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ORIGINAL ARTICLE

Using alternative flours as partial replacement of barbari bread formulation (traditional Iranian bread)

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Abstract Wheat flour is used in most of breads because of its nutrient components and high availability, but different problems are associated with this flour, such as allergies and loss of nutrient components due to milling and refining. In this study, five flours were used (20 %) in combination with wheat flour (80 %).to produce traditional Iranian Barbari bread. These included amaranth, barley, DDGS, rye and oat. Compositional measurements of moisture, fat, fiber, protein and ash content were taken. Physical tests were done to understand the changes in color, thickness, and texture. Results showed that the gluten content of each flour had a significant effect on the texture and thickness of the bread. Bread made with rye flour had the highest L* and that made with oat flour had the highest a*. As for b*, the highest was for the bread made with DDGS. It was also determined that bread made with 20 % DDGS and 80 % wheat flour had the highest fiber and moisture content, while that made with amaranth had the highest ash content, and that with rye had the highest fat. Adding different flours to wheat changed the physical and chemical attributes of final producst significantly.

Keywords Amaranth · Barbari bread · Barley · DDGS · Oat · Rye

Introduction

Cereals are one of the most widely consumed foods in the world because they are inexpensive, readily available and cultivated in most countries. Cereals are the edible seeds or grains of the grass family, *Gramineae*. Cereals and cereal products are important sources of energy, protein and fiber (Mckevith 2004). Though wheat is the most important and highly consumed cereal, the exact location where ancient wheat cultivation began remains a mystery. Some sources point to either the Syria-Palestine area or southern parts of Anatolia. Wheat cultivation spread from Palestine to Egypt and from northern Mesopotamia to Iran, where bread was first developed. Then, from Persia, the growth of bread spread in all directions (Qarooni 1996). Although wheat grain has many nutritional benefits as a food component for humans, most of its nutrients are lost due to milling processes. Thus, ways to add value to products made with all-purpose flour or other wheat flours continuous to gains importance. Since bread is the most consumed cereal product in many countries, fortification can help prevent certain diseases and problems, perhaps even malnutrition.

One way to fortify bread products is to use alternative flours beyond wheat. Different flours have unique nutritional characteristics. For example, oat and barley can enhance the β-glucan content of bread, which can have a significant impact on human health (Marrioti et al. 2006). Barley and oat can contain 3–11 % and 3–7 % of β-glucan, respectively (Sidhu and Kabir 2007). Consumption of barley has increased during the past few years because of its ability to cholesterol and mode blood glucose levels (Skendi et al. 2010). The β-glucan in barley flour can increase the quality of bread by modifying the glycemic and insulin response (Gujral and Gaur 2005). Studies also show that bread made with a blend of wheat and barley flour has acceptable sensory properties (Skendi et al. 2010). Amaranth has twice the lysine content of wheat protein. It also has cholesterol-lowering properties attributable to its nutrient components; its fiber content is three times higher than that of wheat (Ayo 2001). In Europe, rye is the most common cereal grown after wheat. Production of this grain is

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about 15.7 million tons per year (Horszwald et al. 2009). Rye is a cereal with high amounts of dietary fiber; whole grain rye contains 13 to 17 % fiber (Rakhan et al. 2010). Another positive nutritional effect of rye flour is the existence of lignin, phytosterols, and phenolic compounds, which are biologically active components that have antioxidant properties (Horszwald et al. 2009). Oat also offers health benefits because it is high in dietary fiber and protein contents. Besides dietary fiber, oat is rich in essential amino acids, unsaturated fatty acids, minerals and antioxidants (Huttner and Arendt 2010).

Distillers dried grains with solubles (DDGS) may also be a good ingredient for fortification of cereal-based products. DDGS is a product resulting from the fermentation of cereal grains, mostly corn, for the production of fuel ethanol. DDGS is a source of protein, fiber, minerals and vitamins. Different processing methods can be used in production of DDGS, and the method chosen affects the resulting physiochemical properties of the DDGS (Cromwell et al. 1993); the process used can affect the appearance as well as the nutritional content of final product. Variation in the composition of corn can affect the composition of the final DDGS (Belyea et al. 2004). The protein content of DDGS can often range from 27 to 35 %. Many studies have reported on the incorporation of DDGS into food products. For example Finley and Hanomoto (1980) used brewer's spent grain in bread. Tsen et al. (1982, 1983), used DDG in bread and cookies and evaluated their qualities. Wu et al. (1987) supplemented spaghetti using corn distiller's grains. The use of DDGS in food products can help produce healthier baked product with a higher amounts of fiber and protein.

Different types of breads in Middle Eastern countries are made with various types of flours. For example, Baladi and Aish Meharha from Egypt are round, as are Bazlama, Pide and Yufca from Turkey, and they are mainly made with wheat flour. Morocco has pan fried bread made with semolina flour. Afghanistan and Tajikistan have Bolani, which is flat bread stuffed with vegetables. Each of these breads has its own physical and chemical characteristics. Because they are made mainly made with wheat and other milled flours, they can have deficiencies in certain nutrient components that can be improved through fortification.

In Iran, four major types of breads are consumed: Barbari, Lavash, Sangak and Taftoon. Of these, Barbari is the most popular bread, especially in the northern part of Iran, where it originated. Historically, Barbari was brought to Iran during the revolution in Russia, and it became popular among Iranians, and today is consumed in all parts of the country. Barbari crust has a thickness of almost 1–2 mm, length of 67–75 cm, and width of 13.5–20 cm. Barbari is oval shaped, and is often topped with poppy seeds. Barbari has a golden color, from the use of Romal. Romal is made from flour and baking soda which are mixed in boiling water (which then turns the starch in the flour into dextrin) and during baking it produces a golden color. Barbari has a unique smell and taste depending on the amount of sour dough and baking time used.

In this study, five different flours were used for the production of Barbari. The flours used were amaranth, barley, DDGS, oat and rye. Proximate analysis was done on the resulting breads to determine the nutritional changes in the altered formulations. In addition, tests were conducted to understand the physical behavior of each bread. The hypothesis of this study was that adding alternative flours to traditional Barbari bread will enhance the nutrients in the final products.

Materials and methods

Experimental design

Distillers dried grains with solubles (DDGS) was obtained from a commercial ethanol plant in South Dakota. All-purpose wheat flour, amaranth, barley, oat and rye flours were purchased from local markets. Barbari bread was baked as a control at 550 °C for 10 min, only using wheat flour. Five experimental types of Barbari were baked. All in all, there were six different flour mixes; thus, a one factor experimental design with 6 levels was used (Table 1). So, beside the control, 5 types of Barbari bread were baked, each with two replications. The dependent variables in each sample were the physical and chemical attributes.

Preparation

Barley grains were ground in a Restch Mill (GmbH & Co.KG, 5657 HAAN1, Germany) operated at 20,000 rpm using a 0.5 mm sieve. The same procedure was followed for grinding the DDGS. For making the sour dough, 1 g of salt, 9 g of active dry yeast, 400 g of flour, and 650 g of water were used, but not all of the produced sour dough was used in the formulation. Only 35 g of sour dough was used for each batch. For the Romal topping of the bread, 4.2 g of flour, 4.2 g of baking soda, and 85 g of water were used.

For the bread made with only wheat flour (the control), 880 g of all-purpose flour was used; the rest of the ingredients were 4.2 g of sugar, 4.2 g of salt, and 689.76 g of water. For the other breads, the same ingredients were used, except for the amount of flour, where 704 g of all-purpose flour was used with 176 g of alternative flour substituted for wheat flour, and included amaranth, barley, DDGS, oat, rye. To obtain a well-distributed flour for each treatment, wheat flour was mixed with each of the other flours using a blender (Blend Master, Patterson-Kelley, Harsco, East Stroudsburg, PA, USA). A turbofan 32 convection oven was used to bake the breads.

Table 1 Ingredients used in the production alternative cereal-bread breads. Flour substitution level denoted in parentheses

Bread	Wheat Flour (g)	Other Flour (g)	Water (g)	Sugar (g)	Salt (g)	Active dry yeast (g)	Total (g)
Wheat[1] (Control)	800 (100 %)	0	689.76	4.2	4.2	7	1505.16
Amaranth[2]	704 (80 %)	176 (20 %)	689.76	4.2	4.2	7	1585.16
Barley[3]	704 (80 %)	176 (20 %)	689.76	4.2	4.2	7	1585.16
DDGS[4]	704 (80 %)	176 (20 %)	689.76	4.2	4.2	7	1585.16
Oat[5]	704 (80 %)	176 (20 %)	689.76	4.2	4.2	7	1585.16
Rye[6]	704 (80 %)	176 (20 %)	689.76	4.2	4.2	7	1585.16

[1] From market source, HyVee bleached all-purpose flour

[2] From market source, Bob's Red Mill

[3] From market source, Bob's Red Mill

[4] From Wentworth Ethanol, South Dakota

[5] From market source, Bob's Red Mill

[6] From market source, Bob's Red Mill

[7] Sour dough was added in addition to these ingredients

Bread production

Sour dough was prepared the night before bread production. To make the sour dough the ingredients were mixed together very well, and then the bowl of sour dough was covered and left for 18 h at room temperature. To prepare the bread, first one package of yeast was dissolved in warm water, sugar was added, and the mixture put aside for 10 min. Next it was mixed with salt, water, and the flour was added gradually and mixed well. Finally, the sour dough from the previous day was added also. The mixture was mixed well enough until it was not sticky. The next step was proofing, where the dough was put in the proofing cabinet for 1.5 h for the yeast to act. After proofing, the excess gas was punched out of the dough. Then 400 g of the dough was weighed and punched down to form a5.8 cm by 50.8 cm (Fig. 1) square so that all the dimensions were the same for all the breads. The thickness of the dough was measured in three different areas of the edges. Then the Romal was made and brushed on top of the dough. The dough was set aside for another 10 min, and then it was ready to be baked. The baking temperature used for each bread was 500 °C for 10 min. Two loaves of breads were prepared for each treatment, and baked on a pizza stone, to keep the baking conditions close to that of the traditional ovens used for Barbari in Iran.

Physical and chemical properties

After the bread was baked and cooled, the thickness of the edges and of the center of the bread was measured using a digital Vernier calipers (Digimatic Calipers w/Absolute Encoders, Series 500, Mitutoyo Corporation, Kawasaki, Kanagawa, Japan). For the center measurement, the thickness was measured in three different locations of the loaf, since there was some variability in the center because of the existence of bubbles in the middle of the bread which formed during baking. A texture analyzer was used to measure the firmness and extensibility of the bread samples using two different probes: SMS/Chen-Hoseney Dough stickiness RIG and Pizza Tensile RIG (TX.XT- plus texture analyzer, Texture Technologies Corp., Scarsdale, New York, USA). Density was calculated by measuring the weight and the thickness (measurement of volume) of the bread. For each of these variables, duplications were measured for each loaf, so four samples (n=4) for each type of bread were evaluated.

Next, the breads were ground in laboratory mill and moisture content and water activity were determined. Moisture content was determined using method 44–19 (AACC 2000), oven drying at 135 °C (Model Labline, Inc., Chicago, IL, U.S.A). In order to determine water activity, a water activity meter was used (Aqua Lab CX-2, Decagon Devices, Inc, Pullman, Washington, USA).

Color was measured by spectrophotometer (Minolta CM-508d, Ramsey, New Jersey, U.S.A) in which L* is the measure

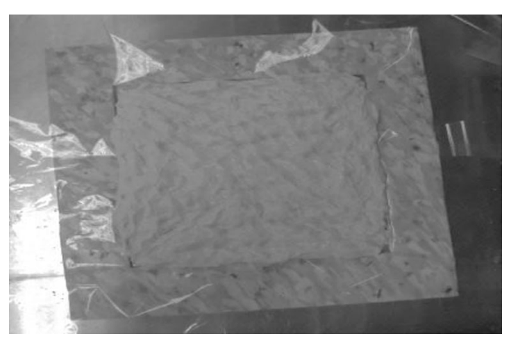

Fig. 1 Forming the dough using a 50.8 cm by 50.8 cm frame (20 in by 20 in)

of lightness, a* is the measure of redness to greenness and b* is the measure of to yellowness blueness.

Protein was measured using the AACC method for combustion, method 46–30 (AACC 2000) with a CE Elantech (Flash EA 1112, ThermoFinnigan Italia S.p.A., Rodano (MI) Italy). Nitrogen was then converted into protein using a conversion factor of 5.7. Fat content was determined using AOAC method 920.39 (AOAC 2003) on an automated Soxhlet extractor using petroleum ether (CH-9230, Buchi laborotechnik AG, Flawil, Switzerland). For the determination of neutral detergent fiber (NDF), method 30–25 (AOAC) was used. Ash content was measured by method 08–03 (AACC 2000) using a muffle furnace (Lindberg/Blue 1100 °C Box furnace BF 51800 series, Ashville, NC), at 525 °C for 2 h.

Data analysis

All collected data were analyzed with Microsoft Excel v.2007 and SAS v.9.0 software (SAS Institute, Cary, NC) using a Type I error rate (α) of 0.05, by analysis of variance (ANOVA) to find if there were significant differences between treatments. If significant differences existed, post-hoc LSD tests were used to determine where the differences occurred.

Results and discussion

The results of the measurements are summarized in Tables 2 and 3, which show the physical and chemical attributes of baked Barbari, respectively.

Physical properties

Thickness of bread

Figure 2 shows cross section pictures of the resulting breads. Thickness in general is related to the gluten content of the flour. In this experiment, the thickness of both the center and edges of breads were measured. The center thickness results show that the lowest measurement was observed for the bread made with 20 % barley substitution, while the highest value was for the bread made with amaranth flour substitution. Significant differences in the thickness of the breads were determined among all treatments, including those made with amaranth, rye flour, and DDGS.

The highest value of edge thickness was obtained for the bread made with rye flour substitution, with the control bread the next highest. The lowest value was for bread made with DDGS. This was because of the attributes of DDGS itself, which do not help in the development of the gluten network in the bread. There were no significant differences between the edge thickness for the bread made with rye flour and bread made with 100 % of wheat flour, but there were significant differences between the bread made with DDGS and all other breads. Tsen et al. (1983) reported that substituting up to 10 % DDGS flour in non-flat breads made with white wheat flour didn't change the volume and quality of the bread; however, replacement of 20 % greatly reduced the loaf volume. Morita et al. (1999) showed that although amaranth flour can be used to improve the quality of wheat bread to a certain level, substitution with 10 % or more amaranth flour gave lower loaf volume and lower taste score. A substitution of 5 % amaranth flour produced an increase in loaf volume, which was due to a disulfide exchange reaction of amaranth

Texture

Texture has a direct impact on consumer acceptability; it affects flavor release, influences appearance and determines mouth feel. Texture and food structure are tightly linked; any change in the structure can also change the texture, which may eventually lead to changes in consumer acceptance (Zappa et al. 2007). In this study, two different textural attributes were studied, the extensibility and the firmness of the bread.

The highest value of extensibility was for the bread made with oat, while the lowest was for amaranth. Significant differences were determined between the extensibility of control bread and that of the oat and rye breads, but there were no significant differences between the control bread and those made with DDGS, barley or amaranth.

Table 2 illustrates that for firmness, the highest value was for the bread made with rye flour, while the lowest value was for that made with oat flour. Furthermore there were significant differences between the control bread and the other breads. Also, significant differences were found between firmness of the bread made with oat compared to all others.

These changes in texture occurred due to the different amounts of gluten, which plays an important role in the texture of final products. To further illustrate, amaranth had the lowest amount of extensibility because of the absence of gluten in this type of flour. Ayo (2001) concluded that increasing the amount of amaranth flour would lead to a significant decrease of texture, which was also due to the poor rising of the dough prior to baking and the high amount of fiber. Gujral and Pathak (2002) found that incorporation of barley flour in the wheat flour at a level of 20 % increased chapathi extensibility; however, addition of higher levels of barley flour decreased the extensibility. Two components, fiber and gluten play an important role in the bread texture profile; fiber can absorb more water than other particles and can prevent them from being fully integrated into the starch/gluten matrix, which will also lead to a power texture (Gould et al. 1989). Better texture was obtained in flat breads made with a wheat cultivar with better gluten quality, which lead to a higher level of gas during

Table 2 Physical properties of resulting breads[1]

Properties	Flour substitution					
	100 % Wheat	20 % Amaranth	20 % Barley	20 % DDGS	20 % Oat	20 % Rye
Thickness in Center (mm)	16.36 b	18.57 a	12.7 d	16.11 b	14.60 c	17.75 a
	(0.23)	(0.64)	(0.80)	(0.75)	(0.61)	(0.08)
Thickness of Edge (mm)	16.41 ab	14.06 c	13.90 c	10.35 d	15.11 bc	17.70 a
	(0.17)	(0.0)	(0.95)	(1.98)	(1.48)	(0.02)
Extensibility[2]	31.10 ab	8.87 c	28.59 ab	28.17 ab	43.76 a	25.71 bc
	(3.42)	(1.09)	(13.04)	(6.97)	(7.71)	(2.99)
Firmness [2]	31.25 c	45.27 b	40.98 b	41.50 b	22.91 d	56.51 a
	(2.28)	(5.24)	(28.59)	(3.08)	(3.45)	(2.82)
Density (g/cm^3)	0.04 a	0.05 a	0.05 a	0.05 a	0.04 a	0.04 a
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
a_w	0.89 ab	0.87 b	0.89 ab	0.92 a	0.75 c	0.91 ab
(−)	(0.0)	(0.01)	(0.00)	(0.01)	(0.05)	(0.00)
L*	47.27 c	56.31 ab	55.78 ab	56.54 ab	54.78 b	62.18 a
(−)	(1.07)	(0.72)	(5.36)	(3.96)	(2.55)	(8.26)
a*	3.33 c	8.85 a	5.76 b	8.41 a	9.49 a	5.38 bc
(−)	(1.85)	(1.22)	(2.33)	(0.86)	(0.50)	(0.61)
b*	13.06 b	19.27 a	19.03 a	20.16 a	19.32 a	19.35 a
(−)	(2.25)	(1.04)	(0.90)	(2.33)	(0.75)	(4.16)

[1] Means followed by similar letters for a given dependent variable are not significantly different at $P<0.05$, LSD. Values in parentheses are standard deviation. a_w is water activity, L*, a* and b* are color parameters. [2] Force was measured over time for firmness and over distance for extensibility

baking, thus causing an increase in the bread volume and porosity (Golmohammadi et al. 2005).

Density

No significant differences were determined between the densities of the breads. The gluten matrix in the dough plays an important role in the final volume of the breads, and therefore the density. Esteller and Lannes (2008) concluded that addition of rye flour can increase the strength of a gluten matrix, thus changing gas retention and ultimately increasing the volume. Another important factor affecting the volume and density is the amount of fiber in the flour. Chen et al. (1988) determined that as the fiber content of the flour increases, the loaf volume generally decreases and the loaf weight increases. This is due to the increase in water absorption caused by the

Table 3 Chemical properties of resulting breads[1]

Properties	Flour substitution					
	100 % Wheat	20 % Amaranth	20 % Barley	20 % DDGS	20 % Oat	20 % Rye
MC (% db)	0.33 d	0.41 ab	0.32 d	0.44 a	0.39 cb	0.35 ad
	(0.05)	(0.03)	(0.0)	(0.03)	(0.02)	(0.0)
Protein (% db)	11.62 a	11.17 b	11.16 b	12.55 c	11.53 a	11.12 b
	(0.27)	(0.15)	(0.06)	(0.10)	(0.07)	(0.41)
Fat (% db)	0.52 c	0.54 c	0.74 b	0.46 c	1.02 a	1.09 a
	(0.07)	(0.06)	(0.10)	(0.05)	(0.17)	(0.11)
Fiber (% db)	0.91 d	1.46 bc	1.70 b	3.57 a	0.99 cd	0.91 d
	(0.19)	(0.34)	(0.45)	(0.38)	(0.35)	(0.16)
Ash (% db)	1.22 c	2.29 a	1.74 b	2.28 a	1.66 b	2.08 a
	(0.39)	(0.20)	(0.30)	(0.09)	(0.01)	(0.04)

Means followed by similar letters for a given dependent variable are not significantly different at $P<0.05$, LSD. Values in parentheses are standard deviation. MC is moisture content

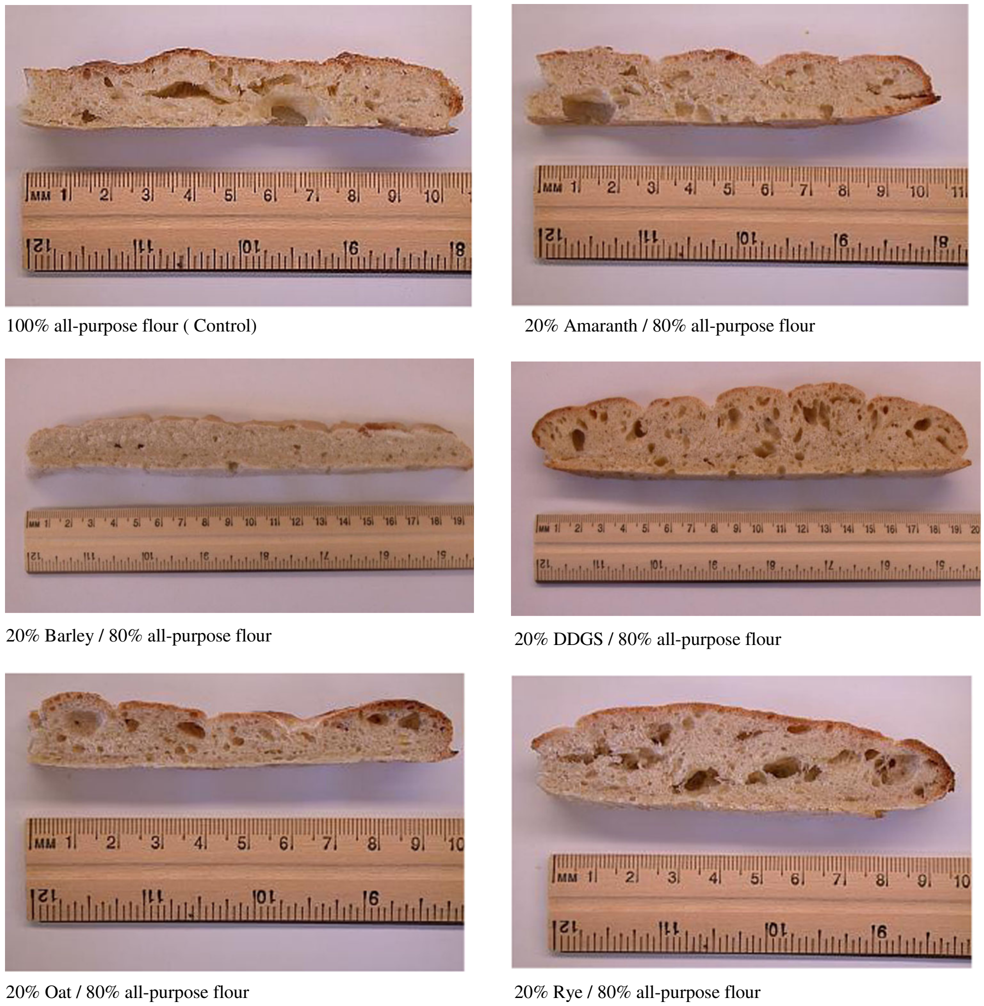

Fig. 2 Cross sections of resulting breads (flour substitution are indicated)

strong water-binding ability of the fiber in the flour, as well as the worked gluten matrix.

Water activity

The results show that the highest value for a_w was for found for the bread made with 20 % DDGS and 80 % wheat flour; the lowest value was found for the bread made with oat flour. No significant differences were identified between the water activity of the bread made with DDGS and the control bread, barley or rye flours. It has been noted in other research that as the protein content of the flour increases, the water activity may increase as well. This may occur because of the hydration of the protein, a process in which protein goes from its dry stage to the solution stage, this is affected by the amino acid composition of the protein (Belgacem and Gandini 2008). The water activity in the bread can also depend on the amount of fiber. As the amount of fiber increases, the water absorption in the bread increases as well. This also depends on the particle size of the fiber. A minimum particle size results in increasing the water binding capacity, since the smaller particles tend to absorb water faster (Sabanis et al. 2009).

Color

Color is a key quality parameter that often affects consumer acceptability. As was previously described, the golden yellow color of Barbari comes from the Romal which is brushed on top of the bread. Romal is made from baking soda and wheat flour dissolved in warm water, which leads to the formation of dextrin, which results in the golden color during baking. During baking, the type of flour and the browning reaction (which are non-enzymatic reactions), play important roles in crust color development. Since bread contains both reducing sugars and amino groups, when it is heated, caramelization and Maillard reactions may take place at the same time. In order for browning reactions to take place, temperatures greater than 120 °C and water activity value less than 0.6 are required. Color also depends on the physiochemical properties of the dough. These properties can include the moisture content, pH, reducing sugar and amino acid content of the flour which was used in the production of the dough (Sabanis et al. 2009). As the results for the color determination show, the value of L* was significantly different in bread made partially with rye flour versus the control, as well as bread made with oat compared to the control. But there were no significant differences in the L* value of breads made with DDGS, amaranth or barley flour. The bread made with rye had the highest value for L*, and the control had the lowest value. As for a* value, the breads made with amaranth, DDGS, and oat were significantly different than the control bread. For the bread made with rye flour and that made with barley, they were not significantly different from the control. The highest value for a* was for bread made with oat, while the lowest was for the control. The results for b* also showed that all the breads were significantly different compared to the control, with the highest value for DDGS, and the lowest value for the control. This was due to the original color of the DDGS, which is more yellow compared to the other flours used in this experiment.

Chemical properties

Moisture content

The results for moisture content (MC) showed that Barbari made with 20 % DDGS had the highest moisture content, while that made with barley had the lowest value. There were no significant differences between bread made with amaranth and with DDGS, or between the control and that made with barley flour. Barbari bread has the highest moisture content, in general, compared to other Iranian breads (Faridi et al. 1982). In a study done by Sabanis et al. (2009), as the amount of fiber increased in the dough, the moisture content of both crumb and crust increased. The amount of fiber can play an important role in binding water and increasing the moisture content of final products.

Protein content

The results showed that the highest protein content occurred in the bread made with DDGS flour, while the lowest was for the rye, which was significantly lower than the control. Protein content of the final product was related to the type of flour which is used in baking, and the degree of extraction in the flour. The protein content of bread can be influenced by the Maillard reaction, as well, and aggregation that can happen due to the dehydration of the surface owing to the high temperature during baking. The protein content of the bread can also be a direct reflection of fermentation in the dough, because this is an important step for protein solubilization (Horszwald et al. 2009).

DDGS is a good source of protein (30 %), and results showed using it results in bread protein content higher compared to all other breads and the control. Similar results were obtained in the study by Wu et al. (1987), where spaghetti was supplemented with corn distillers grains (CDG). Results showed that supplementation with 10 % CDG increased the amount of protein up to 12–14 %. Furthermore, incorporation of 20 % DDG into muffins resulted in higher amounts of protein compared to the control (Reddy et al. 1986). One study determined that although amaranth flour itself is high in essential amino acids such as lysine, when it is added to bread as an alternative flour, the protein content of the bread maybe lower than that of bread made with wheat flour only (Ayo 2001).

Ash content

The highest ash content was found in the bread made with amaranth flour, while the lowest was for the control bread. Amaranth grain has a high nutritional value, the nutritional composition of this grain (such as total protein, amino acid composition, mineral and vitamin content) has been shown to be higher than that of other cereal grains. There were no significant differences between bread made with amaranth, DDGS or rye flour, but there were significant differences between the control and the other breads.

Ash content is directly related to the type of flour used in the production of the bread. Research has shown that the amounts of elements in flour are related to soil and fertilizer composition. Also, neither total ash nor the content of any of the mineral elements are directly related to the reported degree of refinement of the flour (Czerniejewski et al. 1964). In similar studies, supplementation of wheat flour with 10 % DDGS flour can lead to a higher amount of ash in the resulting bread compared to the control (Tsen et al. 1983), as was the case here.

Fat content

The fat content results showed that rye, oat and barley were different in fat content, but amaranth and DDGS did not show any differences. Also, the fat content of bread made with barley was significantly different compared to the breads made with oat and rye flour. The highest value for fat content was for the bread made with rye flour, while the lowest fat value was for the DDGS. However, in a study done on muffins, no change in fat content was found with 10 % DDG substitution (Reddy et al. 1986).

Fiber content

As was expected, the bread made with DDGS had the highest fiber content, while the control bread had the lowest. There were significant differences between the fiber content of the bread made with DDGS and the others. Similar results were obtained by Tsen et al. (1983), when addition of DDG to bread resulted in a higher amount of fiber compared to the control. Also, supplementation of corn distillers grain into spaghetti resulted in a significantly higher amount of fiber compare to the control (Wu et al. 1987). There was no significant difference between the control and the bread made with oat flour. Dietary fiber contains non-starchy polysaccharides and lignin. The methods used to measure the amount of dietary fiber depend on an efficient removal of starch, because if any starch remains, it adds to the dietary fiber value. Bakery products are an important source of dietary fiber. Fiber has different effects on the quality of final products. It can affect the loaf volume, increase the crumb firmness, and lead to changes in crumb color (Saiz et al. 2007). Studies show that fiber can change structure as a result of baking. This is due to the formation of fiber-like substances which are produced by non-enzymatic browning among peptides, free amino acids, and carbohydrates (Faridi et al. 1982).

Conclusions

About 9,000 years ago, people in what is now Iran and Syria began farming wheat and learned how to make grain into bread. The consumption of bread and other cereal-based products has continued up through today, and cereals are still the most consumed food staples around the world. Often, this takes the form of wheat bread. Alternative grains and ingredients such as amaranth, DDGS, and rye can be used in bread production, as well. In this study, five different flours were substituted into wheat flour (at 20 %) to examine the changes in physical and chemical attributes of Barbari, a traditional Iranian bread. Results demonstrated that the bread made with 20 % rye flour (80 % all-purpose flour) had high levels of fat and ash, L*, a* and b* compared to the control. DDGS substitution resulted in the highest protein and fiber of all breads. Also, the bread made with DDGS had the highest b* value. All in all, using different sources of flours in the production of traditional Barbari breads can lead to better products with higher nutrient content. However, the original taste, aroma and texture of the bread must also be considered. In this study, however, they were hot. Overall, a combination of flours could maintain the gluten content; rye can result in better protein content; and DDGS can help increase the amount of fiber. Balancing all of these factors can produce healthier breads while maintaining consumer acceptability.

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