats in dough formulation increased [26]. Of course, it is worth mentioning that barley flour, like oat flour, contains water-absorbing fibrous compounds such as beta-glucan, which justifies the effect of the mentioned

compound in increasing the amount of moisture. This is despite the fact that compared to oat flour, oat flour has less protein and its ability to absorb and retain moisture is somewhat lower than that of whole oat flour. Also, during the malting process, part of the starch, fiber and protein compounds change their structure due to biological and enzymatic activities and become simpler compounds [27], which can reduce the ability to maintain the product's moisture in the cooking process. In this regard, Ravanfar et al. (2013) investigated the effect of barley malt flour (at half, 1, 2, and 4 percent levels) on the quality characteristics of dough and Berber bread and observed that with the addition of barley malt, the water absorption rate of the dough increased. increases [28].

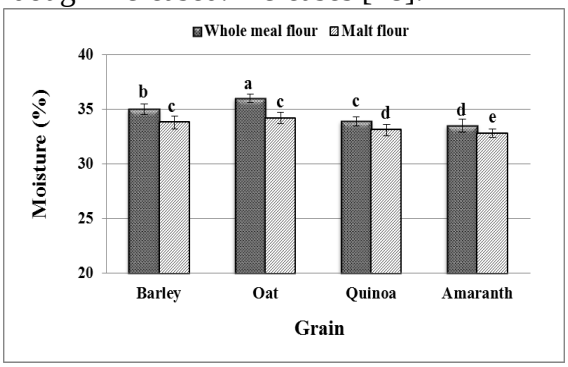

Fig 1. The effect of replacing wheat flour by different grains whole meal flour and malt flour on moisture content of semi-volume Barbari bread
(Means in with different letters differ significantly in $p<0.05$)

3-3-2- protein

The results of the effect of the type of flour replaced with wheat flour on the amount of protein of semi-bulky Berber bread are shown in Figure 2. By examining the results, it was observed that among the investigated grains, oat, quinoa, and amaranth had equal ability to increase the protein content of the final product. On the other hand, the samples containing single grain malt had less protein than the whole flour samples of that grain, so that the samples containing oat, amaranth and quinoa whole flours had the highest amount of protein and the samples containing barley malt had the lowest amount of protein. They gave. The amount of protein in the product is among the factors that are directly affected by the amount of protein in the compounds used in the product. In this regard, according to Table 1, it can be seen that the amount of barley protein is lower than other substitute compounds. In this regard, Pourafshar et al. (2015) also investigated the effect of replacing barley, oat, amaranth, and rye flours (at the level of 20%) with wheat flour on the nutritional and sensory characteristics of Berber bread and stated that the amount of protein in bread The use of oats increased compared to barley in dough formulation [29].

On the other hand, samples containing malted grains have lower protein content compared to samples without malt. As stated in the moisture assessment section, during the malting process, part of the starch, fiber and protein compounds change their structure due to biological and enzymatic activities and become simpler compounds, which may lead to a decrease in the protein content of the product. Also, during the malting process, part of the soluble protein compounds may enter the malt extract and their amount in the malt is reduced. In this regard, Banusha and Vesentaruba (2013) investigated the effect of the malting process on the nutritional content of finger millet and mung beans and stated that during the germination process, the dissolution of amino acids causes an increase in the amount of soluble nitrogen in the extract, which is due to the increase in the activity of the protease enzyme. is [30]. Carvalho and Bellia (2019) also investigated malting from germinated wheat and their results showed that the germination process (humidity 43%, time 78 hours and temperature 12.5 degrees Celsius) will lead

to an increase in the amount of soluble nitrogen in the extract [31] [.

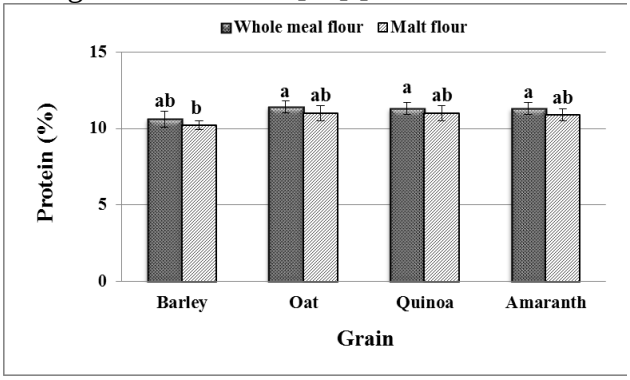

Fig 3. The effect of replacing wheat flour by different grains whole meal flour and malt flour on protein content of semi-volume Barbari bread
(Means in with different letters differ significantly in $p<0.05$)

3-3-3- specific volume and porosity

The results of the effect of the type of flour replaced with wheat flour on the amount of specific volume and porosity of semi-bulky Berber bread are shown in Figure 3. By examining the results, it was observed that the type of flour substituted with wheat flour had a significant effect on the amount of these quantitative characteristics of bread ($P<0.05$). So that among the investigated grains, oat grain had more ability to increase the specific volume and porosity of the final product. On the other hand, the samples containing single grain malt had less specific volume and voids than the whole flour samples of that grain, so that the samples containing whole oat flour and the samples containing amaranth malt had the highest and lowest specific volume, respectively. They had texture porosity.

In the products of the gluten protein baking industry, the main compound responsible for creating a network of air bubbles [32] and because adding these compounds in semi-bulky Berber bread reduces the amount of gluten, it is necessary that the mentioned compounds have a suitable ability to preserve Have air bubbles and uniform distribution in the product. Here, it seems that by increasing the amount of oat flour in the formulation, because this combination has a high amount of protein and moisture-retaining fibrous compounds such as beta-glucan, it has a greater ability to maintain air bubbles and ultimately increase the specific volume and porosity. In this regard, Pourafshar et al. (2015) investigated the effect of replacing flours, barley, oats, amaranth, rye with wheat flour on the nutritional and sensory characteristics of Berber bread and stated that the specific volume of bread when using oats compared to A non-significant increase was found to other substituted compounds in the dough formulation [29]. On the other hand, as mentioned before, during the malting process, part of the starch, fiber and protein compounds are converted into simpler compounds, which can reduce the ability to keep air bubbles in the product during the cooking process. Also, in products containing malt, due to the high enzyme activity (which leads to the destruction of the starch in the dough during fermentation), air bubbles are connected to each other and their exit from the semi-bulky Berber bread dough, which leads to a decrease in porosity. It becomes a product. In this regard, Kao et al. (2022) investigated the effect of substituting oat germ flour at the level of 20% on the textural characteristics and digestibility of starch in the bread product and observed that by substituting sprouted oat flour, the amount of specific volume The product was reduced compared to the control [33].

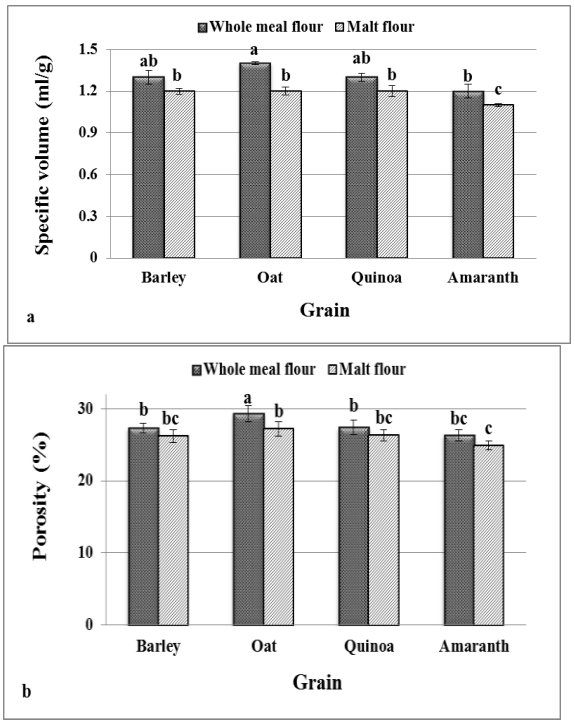

Fig 3. The effect of replacing wheat flour by different grains whole meal flour and malt flour on a: specific volume and b: porosity of semi-volume Barbari bread (Means in each parameter with different letters differ significantly in $p<0.05$)

3-3-4- Shell color

The results of the effect of the type of flour replaced by wheat flour on the amount of color components of the semi-bulky Berber bread crust are shown in Table 3. By analyzing the results, it was observed that only the type of flour replaced with wheat flour had a significant effect on the L* component of the bread crust ($P<0.05$). So that the samples containing malt of one grain had less shell L* component than the samples containing whole flour of that grain. On the other hand, it was observed that the shell of the samples containing malt of one grain had a greater amount of a* component than the whole flour samples of that grain, so that the samples containing oat malt flour and the samples containing whole barley flour had the highest and lowest amount, respectively. They had the a* component. Also, the type of grain and flour replaced with wheat flour did not have a significant effect on the b* component of bread crust ($P<0.05$). In this regard, it seems that the production of simpler sugar compounds during the malting process leads to the intensification of Maillard's non-enzymatic browning reactions and caramelization during the baking process, which in turn darkens the color of the bread crust. It brings with it [34]. In this regard, Yang et al. (2020) also investigated the effect of adding wheat malt (zero, 1, 2.5, 5 and 10%) on the physico-chemical characteristics of the cookie and their results showed that the amount of components L* and a* The shell of the product decreased and increased, respectively, with the increase in the amount of wheat malt replacement in the cookie formulation, which they attributed to the breakdown of proteins and carbohydrates in the malt by enzymes (during the germination process) and as a result, to the intensification of the Maillard reaction [35] [.

In connection with the use of barley, jojoba, amaranth and quinoa flours, it was observed that the amount of the a* component of the shell of the product increased with the replacement of whole jojoba flour compared to other substituted ingredients, and in this regard, Pourafshar et al. Doser and amaranth (at the level of 20%) with wheat flour were investigated on the nutritional and sensory characteristics of Berber bread and they stated that the amount of component a* of the bread crust increased when using whole wheat flour compared to other substituted ingredients [29]. .

Table 3. The effect of replacing wheat flour by different grains whole flour and malted flour on crust color values of semi-volume Barbari bread

Grain	Flour	Crust color (-)		
		L*	a*	b*^{ns}
Barley	Whole meal	53.7±0.7^{a}	11.2±0.2^{d}	19.1±0.1
	Malt	52.2±0.9^{b}	13.5±0.5^{bc}	19.3±0.5
Oat	Whole meal	53.5±0.6^{a}	12.9±0.6^{c}	19.2±0.6
	Malt	52.4±1.0^{b}	15.2±0.4^{a}	19.3±0.6
Quinoa	Whole meal	53.5±1.0^{a}	12.1±0.4^{cd}	19.2±0.7
	Malt	52.4±0.8^{b}	14.2±0.3^{b}	19.2±0.5
Amaranth	Whole meal	53.6±0.8^{a}	13.0±0.5^{c}	19.3±0.6
	Malt	52.2±0.6^{b}	14.1±0.5^{b}	19.2±0.5

(Means in each column with different letters differ significantly in $p<0.05$)
(ns: No significant difference in $p<0.05$)

3-3-5- tissue stiffness

The results of the effect of the type of flour replaced with wheat flour on the hardness of semi-bulky Berber bread during two time periods of 2 hours and 3 days after baking showed that among the investigated grains, oat grain has a greater ability to reduce the There was tissue stiffness in both time periods (Table 4). On the other hand, the samples containing single-grain malt had more texture stiffness than the whole flour samples of that grain, so that the lowest and the highest amount of texture stiffness was observed in the samples containing whole oat flour and the samples containing amaranth malt, respectively.

In fact, factors such as humidity, specific volume and porosity are involved in the hardness of bakery products in the time period immediately after baking. But the most important factor in increasing the stiffness of the texture of these products during the storage period is maintaining and maintaining humidity, because this item strongly affects the level of staleness of the manufactured product and increasing its stiffness during storage [36]. In relation to reducing the hardness of the texture of the product by using oat flour, as stated in the moisture content evaluation section, it is probably because the mentioned composition has a high amount of protein (according to Table 1) and moisture-retaining fibrous compounds such as beta-glucan. They maintain moisture and ultimately reduce tissue stiffness. On the other hand, the higher amount of protein and fat in oats compared to other grains can act as a factor that slows down the staleness process and then stiffens the tissue. In this regard, Kao et al. (2022) stated that oat beta-glucan reduces the plasticity and hardness of the dough [33]. On the other hand, due to the destruction of the structure of starch, fiber and protein compounds due to enzyme activity during the malting processmaking, the product's ability to retain moisture in the cooking process is reduced, which will affect the firmness of the texture. In this regard, Garcia et al. (2021) investigated the effect of adding sprouted oats in gluten-free products and stated that the activity of alpha-amylase, lipase and protease enzymes in sprouted oats is higher than in unsprouted oats [17].

Table 4. The effect of replacing wheat flour by different grains whole flour and malted flour on firmness of semi-volume Barbari bread

Grain	Flour	Firmness (N)	
		2h after baking	3 days after baking
Barley	Whole meal	14.21 ± 0.12^{bcdB}	20.69 ± 0.32^{bcA}
	Malt	15.83 ± 0.02^{bB}	21.95 ± 0.15^{abcA}
Oat	Whole meal	13.80 ± 0.02^{dB}	19.91 ± 0.15^{that}
	Malt	15.05 ± 0.02^{bcB}	21.10 ± 0.15^{bcA}
Quinoa	Whole meal	15.56 ± 0.02^{bB}	21.84 ± 0.15^{abcA}
	Malt	16.73 ± 0.02^{abB}	22.92 ± 0.15^{abA}
Amaranth	Whole meal	15.93 ± 0.02^{bB}	22.14 ± 0.15^{abA}
	Malt	17.14 ± 0.02^{aB}	23.37 ± 0.15^{aA}

(Means in each column with different letters differ significantly in $p<0.05$)
(Means in each row with different letters differ significantly in $p<0.05$)

6-3-3- General acceptance in the sensory test

The results of the effect of the type of flour replaced with wheat flour on the overall acceptance score of semi-bulky Berber bread during sensory evaluation are shown in Figure 4. By examining the results, it was observed that the type of flour replaced with wheat flour had a significant effect on the overall acceptance score of bread ($P<0.05$). So that among the examined seeds, oat seed was able to obtain the highest overall acceptance score in the final product. On the other hand, the samples containing single grain malt had a lower overall acceptance score than the whole grain flour samples, and the highest and lowest overall acceptance scores were observed in the samples containing whole oat flour and the samples containing amaranth malt, respectively. .

In general, in the score of form and shape, which is one of the characteristics that affect the overall acceptance of the product, parameters such as symmetrical or asymmetrical, tearing or loss of a part of the shell or core, the presence of any cavity or empty space, etc. It is determined that these cases are largely influenced by the raw materials in the formulation. In this regard, the sensory evaluators assigned more points to the sample containing 10 whole oat flour due to the uniformity of the texture and symmetry. On the other hand, the characteristics of the skin are examined based on burns, abnormality of color, wrinkles and abnormal surface. In this regard, the evaluators assigned more points to the sample containing 10 whole oat flour due to the brighter color and less wrinkling. In this regard, Salehifar and Shahidi (2007) also investigated the effect of replacing oat flour with wheat flour on the rheological, textural and sensory characteristics of Tufton bread and stated that the color and texture score of the product increased with the increase in the amount of oats in the dough formulation. increased [37]. Also, the presence of abnormal voids and high density and compression of the tissue in such a way that the porosity of the brain of the samples is hidden from the consumer's view, leads to a score deduction. In this section, the taste judges admitted that the sample containing 10 whole oat flours had more regular holes, while these holes were evenly distributed throughout the texture of the product, and this caused the said sample to have a high degree of porosity and

porosity. get more Another important parameter in sensory evaluation is the taste of the final product, and having a good taste and aroma plays a key role in the acceptability of this product. In this regard, the sensory evaluators said that the sample containing 10 whole oat flour created a more pleasant taste in the mouth due to its softer texture, and therefore they gave more points to the said sample.

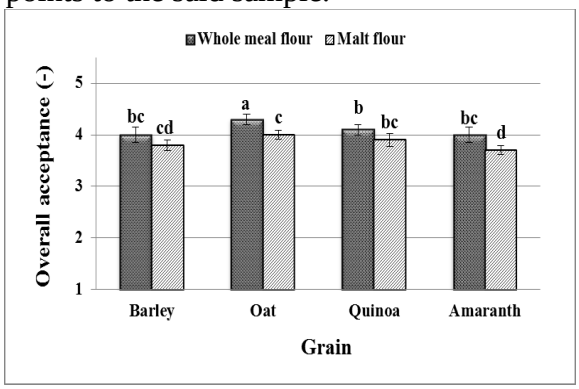

Fig 4. The effect of replacing wheat flour by different grains whole flour and malted flour on overall acceptance of semi-volume Barbari bread (Means with different letters differ significantly in $p<0.05$)

4- Conclusion

The purpose of this research was to investigate the replacement of 10% of wheat flour in the formulation of semi-bulky Berber bread with whole wheat flour, oats, amaranth, quinoa and malt obtained from this grain on the physicochemical properties of semi-bulky Berber bread. Based on the results, it was found that compared to malt flour, wholemeal flour had a greater effect on improving the quantitative and qualitative characteristics of bread, which, as mentioned, is related to the destruction of the structure of proteins and carbohydrates during the process of seed germination. is Also, replacing wheat flour with oats, in addition to improving the nutritional value, resulted in a higher score compared to other grains examined in this research. Therefore, it is possible for producers to enrich their products with Jodoser flour without reducing the quality.

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بررسی ویژگی‌های فیزیکوشیمیایی و بافتی نان بربری نیمه‌حجیم حاوی آرد کامل و مالت غلات و شبه غلات

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چکیده

امنیت غذایی با توجه به محدودیت منابع تولید در کشاورزی و وابستگی به محصولی نظیر گندم همواره در معرض تهدید قرار دارد. کشاورزی پایدار ایجاب می‌کند که در تولید محصولات کشاورزی یک جانبه و تک محصول عمل نگردد. از این‌رو هدف از انجام این تحقیق جایگزینی ۱۰ درصد از آرد گندم موجود در فرمولاسیون نان بربری نیمه حجیم با آرد کامل و مالت حاصل از جو، جو دوسر، کینو و آماراتت و مالت حاصل از این دانه‌ها بود. نتایج نشان داد که نمونه حاوی ۱۰ درصد آرد کامل جو دوسر در بین سایر نمونه‌ها از بیشترین میزان رطوبت، حجم مخصوص و تخلخل برخوردار بود. درحالیکه استفاده از مالت در تمامی نمونه‌ها باعث کاهش میزان پارامترهای مذکور گردید. در خصوص ارزیابی میزان سفتی بافت نتایج نشان داد نمونه حاوی جودوسر در هر دو بازه زمانی ۲ ساعت و ۳ روز پس از پخت از کمترین میزان سفتی بافت برخوردار بود و قابل ذکر است که استفاده از مالت دانه‌های مورد بررسی در مقایسه با خود دانه باعث افزایش سفتی بافت گردید. همچنین میزان پروتئین نمونه‌های حاوی آرد جودوسر، آمارانت و کینوا از سایر نمونه‌ها بیشتر بود. بررسی رنگ محصول نتایج گویای کاهش میزان مؤلفه L* و افزایش میزان مؤلفه a* با افزودن مالت ترکیبات جایگزین آرد گندم بود. طی ارزیابی حسی محصول، ارزیابان حسی به نمونه حاوی ۱۰ درصد آرد کامل جو دوسر بیشترین امتیاز پذیرش‌کلی را اختصاص دادند. بنابراین این امکان وجود دارد که تولیدکنندگان بدون کاهش کیفیت محصولات خود را با آرد جودوسر غنی نمایند.