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Study of Physical Characteristics of Flat Bread Made of Three Iranian Wheat Cultivars

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ABSTRACT

Physical characteristics of Iranian flat bread made of three different cultivars (cv.) of wheat were investigated. The results showed that the effect of the wheat cv. on bread volume, decrease in dough weight during baking and baking time were statistically significant on the level of 1%. Among different cv., Chamran had the maximum increase in bread volume, minimum decrease in weight and minimum baking time; whereas, Marvdasht had the minimum increase in bread volume, the maximum decrease in dough weight during baking and maximum baking time. The effect of cv. on thickness of dough, after secondary proof was not significant. The effect of different baking temperatures on bread volume, and decrease in dought weight during baking and baking time were statistically significant. Minimum baking time was about 11 minutes at 249°C, and maximum baking time was about 15.2 minutes at 232°C. The interaction effect of wheat cv. and baking temperatures on bread volume, decreases in dough weight during baking and baking time were statistically significant. Maximum increase in bread volume was dedicated to Chamran at 260°C and the minimum to Marvdasht at 232°C. Minimum decrease in dough weight was dedicated to Chamran at 260°C and the maximum to Pishtaz at the same temperature. Minimum and maximum baking time were 10 and 17 minutes and dedicated to cv. chamran and Marvdasht at 260 and 232°C, respectively.

Key Words: Wheat cultivars; Flour; Physical characteristics; Baking; Flat bread

INTRODUCTION

The film formation, expansion of gases within gluten net, reduction of solubility of gases, and evaporation of alcohol and other liquids such as water are the examples of the physical changes of dough during baking. These changes occur in different temperatures and largely affect the physical characteristics of the final product (Payan, 1998). In all, thermo-production processes including bread baking, besides chemical characteristics, physical especially thermo-physical properties are important factors in the control of the quality. Hence, in different stages of preparing dough and baking bread, the temperature of the environment in which the dough is produced and the temperature of oven are essential parameters (Faridi & Finney, 1980; Faridi *et al.,* 1983; Christenson *et al.,* 1988; Zanoni & Petronio, 1991; Irani, 1994; Qarooni, 1996; Akram *et al.,* 1998).

The objective of the current study was to examine the effects of various wheat cultivars (cv.), baking temperature, and interaction between temperature and wheat cv. on physical characteristics of flat bread.

MATERIALS AND METHODS

In this study, various cv. of wheat including Pishtaz, Marvdasht and Chamran and baking temperature in three levels involving 232, 249 and 260°C as two factors affecting different characteristics of bread were examined based on a factorial statistical design. Nine treatments in the form of completely randomized fundamental design with 3 replications and in total, 27 samples were baked ($3\times3\times3$). Once the variance analysis of the resulting data based on factorial design model between different levels of two main factors and interaction between them showed a significant difference, mean major effects of factors on observed characteristics as well as their interaction were classified through Duncan method (LSR, $p<0.05$). The software Minitab was used for statistical analysis of data (Jamshidian & Vosoogi, 2004). The effects of physical and chemical characteristics of different wheat cv. were studied because of their effect on the properties of resulting flour and dough on physical characteristics of bread. Then, the prepared samples of dough were baked in an electrical oven with the dimensions of $875\times865\times680$ mm^3.

Determinative Traits of Wheat, Flour and Dough Quality

Physical characteristics. Physical characteristics of different wheat cv. including thousand seed weight, injure bug, efficient loss, inefficient loss and grain color were evaluated. Some physical characteristics such as moisture content percentage, bread volume and grain hardness were determined by Inframatic 8100. According to the relevant diagrams, the amount of water, required time for soaking and secondary moisture content percentage of each cv. was determined. All cv. were soaked in a calculated amount of water for 24 h and then milled by Brabender Type 279002.

Chemical characteristics. 100 g of each cv. was sampled and milled by Laboratory Mill 3100. Chemical characteristics of various cv. such as protein content percentage and Zeleny number were determined by Inframatic 8100. The gluten of flour was measured through both wet and dry method. In wet method, samples were rinsed with tampon solution according to ICC Standard-106.1 by Glutamatic-2100. Rinsing process was carried out

in two stages by two filters with different mesh number. In the second method, wet gluten samples were dried by Glutork 2020 and weighed by Precisa 1600C with the precision of 0.01. Centrifuge 2015 was used for determining the gluten quality. To measure the elasticity of gluten, samples tensioned and dryness and softness of them were calculated. The activity of α-amylase enzyme of sample was determined by Falling Number.

Rheological characteristics. Mechanical characteristics of flour and dough including resistance, expansion time, durability and sagging degree of dough in terms of Farino were determined according to ICC Standard-115 by Bra Bender Farinograph Type 820600. Valorimetric value was used for verifying the strength and weakness of dough.

Technological characterisitcs of dough. In preparing dough, different compositions (Table I) were used that were selected according to instructions of Cereals Chemical and Technological Research Unit, Plant and Seed Breeding and Research Institute, Karaj, Iran.

Dough was combined of flour, sodium chloride, dry yeast, sugar and water. To get better results, firstly dry components were mixed and then water was added. To provide the yeast solution, 2.5 g of leaven, 1.5 g of salt and 1 g of sugar per 100 g of flour of each cv. were mixed and then calculated water by farinograph was added. Resulting solution was added to flour and according to RMT method in laboratory temperature (26-27˚C) was mixed by a mixer with the circular speed of 1400 r.p.m. for 1 minute. Thereafter, dough was placed in a steel container and was maintained in incubator - Cenco Model NO 95086 - in temperature of 30-32˚C and relative humidity of 80% for 30 minutes. The second stage of preparing dough was its proving. To provide the suitable condition for reactivation of yeast, dough was kneaded for one minute in order to exit the produced gases in initial fermentation process. Dough was widened on a 40×20 cm^2 aluminum tray with the thickness of 10 mm and was placed in an incubator for 45 minutes in order to secondary proof. Then the thickness of dough was measured in three points by using a 0.1-mm-precision calliper and its average amount was considered as the thickness of dough. The bread was baked with emergency no-time method in three temperatures (232, 249 & 260˚C). Duration of baking was recorded by chronometer. To determine the decrease in bread weight during baking, four samples with same weight were selected and baked in different studying temperatures. The weight of all bread loaves after being in electrical oven for 8, 10, 12 and 14 minutes and their moisture content and weight loss were measured. The volume of loaves was measured by National Loaf Volumemeter (suitable for volumes less than 1000cc) according to the mothod of substitution of rape seed. To determine the voluminous density of loaves, bread weight was calculated 30 minutes after baking and divided by its volume.

RESULTS AND DISCUSSION

The cv. Pishtaz had more protein percentage, Zeleny number, water absorption percentage and grain hardness than two other cv. - Chamran and Marvdasht (Table II). All the three cv. were poor in protein. Zenely number of Pishtaz, Chamran and Marvdasht wee in the range of rich, moderate and poor wheat, respectively. Pishtaz may have more yield than other cv. due to higher level of water absorption. Considering thousand-seed weight, Pishtaz and Chamran are moderate and Marvdasht is small-grain (Table III). The high protein content in Pishtaz may be due to higher grain hardness. Injure bug in cv. Pishtaz and Marvdasht may have affected the quality of their gluten.

Based on gluten amount, cv. Pishtaz and Chamran were moderate cv. and Marvdasht was found to be poor one (Table IV). Nonetheless quality index and gluten content percentage of cv. Chamran are greater than Pishtaz and Marvdasht. The results of elasticity test of dough show that cv. Chamran has more elasticity than other cv. in spite of higher protein content of cv. Pishtaz. Higher elasticity is due

Table I. Compostions and percentage of materials in dough

Composition	In terms of dry matter % of flour	Weight (g)
Sodium chloride	1.5	6
Sugar	1	4
Yeast	2.5	10
Water	-	a
Flour	-	400

[a]calculated number by farinograph for each cultivar

Table II. Physical and chemical characteristics of different wheat cultivars

Cultivar	Grain hardness	Moisture (%)	Bread volume (cc)	Zeleny Number	Protein content (%)	Water absorption (%)
Pishtaz	59.67	11.47	420.34	31.67	11.47	65.87
Chamran	59.12	12.3	513.12	23	10.9	17.63
Marvdasht	53.67	11.3	293.67	14.33	9.13	57.5

Table III. Physical characteristics of three wheat cultivars

Cultivar	Thousand-seed Weight (g)	Injure bug (%)	Efficient Loss (%)	Inefficient Loss (%)	Grain color
Pishtaz	38	0.3	1	0	Red
Chamran	38	0	0	0	Yellow
Marvdasht	34	0.5	2	0	Yellow

Table IV. Qualitative and quantitative characteristics of gluten for all three cultivars

Cultivar	Under-screen gluten	On-screen Gluten	Total gluten (%)	Gluten quality index	Dry gluten (%)	Gluten elasticity
Pishtaz	0.55	2.3	2.85	80.5	11.5	Tough
Chamran	0.6	2.4	3.0	81	10.9	Normal
Marvdasht	1.27	1.67	2.94	56.67	10	Slack

to higher quality of gluten in cv. Chamran. Therefore, it maintains a higher level of gas during baking which in turn, leads to an increase in bread volume, cavities and its porosity. The study of qualitative characteristics of bread confirms this finding. The results of α-amylase activity measurement show that falling numbers of cv. Chamran, Marvdasht and Pishtaz are 232-250, less than 200 and more than 500, respectively. So in this respect, cv. Chamran is better than other cv., too.

Softening index after 10 and 20 minutes indicates that the decline of farinograph diagram of cv. Marvdasht is faster than cv. Pishtaz (Table V). Hence, the period of dough puffing is shorter in this cv. The required time to reach the peak of farinograph diagram in cv. Chamran, Pishtaz and Marvdasht were 3.5, 1.8 and 1.5 minutes, respectively which show the higher quality of gluten in Chamran. Thus, the time of kneading and durability of dough in cv. Chamran will be greater than cv. Pishtaz and Marvdasht. Consequently, the resistance of the dough of this cv. against mechanical mixer and its durability will be greater than others. The valorimetric values of the flours of Chamran, Pishtaz and Marvdasht were 56, 47 and 42, respectively which show that they can be classified as good, moderate and poor flours, respectively.

The measurements of characteristics including bread volume, the decrease in dough weight during baking, dough thickness after secondary proof, and the baking time of bread are shown in Table VI. The decrease is bread weight during baking and baking time were significant on the level of 1% and dough thickness after secondary proof did not exhibit a significant difference. The bread volume increase was in the range of 537-752 cm^3. Cultivar Marvdasht significantly had lower bread volume. But the difference of bread volume between cv. Pishtaz and Chamran was insignificant. According to Payan (1998), the amount and quality of dough gluten are the main factors affecting bread volume increase and its porosity. Thus, the lower bread volume in cv. Marvdasht may be due to the lower amount and quality of its gluten. The variation range of bread volume decrease is 17.5-29.8 g per 100 g of dry flour. Cultivars Marvdasht and Chamran had the highest and lowest decrease in bread weight, respectively; whereas, the difference between bread weight decrease in cv. Pishtaz and Chamran was not significant. With respect to the inverse relation between dough yield and bread weight decrease, Chamran had higher yield than other cv. The range of bread baking time of Marvdasht and Chamran was significant; whereas, there was not a significant difference between Pishtaz and Chamran in this sense. Chamran had the shortest baking time (11.2 min).

Baking temperature significantly affected baking time and bread weight decrease during baking and bread volume increase (Table VIII). The variation of bread volume was in the range of 617-703 mL and the highest bread volume was gained in the temperature of 249˚C. The variation of baking time was 11-15.2 minutes, being lowest at 260˚C. There was a significant difference in baking time between 232˚C

Table V. Some results of Farinograph test of wheat cultivars Pishtaz, Chamran and Marvdasht

Cultivar	Softening degree after 10 min (farino)	Softening degree after 20 min	Development Time (min)	Dough Resistance (min)	Valorimetric value
Pishtaz	65	100	1.8	5	47
Chamran	65	130	3.5	6	56
Marvdasht	135	220	1.5	3	42

Table VI. The effect of cultivar on characteristics including volume, weight decrease, baking time of bread and dough thickness after secondary proof

Characteristics	Pishtaz	Chamran	Marvdasht	Cultivar effect
Bread volume (ml)	683.89a	752.22a	537.56b	**
Weight decrease (g)	30.52b	17.52a	29.85b	**
Dough thickness (mm)	19.88	20.64	20.22	ns
Baking time (min)	12.89b	11.22a	14b	**

* significant on the level of 5% ** significant on the level of 1% ns: insignificant

Table VII. The effect of baking temperature on bread volume, weight decrease and baking time

Characteristics	Temperature			Effect of baking Temperature
	232˚C	249˚C	260˚C	
Bread volume (ml)	617.22	702.78	653.67	*
Weight decrease (g)	24.25	23.74	29.89	**
Baking time (min)	15c	12.11b	11a	**

* significant on the level of 5% ** significant on the level of 1% ns: insignificant

Table VIII. Interaction effect of wheat and baking temperature on volume, weight decrease, baking time and dough thickness

	Varieties									Interaction
	Pishtaz			Chamran			Marvdasht			between variety
Baking temperature (˚C)	232	249	260	232	249	260	232	249	260	and temperature
Bread volume (ml)	721.7abc	706.67abc	623.3cd	663.3bc	786.7ab	806.7a	466.7e	615d	531de	*
Weight decrease (g)	30.04e	22.58bcd	38.93e	20.25abc	17.05ab	15.26a	22.246bcd	31.6e	35.48e	**
Dough thickness (mm)	19.33	20.67	19.67	19.5	20.77	21.67	19.67	21	20	ns
Time (min)	15.67e	12bcd	11ab	12.33bcd	11.33abc	10a	17e	13cd	12bcd	**
Voluminous density(g/cc)	0.422	0.440	0.498	0.465	0.396	0.389	0.665	0.469	0.538	
Moisture decrease (%)	8.9	6.8	11.4	6.2	5.2	4.6	4.1	9.8	11	

* significant on the level of 5% ** significant on the level of 1% ns: insignificant

compared with that at 249 and 260˚C; whereas, it did not differ between 249 and 260˚C. Therefore, it is recommended to use baking temperature of 250˚C in order to save energy and time as already reported previously (Akram, 1998).

There was a significant interaction effect between cv. and baking temperature on bread volume, and between weight decrease and baking time (Table VIII). But the dough thickness after secondary fermentation was insignificant. Cultivar Chamran at 260˚C and cv. Marvdasht at 232˚C had the lowest and highest voluminous density, respectively. Cultivar Pishtaz at 260˚C and cv. Marvdasht at 232˚C had the highest and lowest decrease in moisture percentage, respectively. The voluminous density of bread was in the range of 0.389-0.665 g/mL and the decrease in moisture percentage was in the range of 4.1-11.4% that has a negligible difference from the findings of Unklesbay and Unklesbay (1981). This difference may be due to the difference in its baking method and higher bread thickness.

It is evident from the results that cv. Chamran at 260˚C has the highest increase in bread volume, lowest baking time, lowest voluminous density and lowest decrease in weight. Therefore, it is suggested that this cv. has better physical characteristics than Marvdasht and Pishtaz.

Cultivar Chamran at 260˚C and Marvdasht at 232˚C had the highest (850 mL) and lowest increase in bread volume, respectively (Fig. 1). The diagram of bread volume

Fig. 1. Effect of wheat cultivar in different baking temperatures on bread volume

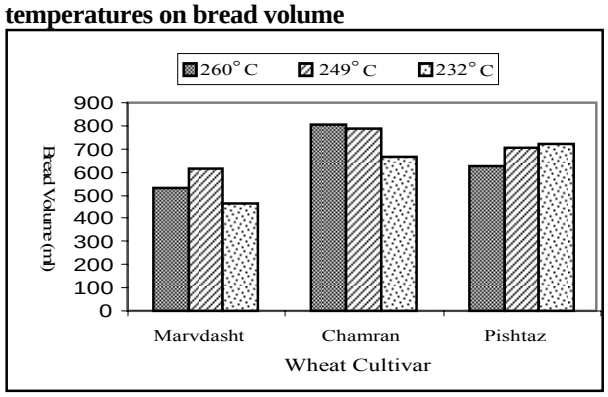


Fig. 2. Decrease in bread weight during baking in different temperatures

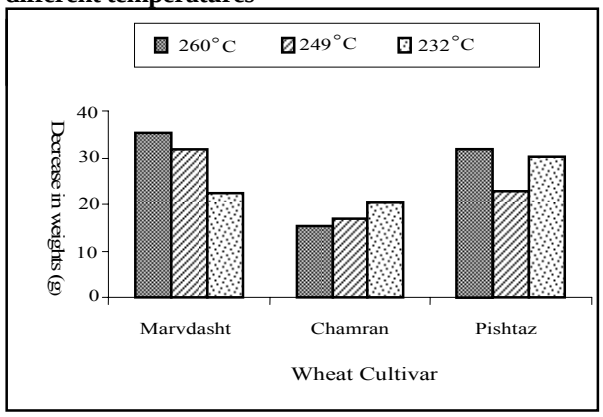
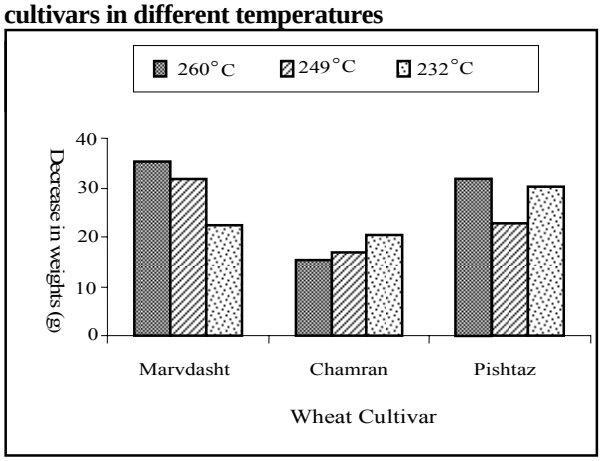


Fig. 3. Comparison of bread baking time in different cultivars in different temperatures



increase shows that cv. Chamran has higher increase in volume than Marvdasht at all the three temperatures. All these cv. reach to the highest increase in bread volume at a certain temperature, so each one has to be baked at a different temperature. The results revealed that cv. Chamran and Marvdasht both had the lowest and highest decrease in weight, respectively at 260˚C (Fig. 2). It is evident from Fig. 2 that cv. with high, moderate and poor quality had the lowest decrease in weight at 260, 249 and 232˚C, respectively. Cultivar Chamran had the lowest decrease in weight at all the three temperatures. Cultivar Chamran and Marvdasht had the shortest and longest baking time at all the three temperatures, respectively (Fig. 3). However, among all three cv., the shortest baking time was gained at 260˚C.

REFERENCES

Akram, A., T. Tavakoli and P. Irani, 1998. The study of temperature and moisture variation trend during qualitative baking of bread Barbari in electrical oven. *Agron. J. Iran,* 681–92

Christenson, M.E., C.H. Tong and D.B. Lund, 1988. Physical properties of baked products as functions of moisture content and temperature. Processing and preservation. *J. Food,* 13: 201–17

Faridi, H.A. and P.L. Finney, 1980. Technical and nutritional aspects of Iranian bread. *Bakers Dig*, 54: 14–22

Faridi, H.A., P.L. Finney and G.L. Rubenthaler, 1983. Iranian bread relative bioacailability of zing. *J. Food Sci.,* 48: 107–9

Irani, P., 1994. The study of bread quality loss and wastage and its solutions. *Proc. 3rd Conf. Agronomy and Crop Breeding.* pp. 45–75. September 3-8, Tabriz University, Iran

Jamshidian, A. and A. Vosoogi, 2004. *Preliminary Training of Software Minitab Release* 11.12. 2nd Publication. Ardakan Publishers, Tehran, Iran

Payan, R., 1998. *An Introduction to Cereal Production Technology.* Nopardazan Pub., Tehran, Iran

Qarooni, J., 1996. *Flat Bread Technology,* p. 206. Chapman and Hall, New York

Unklesbay, N. and K. Unklesbay, 1981. Thermal conductivity of white bread during convective heat processing. *J. Food Sci.,* 47: 247–59

Zanoni, B. and M. Petronio, 1991. Effect of moisture and temperature on the specific heat of bread. *J. Food Sci.,* 3: 238–42

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