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Evaluation of physiochemical and rheological properties of some local wheat cultivars and their relationships to baking characteristics

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Abstract

In order to assess the bread-making potential for different cultivars and understanding there different effects on baking quality and find out the opportunity of using the suitable cultivar for suitable end product twelve different locally wheat cultivars Ala, Aras, Azad , Bakrajow , Charmo, Hamada, Hasad, Hazha , Marf, Shaho, Sarah and Tamuz were evaluated for physiochemical, rheological and baking test properties. Chemical composition of cultivars in terms of protein, fat ,carbohydrate , moisture and ash percentages were obtained from the highest values (11.4 , 3.9 , 74.7 , 16.6 ,0.56) to the lowest values (5.1, 1.5, 69.7, 14.4, 0.51) respectively. While wheat and baking quality of cultivars in terms of Total wet gluten, Gluten index, Thousand grain weights, Hectoliter weights, Loaf Weight, Loaf volume and Specific loaf volume (4.2 g, 99 , 31.6g, 89.4 kg/hl, 90.6g, 236.6 cm3, 2.81 cm3/g) respectively, to the lowest (1.1 g, 28, 23.6 g 74.4 kg/ hl, 81.6 g, 133.3 (cm3), 1.51 cm3/g respectively. According to sensory evaluation characters of loaf breed quality in terms of (Volume, Crust, Color, Symmetry, Bake uniformity ,Texture, Crumb, Grain, Aroma and Taste were obtained from the highest values (12.3, 4 , 4.6 , 4.3 , 13.6 , 7.6 , 8.3 , 8.6 , 16.6) to the lowest values (8.6, 2.6,1.3 , 1.6 , 7.3 , 4.6,5.3 , 5.6, 11.3) respectively. While for Amylograph and Farinograph characteristics for cultivars flours in terms of (Water absorption ,Developing time ,Stability time ,Time to break down and Gelatinization temp) were obtained from the highest values(75.6 ,15.4 min , 17.4 min , 17.4 FU , 62.3°C) to the lowest values (63.4 ,4.4 min , 1.6 min, 4.5 FU, 57.3 °C) respectively. Results from this study approved that there were significantly differences between all cultivars. These results indicate that there were possibilities to select suitable cultivars for suitable end product like bread with improved baking quality.

Introduction

Wheat is cultivated worldwide primarily as a food, wheat has also been considered as an energy crop *[1]* Wheat is one of the most important crops in the world *[2]*. Cereal-based food products have been the basis of the human diet since ancient times. Protein content is in turn influenced mainly by nitrogen fertilization cereal storage proteins of wheat play a fundamental role in the bread making process. They have the ability to form gluten, a necessary network to amalgamate the other wheat components, mainly carbohydrates, and the gas produced during proof. The gluten characteristics are one of the main parameters that govern flour quality and subsequent bread making quality of the wheat *[3]*. Several factors affect the final gluten quality such as cultivar, environmental conditions, and post harvest conditions. Variability in any of them could

result a reduced capacity of the storage proteins to form gluten, the amount of protein in flour is an index of protein content and the physical properties of washed out gluten provide an index of flour strength *[4]*. Numerous breeding programs have attempted to improve bread making quality of wheat; however some new cultivars developed are not appropriate for bread making and require some protein modifications. While the protein quality is determined primarily by the wheat cultivar and genotype. The baking potential of wheat flours is influenced by many factors, most notably protein content .Differences in baking quality of cultivars have been related to differences in gluten composition. Dough Rheology characterization, which relates to dough handling properties and the tendency towards the dough to contract is an important parameter in the evaluation of dough wheat quality. The purpose of the present study was to investigate the major physical, chemical, sensory evaluations and rheological characteristics of some locally wheat cultivars.

Materials and Methods

A. ***Materials***

Twelve different locally wheat cultivars Ala, Aras, Azad , Bakrajow , Charmo, Hamada, Hasad, Hazha , Marf, Shaho, Sarah and Tamuz , were provided from the Ministry of Agriculture, the General Commission for Scientific Agricultural Research center which is located in the Bakrajow city in Sulaimani governorate-Kurdistan- Iraq.

B. Test Weight

Test weight was determined using the approved method of the American Association of Cereal Chemists 55-10 and thousand grains were counted and weighed Kg/ hl *[5]*.

C. Dough Bread-Baking Method

Measurement of characteristics of dough bread baking process was determined by following several processing steps starting from the dough mixing to optimum dough development, bulk fermentation 60 min, dividing and rounding (50 g pieces), intermediate proof (10 min), sheet, final proof (30 min), baking (288 °C for 15 min), cool. Basic Straight-Dough Bread-Baking Method10-09.01 .Long fermentation was used for Dough Bread-Baking *[6]*.

D. Baking quality evaluation of loaf bread

The dough pieces were baked in electric oven. And then the bread parameters and sensory evaluation characters like volume crust color, symmetry, bake uniformity, texture, grain and aroma were evaluated according to AACC Method 10-12.01 baking guidelines for scoring experimental bread *[7]*.

E. Measurements of Bread Volume

Bread volume was evaluated for its weight, volume and weight to volume ratio. The volume of a loaf was measured by rape seed displacement method using loaf volume meter (AACC, 2000) AACC Method 10-05.01 Was used for Measurement of Volume by Rapeseed Displacement and weight of fresh loaves was measured with a digital balance *[8]*.

F. Rheological Characteristics of Dough

Amylograph procedure was used for rheological characteristics according to AACC Methods 61-01.01 Amylograph Method for Milled Rice was performed using a 60 g of sample *[9]*.

G. Chemical Composition of local wheat cultivars

The following methods were used for flour analysis AACC Method 08-21.01 Prediction of Ash Content in Wheat Flour—Near-Infrared, Method 39-10.01*[10]*.Near-Infrared Reflectance Method of Protein Determination in Small Grains *[11]*, AACC Method 0-10.01Crude Fat in Flour, Bread, and Baked Cereal Products *[12]*, AACC Method 44-01.01 Calculation of Percent Moisture *[13]*, AACC Method 76-13.01 Total Starch Assay Procedure Megazyme Amyloglucosidase/Alpha-Amylase Method *[14]*. AACC Method 38-12.02 Determination of Gluten Index *[15]*.

H. Method of Statistical Analysis

For the statistical tests of variance analysis, least significant difference (LSD) test and SPSS software, version 18, were used.

Results and Discussions

Flour samples showed considerable variations, different cultivars contained protein, fat, carbohydrate, moisture and ash had different results data in table1indicate that there were significant differences between all compositions were determined to assess their contribution to the quality of the prepared bread. These compositions are important factors of determination of the quality of the wheat type because it reflects on the quality of the end products *[16]*.

Table -1: approximate composition of wheat flours from different cultivars used in the study.

Cultivars	*Protein %*	*Fat %*	*Carbohydrate %*	*Moisture %*	*Ash %*
Ala	*10.4 b*	*2.7 b*	*72.2 h*	*14.4 e*	*0.51 b*
Aras	*9.7 c*	*1.5 e*	*72.5 g*	*15.8 bc*	*0.56 a*
Azad	*9.1 d*	*1.5 e*	*73.2 e*	*15.6 cd*	*0.55 a*
Bakrajow	*6.7 g*	*2.8 b*	*73.7 d*	*16.3 ab*	*0.54 a*
Charmo	*7.7 f*	*2.8 b*	*72.7 f*	*16.3 ab*	*0.52 b*
Hamada	*6.6 g*	*2.7 b*	*74 c*	*16.5 a*	*0.52 b*
Hasad	*8.6 e*	*2.7 b*	*71.5 i*	*16.6 a*	*0.56 a*
Hazha	*7.2 f*	*1.5 e*	*74.7 b*	*16.1 ab*	*0.52 b*
Marf	*11.4 a*	*3.9 a*	*69.7 j*	*14.5 e*	*0.51 b*
Shaho	*5.1 h*	*2.5 c*	*75.2 a*	*16.6 a*	*0.55 a*
Sarah	*8.4 e*	*1.8 d*	*74 c*	*15.3 d*	*0.51 b*
Tamuz	*7.6 f*	*1.5 b*	*74 c*	*16.3 ab*	*0.55 a*
MSE	*0.06*	*0.008*	*0.001*	*0.091*	*0.001*

Values with different superscripts letters in the same column are statistically significant at $P \leq 0.01$.

Data onto table 2 shows that the different flours gave different results from all tested parameters of the cultivars and there were highly significant differences between Total wet gluten, Gluten index, Thousand grain weights, Hectoliter weights, Loaf Weight, loaf volume and Specific loaf volume (4.2 g, 99 , 31.6g , 89.4 kg/ hl, 90.6g, 236.6 cm3, 2.81 cm3/g) for (Marf, Hamada, Sarah and Tamuz, Sarah, Sarah, Aras and Aras) respectively .It is obvious that all these parameters are referred to a good indicators for baking dough quality . For all cultivars, bread making tests was performed as good indicator especially specific loaf volume *[17]*. The baking potential for wheat flours is influenced by many factors, most notably protein content, Gluten separated from whole wheat meal or wheat flour by the Glutomatic equipment is centrifuged to force wet gluten through a specially constructed sieve under standardized conditions. The total weight of the gluten is defined as gluten quantity. The percentage of wet gluten remaining on the sieve after centrifugation is defined as the Gluten Index. If the gluten is very weak all of the gluten may pass through the sieve, when nothing passes through the sieve, the Gluten Index is strong. Wet gluten in wheat flour is a visco-elastic substance made of gliadin and glutenin. The Gluten Index is a measure of the gluten characteristics, which indicates whether the gluten is weak, normal or strong *[18]*. Many studies investigating bread wheat baking performance have addressed protein properties, with particular emphasis on gluten strength. Differences in baking quality among cultivars have been related to differences in gluten composition *[19; 20]*. The variations in functional properties of a wheat cultivar are attributed largely to its gluten quality and quantity bread-making quality increases linearly with increases in protein content, but for a given protein it is largely a function of the qualitative nature of gluten proteins *[21]*. Various researchers have attempted to avoid the baking tests by predicting bread quality of prediction models in which combination of measurements made from grain, flour and dough were used. For instance when trying to predict loaf volume, glutenin quantity, protein content, moisture content they concluded that loaf volume is an important indicator for predicting the wheat baking performance, to perform baking tests in order to achieve a reliable evaluation *[22;23]*. Results showed for parameters thousand grain weight and hectoliter weight from the sound kernels test weight values were generally high and showed significant differences

between all the samples .The variations of values for the studied characteristics of the different flours are likely to be the results of cultivars variation *[24].*

Table- 2: Wheat and baking quality parameters

Cultivars	Total wet gluten (g)	Gluten index	Thousand grain weight (g)	Hectoliter weight (kg/ hl)	Loaf Weight(g)	Loaf Volume (cm^3)	Specific loaf volume(cm^3/g)
Ala	3.4 b	49 d	24.6 f	77.5 g	90 a	192.3 d	2.11 e
Aras	2.1 f	28 h	28.3 de	79.8 ef	84.6 def	236.6a	2.81 a
Azad	2.2 f	29 h	29.3 cd	76.2 h	85.6 cdf	163.3 e	1.90 f
Bakrajow	2.7 d	36 g	30.6 ab	87.6 b	83.6 ef	150.3 f	1.79 g
Charmo	2.4 e	45 ef	30.6 ab	79.8 f	89 abc	210 b	2.31 cd
Hamada	1.1 h	99 a	23.6 f	83.2 c	89.6 ab	201 c	2.23 d
Hasad	3.3 b	48 ef	27.3 e	74.6 i	81.6 f	149.3 f	1.79 g
Hazha	2.1 f	41 f	30 cb	80.7 d	87.6 abcd	213.3b	2.44 b
Marf	4.2 a	44 f	24.6 f	74.4 i	89.6 ab	213.3b	2.37 bc
Shaho	1.5 g	93 b	27.6 e	77.5 g	88 abcd	133.3 g	1.51 i
Sarah	3.1 c	61 c	31.6 a	89.4 a	90.6 a	152.6 f	1.68 h
Tamuz	2.2 f	95 ab	31.6 a	80.4 de	87 bcde	201.6 c	2.31 cd
MSE	0.005	5.03	0.388	0.129	4.333	10.39	0.0032

Values with different superscripts letters in the same column are statistically significant at $P \leq 0.01$.

The variables and their ranges measured for the breads produced from the different cultivars. Significant differences were found for the results of the sensory analysis of the bread samples are presented in table 3 for Volume, Crust, Color, Symmetry, Bake uniformity ,Texture, Crumb, Grain, Aroma and Taste 12.3, 4 , 4.6 , 4.3 , 13.6 , 7.6 , 8.3 , 8.6 , 16.6 for Hamada, Ala, Hamada, Ala, Bakrajow, (Ala- Bakrajow - Charmo) ,(Azad- Bakrajow- Sarah) ,Ala and Ala respectively. Bread quality, expressed through bread yield, all bread made from different wheat cultivars were suitable for baking approved by sensory evaluation characters of loaf breed quality.

Table- 3: Effect of flours from different cultivars on the sensory evaluation characters of loaf bread quality.

Cultivars	Volume (15)	Crust color (5)	Symmetry (5)	Bake uniformity (5)	Texture (15)	Crumb color (10)	Grain (10)	Aroma (15)	Taste (20)
Ala	11 a	4 a	2.3 a	4.3 a	8.6 ef	7.6 a	7.33 ab	8.6 a	16.6 a
Araz	10.6 abc	2.6 b	3 abcd	4 a	11.3 bcd	6.3 abc	6.6 bc	7.5 abc	11.3 c
Azad	9.3 bc	3.3 ab	2 cd	3.6 a	10.3 cdf	7 ab	8.3 a	5.6 e	11.6 c
Bakrajow	10 abc	3.3 ab	3 abcd	1.6 b	13.6 a	7.6 a	8.3 a	8.3 ab	12.6 c
Charmo	11.6 ab	3.3 ab	2.3 bcd	4.3 a	11.3 bcd	7.6 a	7.3 ab	7.6 abc	12.6 c
Hamada	12.3 a	2.6 b	4.6 a	3.3 ab	9 ef	5.6 bcd	7.3 ab	6.6 cde	16.6 ab
Hasad	10.6 abc	3,6 ab	3.6 abc	2 .a	7.3 f	5.3 cd	5.3 c	7.3 bcd	13 bc
Hazha	8.6 c	3.6 ab	2.3 bcd	3.6 a	8.3 ef	4.6 d	7.3 ab	5.6 e	12.3 c
Marf	12 a	2.6 b	2.3 bcd	4.3 a	12 abd	7.3 a	7.3 ab	7.6 abc	15.3 ab
Shaho	11.6 ab	3.3 ab	1.3 d	2.6 ab	9.3 def	6.6 abc	6.6 bc	6.6 cde	13.3 bc
Sarah	8.6 c	3.3 ab	4 ab	3 ab	8.6 ef	7.3 a	8.3 a	7.6 abc	12.3 c
Tamuz	11.6 ab	3.3 ab	3.3 abc	3 ab	13.3 ab	6,6 abc	6.6 bc	6.3 de	11.6 c
MSE	2.083	0.388	1.388	1.508	1.444	0.638	0.750	0.500	2.361

Values with different superscripts letters in the same column are statistically significant at $P \leq 0.01$

Rheological measurements have traditionally been used to give some indication of the probable baking quality of dough .Gluten is the major protein in wheat flour dough's, responsible for their unique viscoelastic

behavior. It is now widely accepted that gluten proteins are responsible for variations in baking quality, and in particular it is the insoluble fraction of the HMW glutenin polymer, which is best related to differences in dough strength and baking quality of different wheat varieties *[25].*There were remarkable differences in Farinograph and Amylograph characteristics between cultivars. Rheological measurements have traditionally been used to give some indications of the probable baking quality of dough to assess and predict the physical dough properties and bread-making potential information provided by these instruments is limited to empirical correlations and does not involve the measurement of a well-defined physical quantity *[26]*.

Table- 4: Amylograph and Farinograph characteristics of flours from different cultivars

Cultivars	*Water absorption (%)*	*Developing time (min)*	*Stability time (min*	*Time to break down (FU)*	*Gelatinization temp. (°C)*
Ala	*70 .6 e*	*8.4 f*	*11.4 e*	*15.4 ab*	*57.3 e*
Araz	*72.3 c*	*5.7 h*	*1.8 j*	*6.6 de*	*59 de*
Azad	*69.6 f*	*8.4 f*	*13.6 d*	*11.6 c*	*61.3 abc*
Bakrajow	*70.6 d*	*15.4 a*	*16.4 b*	*15 .6 ab*	*58.5 de*
Charmo	*68.5 g*	*11.5 c*	*17.4 a*	*14.5 b*	*59.6 cd*
Hamada	*75.6 a*	*7.4 g*	*2.8 i*	*7.7 d*	*62.3 a*
Hasad	*69.6 e*	*10.8 d*	*13.6 d*	*16.2 ab*	*57.6 e*
Hazha	*73.6 b*	*9.7 e*	*9.6 f*	*11.8 c*	*58.3 de*
Marf	*75.6 a*	*7.4 g*	*3.6 h*	*8.3 d*	*61.6 ab*
Shaho	*63.4 h*	*4.4 i*	*1.6 j*	*4.5 e*	*60 bcd*
Sarah	*72.7 c*	*7.4 g*	*7.8 g*	*8.3 d*	*61.3 abc*
Tamuz	*72.6 c*	*14.4 b*	*14.6 c*	*17.4 a*	*61.3 abc*
MSE	*0.077*	*0.064*	*0.025*	*2.230*	*1.250*

Values with different superscripts letters in the same column are statistically significant at $P \leq 0.01$

FU= Farinograph Unit, AU= Amylograph Unit, min= Minutes

Conclusions

These results show different response to baking test of different wheat cultivars. The selected testes of the selected cultivars were well suited for rheological properties and loaf breads baking properties, as they showed a great variability in properties, but are still characterized as loaf breads wheat. Oscillation measurement of a loaf breads dough from the tested cultivars reflected differences, which are likely to be related to dough structural differences. Results from the Farinograph parameters showed that there were remarkable differences in baking quality of dough characteristics between cultivars. The previously results were the major finding of my work hopping that these results which I reach via my study will help bakers to select suitable cultivar for suitable product and this will help both the bakers and the consumers together in matters of economic and health .

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