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DETERMINATION OF DESIRABLE QUALITY INDICES FOR EVALUATING THE QUALITY OF IRANIAN BARBARI BREAD

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ABSTRACT

This study was implemented by using three Barbari flours (named F_s, F_m and F_w) with different physical, chemical and rheological properties. Quality analysis of Barbari breads (P_{b1}, P_{b2} and P_{b3} made of F_s, F_m and F_w flours respectively) characterized on chemical, physical, sensory and textural properties.The results showed that F_s with higher protein content, increased zeleney volume, lower falling number and higher damaged starch had higher water absorption and produced strong dough. The results of breads evaluation indicated that P_{b1} had higher protein content, more specific volume and lost lower moisture and weight during storage. Sensory analysis showed that bread P_{b3} had more firmness, less porosity and undesirable form and flavor than breads P_{b1}& P_{b2} during storage days. The values of hardness, chewiness and gumminess properties obtained from texture analyzer in bread B_3 was more than breads P_{b1}& P_{b2}. Therefore according to the results of this study bread P_{b1} made of strong flour had more desirable quality characterization and higher shelf life than breads P_{b2} and P_{b3}.

INTRODUCTION

Bread as a staple food provides significant part of energy, protein, minerals and B group vitamins on diet in many countries. Nowadays, different kinds of breads are produced which can be divided into three categories with respect to their specific volume (volume/weight): those with high specific volume such as pan breads, those with medium specific volume such as French and rye breads, and those with low specific volume such as flat breads (Faridi, 1988; Qarooni, 1996 & Collar et al., 1999). Flat breads are oldest, most diverse, and most popular products in the world. They differ in the type of flour, manner of sheeting or in the appearance of the end product. These products are a major form of wheat consumption in many Middle Eastern and North African countries (Paulley, 1998; Coskuner et al., 1999). Today in Iran, many types of flat breads, such as T aftoonn Lavash, Sangak and Barbari are produced and consumed (Faridy, 1981). Barbari is one of the most popular flat breads which is made from Barbari flour, along with water, salt, yeast or sourdough and then baked on the hot flat surface (Qarooni, 2004). Statistics have shown that more than 30 percent of traditional bread products due to low quality become waste. Thus the study of factors affecting the quality of the bread and reduce their waste is very important (Ghoreishi rad et al., 2011).Understanding desirable flour quality specifications for each kind of bread and the correct baking process in order to ensure greater consistency and quality of product is one of the most important requirements in baking programs (Quail, 1996). Generally the bread making performance of wheat flour is governed by its qualitative indicators specially the quantity and quality of its proteins. Flours of high protein content often yield bread with good quality. However, flours with the same protein content do not necessarily produce breads of similar quality (Toufeili et al., 1999).The relationship between flour quality and bread characteristics is one of the most important quality criterions of breads. Flat breads are baked from dough sheets. They have a short baking time about 2-3 minutes (Faridi et al., 1982), thus the impact of flour quality features like gluten quantity and quality, falling number, ash percent, moisture content, particles size and damaged starch percent on

the end product characteristics may be different in flat breads compared with pan breads, which are baked for longer and have sufficient time to expand (Faergestad et al., 2000).Different physical, chemical & mechanical such as firming and staling properties effect the consumer acceptability of bread. Starch retro gradation is implicated in staling, gluten and its interactions with starch may also have a role in the staling process (Martin, 1991 & Collar, 2009). In addition to tests of physical, chemical and sensory, a variety of tests may be used to assess texture and changes in the cellular structure of bread during the staling process. Some measurement of mechanical properties is employed in shelf-life studies for assessing the product quality changes (Lagrain et al., 2013).

Paulus (1986) reported that poorer sensory attributes, such as a less desirable crumb structure, a decrease in palatability and staling are more prevalent in low protein breads. In this respect sensory analysis is good but may not be sufficient on its own to characterize the staling process (Paulus, 1986). Scalon (2000) studied the bread quality of flours with different dough strength. Results showed that bread crumb structure of stronger doughs was stiffer and compressed less than the breads of weak doughs (Scalon et al., 2000). Aamodt (2005) studied the effect of protein quality and

content on Hearth bread characteristics and indicated that an increased protein quality improved Hearth bread characteristics to a larger extent than increased protein content (Aamodt et al., 2005). Ghanbari & Farmani (2013) studied theinfluence of hydrocolloids on dough rheological properties and quality of Barbari. They evaluated chemical composition of flour, rheological properties of the dough and textural and sensory properties of bread. Results showed that hydrocolloid addition to the bread formulation could improve the sensory properties of Barbari bread and retarded the staling process (Ghanbari & Farmani, 2013).Lagrain (2013) evaluated therole of gluten and starch in crumb structure and texture of fresh and stored straight-dough bread. During this research while the elastic modulus of bread crumb strongly increased upon storage, image analysis demonstrated that its cellular structure did not change. Changing gluten properties in dough had a profound impact on bread density and its foam structure without affecting the rheological properties of the crumb cell walls (Lagrain et al., 2013).

The purpose of this study is to determine desirable quality indicators for evaluating the quality of Iranian traditional Barbari bread based on the quantitative data. Providing quantity scope for these indicators will be

performed for the first time about Iranian Barbari bread. For this target, a variety of physical, chemical and rheological properties of flours and doughs with different qualitative characteristics specified.Then physical, chemical, sensory and textural properties of breads were evaluated.The results of this study can be used in documentation system and will be effective to improve the quality of traditional Barbari bread and reducing waste. The results can help to inform about the use of flour with appropriate and desirable characteristics for the production of Barbari bread and rating its quality.

MATERIALS AND METHODS

Preparation of Various Kinds of Flour with Different Quality

Three kinds of Barbari flours with different quantities of protein content, wet gluten, zeleny volume, falling number, damaged starch and with the same 85% extraction rate (named F_s, F_m and F_w) for preparation Barbari breadaccording to Iran National Standard No. 103 were prepared in Arddaran factory. Some Barbari flour features in the standard include: Ash (based on the dry matter): 0.701 to 0.850 %, the moisture content: max 14.2%, Protein (based on the dry matter): min 11%, wet gluten: min 26, Zeleny sedimentation volume: 15-35 ml and damaged starch: 1-8%. To make F_S flour, amixture of 60% flour obtained from

imported wheat (Australia and Russia) and 40% flour made from Iran cities wheat (Khuzestan and Ilam) was used. For preparation F_m flour, amixture of 40% wheat flour from imported wheat of above countries and 60% flour from domestic wheat and for production of F_W flour, 100% of flour obtained from domestic wheat were used. These were used for experimental tests, and bread making. Baker's yeast was obtained from Fariman Company and salt was purchased from a local market.

Physical and Chemical Evaluation of Wheat Flour

Moisture content, ash, ash insoluble in acid, Protein, Zeleny sedimentation volume, wet gluten, gluten index, falling number, pH and damaged starch were determined in triplicate according to American Association of Cereal Chemists (AACC) procedures 16-44, 08-01, 46-12, 56-11, 56-81 and 38-11 respectively (AACC, 2000).

Rheological Measurements of the Dough

The viscoelastic behaviour of dough samples was determined by an Alveograph (Chopin, France), following the standard method AACC 54-30 (AACC, 2000). Monitored parameters were the tenacity or resistance to extension (P), dough extensibility (L), swelling (G), P/L (configuration ratio of curve), deformation energy (W) and Ie (index

elasticity). Dough rheology during mixing was determined by a Consistograph (Chopin, France) following the standard method AACC 54-50 (AACC, 2000). Parameters recorded were: maximum pressure (PrMax), water absorption capacity (HYD2200, water required to yield dough consistency equivalent to 2200 mb of pressure measured at constant hydratation), time, in s, to reach maximum pressure (TprMax), time, in s, for the pressure to rise above PrMax minus 20% or tolerance (Tol), the drop in pressure at 250 s from PrMax minus 20% (D250), and the drop in pressure at 450 seconds from PrMax minus 20% (D450). Visco elasticity of sample blends was determined according to the following: flour is mixed with salted water, five dough samples are prepared, the samples are left to rest and the dough samples swell under controlled test conditions. The Consistograph records the pressure during mixing and from it deduces the water absorption of the flour. The curve and the associated calculated parameters are handled automatically by the integrated Alveolink (Callejo etal., 2009).

Preparation of Barbari Bread

Barbari bread prepared without addition any improvement in standard bakery and by professional baker, according to code of practice of Barbari bread production that has been approved in Iran Standard National Committee for Agriculture & Food. Production method and the amount of raw materials used in producing different kinds of Barbari breads obtained from flours with different quality characteristics were considered identical. Wheat flours were baked using straight-dough method (approved method 10-10B AACC). The formula used to make Barbari breads is as follows: wheat flour, baker's yeast (0.25 % of flour weight) and sodium chloride (1-2% of flour weight) and the optimum amount of water calculated from water absorption which was measured by Consistograph. The complete mixing of the dough samples was performed in a fork-type mixer at 35 rpm within 10 minutes. The dough was fermented at 30°C and a relative humidity of 85% for 60 minutes in a fermentation cabinet, divided into 650 g balls and then the intermediate proofing conducted for 10 minutes. The process was followed by flattening and final proofing for 5 minutes. The baking of Barbari bread was performed for 10-12 minutes in a traditional oven at 250°C. Baked loaves were then allowed to cool down to room temperature, packed in polypropylene bags and kept in room temperature for 4 days to determine the physical, Chemical, sensory & textural changes of Barbari breads.

Physical and Chemical Analysis of Barbari Breads

Thickness and surface area of three kinds of Barbari bread (named P_{b1}, P_{b2} and P_{b3}) determined using tools such as culis and ruler, breads weight and weight loss percent after breads baking measured by electronic balance ($\pm$ 0.0001) and breads specific volume evaluated by seed canola replacement method in triplicate (Weinig & Kim, 2008). Breads density was obtained through the ratio of samples mass to their volume. To obtain the volume of samples, cube-shaped pieces of bread with specific dimensions (10×10) from the central sections of breads cutted and by multiplying length, width and height obtained volume (Lazaridou etal., 2007).

Chemical measurements such as moisture content, ash, Protein, fat, salt and pH were determined in triplicate according to American Association of Cereal Chemists (AACC) procedures 16-44 A, 08-01, 46-12, 56-11 respectively (AACC, 2000). Evaluation of mass, volume, density and moisture of samples were carried out in immediately, 24, 48 and 72 hours after baking, for kinds of Barbari breads in triplicate.

Texture analysis

The strength, firmness and staling rate of Barbari breads determined by Texture Analyzer (Brookfield, CT3, USA) according to American Association of Cereal Chemists (AACC) procedure 74-10 in immediately, 24, 48 and 72 hours after baking, for kinds of Barbari bread in triplicate. Barbari bread slices with Dimensions 2 * 2 cm and thickness 15 mm from central and lateral parts of bread were selected. Bread samples were then seated on the platform and a circular probe (TA-BTKI, D: 38.1 mm and L: 20mm) loaded at speed of 0.5 mm/s, target 30 % and trigger load 0.5 N to compress sample. The entire process consists of two stages of compression; two curves wereobtained to show the amount of power for compression in bread crumb. Various textural properties of samples such as hardness, chewiness and gumminess can be achieved from the curve (Balestra, 2009).

Sensory Evaluation

The sensory evaluation of fresh breads and then cooled and packed in polyethylene bags in 24, 48 and 72 hours after baking was carried out by ten experienced persons. The attributes evaluated were shape and form, taste and aroma, lower and upper surface characteristics, void and porosity, chew-ability, and texture (firmness or softness). Sensory indexes of bread samples were evaluated in a hedonic manner. Each attribute was scored from 0 (lowest) to 5 (highest). The following formula was used to calculate the

overall score (Q) of each bread sample, $Q=\Sigma (P.G)/(\Sigma G)$, where, P and G were the sensory score and assessment coefficient of each attribute, respectively. The G value for appearance(form and shape), lower surface specification, upper surface specification, void and porosity, chew-ability,

texture(firmness and softness) and taste and aromawere 2, 1, 2, 3, 3, 4 and 5, respectively (Ghanbari & Farmani, 2013). Bread quality grading according to the panels sensory scores was shown in table 1.

Table1. Bread quality grading

Score	Bread quality grading
4.50- 5	So Good
4- 4.49	Good
3-3.99	Satisfactory
2- 2.99	Less Satisfactory
1-1.99	Not Satisfactory
0-0.99	Unacceptable

Statistical Analysis

All determinations were made in triplicate, and mean values are presented. The data collected from studies wasanalyzed using SPSS version 21 (SPSS Inc., Chicago, IL). Analysis of variance and factorial experiment in a completely randomized design was performed to determine significant differences in each factor. A probability of <0.05 was used to establish statistical significance for fixed effects and interactions using Duncan's multiple-comparison test. Analysis of data obtained from sensory evaluation was carried out using Friedman statistical method.

RESULTS AND DISCUSSION

Physical and Chemical Tests Results of Wheat Flour

The chemical and physical results of Barbari flour types were presented in Table 2. Moisture content, ash and ash insoluble in acid content and pH of flours had no significant differences, but differences in protein content, wet gluten percent, gluten index, zeleny volume, falling number and damaged starch of Barbari flour types were detectable and affected flour characteristics. The content of protein and wet gluten reflected the quantity of protein in flour; gluten index and zeleny tests indicated the quality of the protein in types of flours with different quality characteristics. The protein content, wet gluten, gluten index and zeleny volume in F_s was higher than F_m and in F_m was more than F_w. Significant difference in the mentioned four Characteristics of types of

Barbari flour (F_S, F_m and F_w) were fundamental factors for making the flours with different quality properties.There was significant different between the falling number test and damaged starch results of three types of flour. F_S had less falling number than F_m and F_m had lower falling number than F_w. Lower falling number and more activity of alpha-amylase in F_S is probably due to differences in the type and nature of the wheat varieties used to produce flour with different quality characteristics. Notably, increased amylase activity but not

outside of the normal range leads to further decomposition of starch and thus help feed the yeast and fermentation of bread, therefore volume and organoleptic properties of bread can be affected.Damaged starch percent in F_S was higher than F_m and in F_m was more than F_w that it seems to be due to differences in the type and quality characteristics of the wheat used for the production of F_S, F_m and F_w flours, including the difference in the endosperm tissue, protein content and the hardness of wheat.

Table 2: The mean chemical and physical results of Barbari flour types

*Means within the same column having different letters are significantly different (p< 0.05)

properties / Types of flour	Moisture %	Ash % (based on the dry matter)	Ash insoluble in acid %	Protein % (based on the dry matter)	Wet gluten %	Gluten Index	Zeleny ml	Falling numbers s	PH	Damaged starch %
F_s	11.505 ± 0.112 a	0.731 ± 0.017 a	0.010 ± 0.000 a	13.095 ± 0.002 a	29.955 ± 0.005 a	90.528 ± 0.041 a	33.000 ± 1.154 a	358.000 ± 0.577 a	6.053 ± 0.044 a	5.900 ± 0.057 a
F_m	11.498± 0.009 a	0.732 ± 0.011 a	0.010 ± 0.000 a	11.320 ± 0.000 b	26.005 ± 0.002 b	84.690 ± 0.000 b	25.000 ± 0.000 b	370.000 ± 0.000 b	6.116 ± 0.020a	2.200± 0.000 b
F_w	11.334 ± 0.005 a	0.721 ± 0.017 a	0.010 ± 0.000 a	9.590 ± 0.005 c	21.406 ± 0.004 c	77.234 ± 0.003 c	17.750 ± 0.144 c	385.000± 2.887 c	6.030 ± 0.035 a	1.600± 0.057 c

Results of Rheological Measurments of the Dough

The tests results of Alveo & Consistograph on different types of Barbari flour were shown in Table 3. The average results of Alveograph, the tenacity or resistance to extension (P), dough extensibility (L), swelling (G), P/L

(configuration ratio of curve), deformation energy (W) and Ie (index elasticity) of Barbari flour types (F_S, F_m and F_w) had significant differences.The average results of Consistograph, the maximum pressure (PrMAX), water absorption (HYD) and D 250 and D 450 of types of Barbari flours (F_S, F_m

and F_w) showed significant differences. TPrMAX and Tol of F_S differed significantly with F_m and F_w flours but in these cases there were no significant difference between F_m and F_w flours. According to the results, F_S proportion to F_m and F_w flours had higher average values in P, P / L, W, Ie, PrMAX, HYD, TPrMAX and Tol but had lower mean results in L, G, D250 and D450. The results were due to the direct effect of reducing of

protein, wet gluten and Zeleny volume and thus quality reduction of the gluten network in F_w proportion to F_m and F_s flours. The results of dough rheology evaluation of this study confirmed the results of Callejo's research that evaluated wheat and rye doughs rheological properties with different gluten quantity and quality by Aleo & Consistograph (Callejo etal., 2009).

Table 3: Average results of rheological test of Barbari flour types

Properties	Alveogram						Consistogram					
									CH		AH	
Typ es of Flour	P (mm)	L (mm)	P/L	G	W (10^{-4}J)	Ie	PrMax (mb)	HYD2200 (%)	TPr Max (s)	Tol (s)	D250 (mb)	D450 (mb)
F_s	96.330 ± 2.028 [a]	80.000 ± 1.155 [a]	1.203 ± 0.043 [a]	20.366± 0.088 [a]	250.000 ± 0.000 [a]	51.833± 0.120[a]	2723.67 0±9.062 [a]	56.567±0. 088[a]	118.00 0±1.15 5[a]	190.0 00±1. 155[a]	431.000 ±1.155[a]	809.000 ±0.577[a]
F_m	84.000 ± 2.646 [b]	90.330 ± 2.404 [b]	0.926 ± 0.047 [b]	21.166 ± 0.272[b]	176.670 ± 2.981[b]	42.733± 2.629[b]	2492.00 0±8.718 [b]	54.333±0. 033[b]	98.000 ±3.464 [b]	145.0 00±2. 887[b]	699.000 ±1.732[b]	1050.00 0±2.887 [b]
F_w	51.330 ± 2.906 [c]	97.330± 1.856 [c]	0.530 ± 0.020 [c]	21.766 ± 0.088 [c]	96.670 ± 1.812[c]	31.466± 2.118[c]	2041.33 0±9.486 [c]	52.333±0. 088[c]	96.000 ±1.155 [b]	140.0 00±1. 155[b]	768.330 ±1.453[c]	1106.00 0±1.155 [c]

*Means within the same column having different letters are significantly different (p< 0.05).

Physical and Chemical Tests Results of Barbari Breads

Average physical and chemical test results of Barbari breads made from F_S, F_m and F_w flours (named P_{b1}, P_{b2} and P_{b3} respectively) were presented in Table 4. Average protein content (based on dry matter) of Barbari bread types obtained from F_S, F_m and F_w flours had

significant difference with each other.Bread from F_S flour had more protein content proportion thanbreads from medium and weak flours. This is due to differences in the protein content of kinds of flour (F_S, F_m and F_w) that had direct effect on the protein content of breads.Average ash percent (based on dry matter) and pH values of P_{b3} differed

significantly to P_{b1} and P_{b2}, but there was no significant difference between ash contents and pH values of P_{b1} and P_{b2}. Mean ash values of P_{b1} and P_{b2} were more than ash content of P_{b3}.Average fat content and salt percent (based on dry matter) of Barbari bread types obtained from strong, medium and weak flours had no significant difference with each other.Mean results of physical tests, divided dough weight, area, thickness, bread weight

and weight loss of Barbari bread types after baking had no significant difference. Average results of specific volume test of Barbari breads differed significantly. Specific volume value of P_{b1} was more than $P_{b2}$and P_{b2} had higher specific volume value than P_{b3}. This indicated that bread achieved from F_s was able to hold more gas from the fermentation that had a direct effect on the specific volume of the bread.

Table 4: Average results of chemical and physical tests of Barbari bread types

Properties Types of Barbari Bread	Ash % (based on the dry matter)	Protein % (based on the dry matter)	Fat % (based on the dry matter)	Salt % (based on the dry matter)	PH	Height mm	Area Cm²	Devided Dough G	Bread Weight g	Loss Weight %	Specific Volume ml/g
P_{b1}	1.134±0.000ᵃ	10.456±0.002ᵃ	0.324±0.002ᵃ	1.572±0.004ᵃ	5.923±0.003ᵃ	12.250±0.433ᵃ	1175.333±80.963ᵃ	650.670±14.530ᵃ	466.606±3.238ᵃ	25.483±1.264ᵃ	2.399±0.004ᵃ
P_{b2}	1.133±0.000ᵃ	9.082±0.009ᵇ	0.297±0.000ᵇ	1.575±0.000ᵃ	5.946±0.012ᵃ	12.166±0.726ᵃ	1145.000±77.306ᵃ	650.670±14.530ᵃ	463.718±3.238ᵃ	25.942±1.327ᵃ	2.337±0.008ᵇ
P_{b3}	1.130±0.000ᵇ	7.820±0.002ᶜ	0.281±0.002ᶜ	1.575±0.001ᵃ	6.000±0.005ᵇ	11.750±0.901ᵃ	1118.333±73.842ᵃ	650.670±14.530ᵃ	461.763±4.640ᵃ	26.268±1.005ᵃ	2.277±0.007ᶜ

*Means within the same column having different letters are significantly different (p< 0.05).

Average results of some physical and chemical tests of Barbari bread types in storage dayswere shown in table 5. According to the results, the average moisture content and weight of Barbari bread types had separately significant differences in storage various days. There was significant difference between the average moisture content of Barbari bread types in the same storage days. The mean weight of Barbari breads also

differed significantly during the same storage time. Average moisture content and weight of all three types of Barbari bread decreased with increasing storage time. The mean values of moisture and weight of P_{b1} were more than P_{b1} and P_{b1} were higher than P_{b3} during all the storage days. The trends of moisture loss and weight reduction of P_{b3} during storage time were higher than other breads. This is associated with flour qualitative features, so

that the lower protein content, wet gluten, Zeleny volume and generally weaker endosperm tissue and gluten network of flour used for this type of Barbari bread led to attract and retain less water. So it lost moisture faster and had more weight loss than other Barbari breads. There was significant difference between the mean volume of Barbari bread types separately, in the first, second and third storage days, but significant difference was not observed in the third and fourth days. Average volume of Barbari bread types in the same storage day, had significant differences. In all three types of bread with increased storage time until the third day, breads volume increased. On the first storage day, the volume of P_{b1} was more than P_{b2} and P_{b2} had higher volume than P_{b3}, but on the second, third and fourth storage days P_{b3} had more volume than P_{b1} and P_{b2}. The trend of volume increasing in P_{b3} was more than the others. Increasing the volume of Barbari breads was due to the increased thickness of the breads during storage time. The thickening may be caused by dehydration; starch retro gradation and staling of breads especially P_{b3} during storage time. The average density values of Barbari bread types had separately significant differences in storage days. There was significant difference between the mean densities of Barbari bread types in the same storage days. Since density of the breads is related to the weight and volume of them. Reduction in weight and increasing the volume of breads during storage time caused decreasing in density. Therefore, as shown in table 5, the average density values decreased in all three types of bread with increased storage time. The mean density values of P_{b1} were more than P_{b2} and P_{b2} were higher than P_{b3} during all the storage days.

Table 5: Average results of some physical and chemical tests of Barbari bread types in storage days

Types of Barbari Bread	Storage Time	Properties			
		Moisture %	Weight g	cm³Volume	g/cm³Density
P_{b1}	Day 1	30.525±0.002[(a)(a)]	47.225±0.014[(a)(a)]	122.534±0.139[(a)(a)]	0.390±0.000[(a)(a)]
	Day 2	28.725±0.000[(b)(d)]	45.852±0.006[(b)(d)]	133.616±0.659[(b)(d)]	0.343±0.001[(b)(d)]
	Day 3	28.225±0.001[(c)(g)]	44.845±0.002[(c)(g)]	138.842±0.735[(c)(g)]	0.323±0.001[(c)(g)]
	Day 4	25.224±0.003[(d)(j)]	44.045±0.025[(d)(j)]	138.842±0.735[(c)(j)]	0.317±0.001[(d)(j)]
P_{b2}	Day 1	29.852±0.001[(e)(b)]	47/002±0.025[(e)(b)]	121.008±0.132[(d)(b)]	0.386±0.001[(e)(b)]
	Day 2	27.922±0.004[(f)(e)]	45.622±0.018[(f)(e)]	139.227±0.923[(e)(e)]	0.328±0.002[(f)(e)]
	Day 3	25.222±0.000[(g)(h)]	44.112±0.006[(g)(h)]	143.075±0.798[(f)(h)]	0.308±0.001[(g)(h)]
	Day 4	24.124±0.002[(h)(k)]	43.212±0.005[(h)(k)]	143.075±0.798[(f)(k)]	0.302±0.001[(h)(k)]
	Day 1	29.248±0.002[(i)(c)]	46.552±0.012[(i)(c)]	117.720±0.307[(g)(c)]	0.385±0.001[(i)(c)]

P_{b3}	Day 2	$27.052\pm0.004^{(j)(f)}$	$45.525\pm0.014^{(j)(f)}$	$145.799\pm0.508^{(h)(f)}$	$0.312\pm0.001^{(j)(f)}$
	Day 3	$24.152\pm0.000^{(k)(i)}$	$43.975\pm0.008^{(k)(i)}$	$150.564\pm1.163^{(i)(i)}$	$0.292\pm0.002^{(k)(i)}$
	Day 4	$22.951\pm0.002^{(l)(l)}$	$43.025\pm0.014^{(l)(l)}$	$150.564\pm1.163^{(i)(l)}$	$0.285\pm0.002^{(l)(l)}$

*Means within the same column having different letters are significantly different (p< 0.05)
*The first letters in parentheses are for comparison of Barbari breads separately at different times
*The second letters in parentheses are for comparison of Barbari breads at the same times

Results of Texture Analysis

Average results of texture analysis of Barbari bread types in storage days were shown in table 6. In relation to differences in textural characteristics of Barbari bread types with different quality properties, mean hardness in both cycle chewiness and gumminess of Barbari breads separately showed significant differences on different storage days. The average results of these features in a variety of Barbari bread during the same storage time, the average hardness of cycle 1 of Barbari bread types were not significantly different on the first day. But on the second, third and fourth storage days separately significant difference was observed between the hardness of cycle 1 of Barbari breads. Average hardness of cycle 2 of Barbari breads did not have significant difference on the first day. There was no significant difference between the hardness of cycle 2 of P_{b2} and P_{b2} on second and third days. But on the fourth day, there was a significant difference between the mean hardness of cycle 2 of three types of bread. The average results of chewiness and gumminess of Barbari breads had no significant difference on the first day. There were only significant differences between chewiness and gumminess results of P_{b1} and P_{b3} on the second day. On the third day storage, the results of two features of P_{b1} had significant difference with P_{b2} and P_{b3}, but significant differences were not found between the results of P_{b2} and P_{b3}. The chewiness and gumminess of Barbari bread types were significantly different on the fourth day. The average results of above features in second, third and fourth days of storage in P_{b1} were less than P_{b2} and P_{b3}. This represented softer and more desirable texture of P_{b1} than P_{b2} and P_{b3} that was due to absorb and retain more moisture, resulting in lower rate of staling and firming process in storage time. It relates to quality characteristics of the used flour such as the amount and quality of gluten and starch particle size. Fessas and Schiraldi (1998) showed that one of the reasons for decreasing in the perceived firmness of breads with higher protein during storage must be due to the dilution of starch that delayed retro gradation, but there is a positive relationship between protein content and water absorption (Fessas and Schiraldi 1998).Therefor flour with strong quality characteristics   (higher

quantity and quality protein, more damaged starch) have higher water absorption. Staling and firming of breads is supposed to depend on the moisture content, and in breads richer in water, staling was delayed. textural results of this research are in agreement with results of Scalon (2000) that studied the bread quality of flours with different dough strength and also confirm Aamodt research (2005) that evaluated the effect of protein quality and content on Hearth bread characteristics (Scalon etal., 2000; Aamodt etal., 2005). Lagrain (2013) evaluated role of gluten and starch in crumb structure and texture of fresh and stored straight-dough bread. Textural characteristics results of breads are in agreement with the results of this research (Lagrain *et al*., 2013).

Table 6: Average results of texture analyzer test of Barbari bread types in storage days

Types of Barbari Bread	Storage Time	Textural Properties			
		Hardness Cycle 1 N	Hardness Cycle 2	Gumminess N	Chewiness mj
Pb1	Day 1	4.137± 0.408[(a)(a)]	4.038±0.410[(a)(a)]	3.387±0.331[(a)(a)]	8.653±0.813[(a)(a)]
	Day 2	10.320±0.548[(b)(c)]	9.813±0.469[(b)(c)]	7.920±0.345[(b)(b)]	19.686±1.177[(b)(b)]
	Day 3	17.109± 0.441[(c)(f)]	15.671±0.568[(c)(e)]	10.572±0.570[(c)(d)]	23.310±1.062[(c)(c)]
	Day 4	22.939± 0.476[(d)(i)]	21.274±0.791[(d)(g)]	15.802±0.485[(d)(f)]	38.740±0.935[(d)(e)]
Pb2	Day 1	5.460± 0.407[(e)(ab)]	5.241±0.348[(e)(a)(b)]	4.499±0.245[(e)(a)]	11.540±0.580[(e)(a)]
	Day 2	12.417 ± 0.746[(f)(d)]	11.688±0.610[(f)(d)]	8.809±0.084[(f)(bc)]	21.726±0.799[(f)(b)]
	Day 3	19.513±0.562[(g)(g)]	18.619±0.598[(g)(f)]	14.046±0.810[(g)(e)]	34.736±2.874[(g)(d)]
	Day 4	28.514± 1.115[(h)(j)]	26.569±0.671[(h)(h)]	18.996±0.787[(h)(g)]	45.590±2.678[(h)(f)]
Pb3	Day 1	6.260± 0.615[(i)(b)]	6.081±0.612[(i)(b)]	4.859±0.591[(i)(a)]	11.976±1.779[(i)(a)]
	Day 2	14.435±0.338[(j)(e)]	13.278±0.336[(j)(d)]	9.923±0.484[(j)(c)]	23.373±1.561[(j)(b)]
	Day 3	21.581± 0.140[(k)(h)]	19.953±0.145[(k)(f)]	14.917±0.676[(k)(e)]	36.616±2.418[(k)(d)]
	Day 4	33.076± 0.115[(l)(k)]	31.691±0.208[(l)(i)]	31.691±0.114[(l)(h)]	66.473±0.463[(l)(g)]

*Means within the same column having different letters are significantly different (p< 0.05)
*The first letters in parentheses are for comparison of Barbari breads separately at different times
*The second letters in parentheses are for comparison of Barbari breads at the same times

Sensory Evaluation Results of Barbari Breads

Average results of sensory evaluation of Barbari bread types in storage days were presented in table 7. According to statistical results, average points of form & figure, properties under bread, properties on bread, porosity, chewiness, hardness, flavor & taste and mean total point of Barbari bread types had separately significant difference in

different storage days. There were also significant differences between average results of these features in a variety of Barbari bread during the same storage time, only there was no significant difference between average score of flavor and taste property of P_{b2} & P_{b3} in third storage day. In all days of storage, average points of mentioned features and the average total score of P_{b1} were more than P_{b2} and P_{b2} were higher than P_{b3}. Average scores of above features and mean total score of P_{b1} on the first day were so good, on the second day were satisfactory, on the third day were not satisfactory and on the fourth storage day, average scores of form & figure, properties under bread, properties on bread, porosity and total point were not satisfactory and mean points of chewiness, hardness and flavor & taste were unacceptable. Mean points of sensory properties of P_{b2} were good on the first day. On the second day, average scores of form & figure, properties under bread, properties on bread were satisfactory and mean points of other features were less

satisfactory. On the third day, average points of chewiness and firmness were unacceptable, mean scores of other properties were not satisfactory and on the fourth storage day average scores of all features were unacceptable. Average sensory points of P_{b3} were respectively satisfactory on the first day and less satisfactory on the second day. On the third day, average points of form & figure, properties under bread and properties on bread were not satisfactory, mean scores of other features were unacceptable and on the fourth storage day average scores of all features were unacceptable. The results show that P_{b1} from the strong flour had softer texture and better appearance characteristics, porosity and taste than Barbari breads made from average and weak flours. P_{b1} showed more storage ability and had slower staling trend during storage that depends directly on quality features of flour specially gluten quantity and quality. These results confirmed the results of texture analyzer about hardness and chewiness features of breads.

Table 7: Average results of sensory evaluation of Barbari bread types in storage days

Types of Barbari Bread	Storage Time	Sensory Properties							
		Form & figure	properties under bread	properties on bread	porosity	chewiness	hardness	falavour & taste	total point
P_{b1}	Day 1	4.842± 0.053[(a)(a)]	4.882±0.028[(a)(a)]	4.886±0.030[(a)(a)]	4.935±0.019[(a)(a)]	4.914±0.022[(a)(a)]	4.910±0.022[(a)(a)]	4.927±0.021[(a)(a)]	4.907±0.019[(a)(a)]
	Day 2	3.298±0.046[(b)(d)]	3.393±0.036[(b)(d)]	3.401±0.035[(b)(d)]	3.247±0.054[(b)(d)]	3.249±0.028[(b)(d)]	3.316±0.046[(b)(d)]	3.336±0.073[(b)(d)]	3.311±0.038[(b)(d)]
	Day 3	1.751± 0.081[(c)(g)]	1.724±0.056[(c)(g)]	1.664±0.073[(c)(g)]	1.543±0.036[(c)(g)]	1.449±0.040[(c)(g)]	1.438±0.039[(c)(g)]	1.610±0.081[(c)(g)]	1.566±0.033[(c)(g)]
	Day 4	1.137± 0.059[(d)(j)]	1.151±0.050[(d)(j)]	1.115±0.039[(d)(j)]	1.064±0.040[(d)(j)]	0.928±0.029[(d)(j)]	0.942±0.026[(d)(j)]	0.942±0.037[(d)(j)]	1.005±0.029[(d)(j)]
P_{b2}	Day 1	4.148± 0.041[(e)(b)]	4.140±0.036[(e)(b)]	4.165±0.037[(e b)]	4.090±0.030[(e)(b)]	4.059±0.025[(e)(b)]	4.078±0.038[(e)(b)]	4.401±0.039[(e)(b)]	4.176±0.020[(e)(b)]
	Day 2	3.077 ± 0.054[(f)(e)]	3.073±0.056[(f)(e)]	3.105±0.055[(f)(e)]	2.567±0.033[(f)(e)]	2.526±0.036[(f)(e)]	2.509±0.034[(f)(e)]	2.551±0.031[(f)(e)]	2.675±0.027[(f)(e)]

	Day 3	$1.312\pm0.028^{(g)(h)}$	$1.335\pm0.021^{(g)(h)}$	$1.296\pm0.023^{(g)(h)}$	$1.072\pm0.041^{(g)(h)}$	$0.980\pm0.032^{(g)(h)}$	$0.941\pm0.035^{(g)(h)}$	$1.013\pm0.020^{(g)(h)}$	$1.076\pm0.020^{(g)(h)}$
	Day 4	$0.928\pm0.034^{(h)(k)}$	$0.919\pm0.041^{(h)(k)}$	$0.888\pm0.030^{(h)(k)}$	$0.766\pm0.024^{(h)(k)}$	$0.759\pm0.025^{(h)(k)}$	$0.742\pm0.027^{(h)(k)}$	$0.800\pm0.029^{(h)(j)}$	$0.804\pm0.021^{(h)(k)}$
P_{b3}	Day 1	$3.988\pm0.047^{(i)(c)}$	$3.876\pm0.038^{(i)(c)}$	$3.890\pm0.033^{(i)(c)}$	$3.510\pm0.049^{(i)(c)}$	$3.420\pm0.045^{(i)(c)}$	$3.401\pm0.040^{(i)(c)}$	$3.491\pm0.034^{(i)(c)}$	$3.573\pm0.027^{(i)(c)}$
	Day 2	$2.394\pm0.035^{(j)(f)}$	$2.399\pm0.040^{(j)(f)}$	$2.406\pm0.041^{(j)(f)}$	$2.144\pm0.046^{(i)(f)}$	$2.095\pm0.039^{(i)(f)}$	$2.099\pm0.045^{(j)(f)}$	$2.171\pm0.052^{(j)(f)}$	$2.198\pm0.039^{(j)(f)}$
	Day 3	$1.139\pm0.041^{(k)(i)}$	$1.158\pm0.047^{(k)(i)}$	$1.155\pm0.049^{(k)(i)}$	$0.869\pm0.038^{(k)(i)}$	$0.849\pm0.031^{(k)(i)}$	$0.835\pm0.032^{(k)(i)}$	$0.906\pm0.033^{(k)(h)}$	$0.938\pm0.022^{(k)(i)}$
	Day 4	$0.680\pm0.023^{(l)(l)}$	$0.670\pm0.022^{(l)(l)}$	$0.660\pm0.028^{(l)(l)}$	$0.550\pm0.028^{(l)(l)}$	$0.469\pm0.023^{(l)(l)}$	$0.449\pm0.017^{(l)(l)}$	$0.498\pm0.018^{(l)(k)}$	$0.534\pm0.015^{(l)(l)}$

*Means within the same column having different letters are significantly different (p< 0.05)
*The first letters in parentheses are for comparison of Barbari breads separately at different times
*The second letters in parentheses are for comparison of Barbari breads at the same times

CONCLUSION

Results indicated that flour quality characteristics such as protein quality and quantity, damaged starch percent and falling number affected dough rheological parameters, physical, chemical and sensory properties of bread, textural attributes and staling process. F_s with higher protein content, increased zeleney volume, higher damaged starch and lower falling number had more resistance to extension (P) and higher water absorption, also other Aleo & Consist graph parameters were affected largely by flour quality specially its protein. In general, high protein quality and quantity in flour produced strong dough. F_s made P_{b1} with higher protein content and more specific volume that lost lower moisture and weight and its density reduction was less than P_{b2} and P_{b3} during storage. The values of hardness, chewiness and gumminess properties obtained from texture analyzer in P_{b3} was more than P_{b2} and in P_{b2} was higher than P_{b1}, thus F_S with higher protein quantity and quality reduced firming and staling of bread during storage. Sensory analysis showed lower scores in bread made from weak flour with low protein and zeleney volume and P_{b3} had more firmness, less porosity and undesirable form and flavor than P_{b2} & P_{b1} during storage days. These results confirmed the results of texture analyzer about hardness and chewiness features of breads. Therefore according to the results of this study P_{b1} made of F_s had more desirable quality characterization and higher shelf life than P_{b2} and P_{b3} .

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