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Full Length Article

Spread and Microwave Oven Baking Test for Bread Making Quality

ISMAIL SAIT DOGAN[1], ONDER YILDIZ† AND BURHAN TASAN
Department of Food Engineering, Faculty of Engineering and Architecture, Yuzuncu Yil University, 65080-Van, Turkey
†Department of Food Engineering, Faculty of Engineering, Igdir University, 76000-Igdir, Turkey
[1]Corresponding author's e-mail: isdogan@yyu.edu.tr

ABSTRACT

Spread ratio test of dough and microwave-baked bread were used to study the effects of various flour sources and addition of 2% vital gluten and 12% wheat starch. Before fermentation and at 30, 60 and 90 min of proof time, the width (W) and height (H) of fermented dough was measured and the spread ratio (W/H) was calculated as an indicator of spreading. At the end of each proof time, the dough was baked in a microwave oven at the setting of 600 W for 150 s. At the end of baking, specific volume and ratio of pore area to the total area (proportion), form factor of microwave-baked bread were compared with the mentioned attributes of control bread. Spread ratios of dough and microwave-baked breads were also compared with each other. Addition of gluten and starch to flours and proof time significantly altered the spread ratios of dough, but only proof time significantly affected the spread ratio of microwave-baked bread ($P < 0.001$). Only flour source significantly altered the specific volumes and proportions of both microwave-baked and control breads. A combination of spread ratio and microwave-baking test has potential for flour quality evaluation for bread-making.

Key Words: Bread quality; Flour quality; Microwave baking; Proportion; Spread ratio

INTRODUCTION

The baking industry uses different types of wheat flour depending on the product to be made. Larger mills grind five or six principle flours and then blend these flours depending on the flour requirements. Flour quality for a specific bread-making cannot be determined by only one specific parameter. Bread-making industries are strongly demanding more physical and chemical testing for quality evaluation (Miralbes, 2004).

The baking industries require uniform flour quality for acceptable final product. Baking quality of wheat flour for bread-making is determined by means of analytical, rheological and finally baking tests. Commonly used tests for flour quality such as farinograph, extensograph, alveograph and baking test, etc are mostly time-consuming, expensive and professional technicians are needed to run the experiments. Therefore, flour quality control for bread-making needs quick and practical method for predicting rheological properties of fermented dough.

The fundamental rheological attributes of fermented dough is difficult to define and not repeatable because of continuous changes in the rheological properties and heterogeneity of fermented dough (Dogan, 2002). Matsumoto (1986) suggested that the evaluation of the rheological properties of fermented dough should differ from un-fermented dough. He measured the internal pressure of dough during fermentation and correlated the results with the tension of the gas membrane.

The use of microwave oven in baking studies has recently increased. Microwave heating is a relatively inexpensive technique that offers unique advantages such as convenience and fast heating. The microwaves interact directly with the baked object. Greater penetration of microwave energy speeds up the baking process and heating and expansion of bread occur too quickly. Microwave heating raises the temperature from the outside to inward and also cooks/bakes the food uniformly throughout while radiant or convection heating. Although microwave baking shorten the conventional baking time significantly, there are many quality problems with microwave-baked products. Resulting bread has similar volume and crumb grain to conventionally baked bread but lack of crust and colour formation, firm and tough texture, rapid staling and a dry product (Sumnu, 2001). To overcome this shortness, a hybrid oven including microwave and conventional heating has also been tested.

In determining the quality of flour for bread-making, easy to apply and practical method is required to accelerate the evaluation process. Practical, quick and the test giving comparable results with standard methods is required.

The aim of the study was to observe the effects of flour source, gluten level in bread-making using spread ratio test of dough and microwave-baked bread. Bread volumes and crumb grains of microwave-baked bread were compared with that of control bread baked in a convection oven.

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MATERIALS AND METHODS

Samples: Three commercial un-treated wheat flours were obtained from Başer Food Comp., Sakarya, Turkey; Akova Flour and Feed Comp., Sakarya, Turkey and Toprakcan Flour and Food Comp., Van, Turkey. To those flour samples also 2% wheat gluten (Meelunie America, Inc., USA) and 12% wheat starch (Tate & Lyle Europe N.V., Belgium) were included to widen the strength of flours to the average protein content of 9.5-14%, which is appropriate for various types of bread production.

Dough preparations: Dough was prepared using a total of 300 g of (flour, flour+2% vital gluten or flour+12% starch depending on the used formula), water (determined based on the Farinographic absorption), 1.8% salt, 0.8% instant active dry yeast (Pakmaya Food Comp., Istanbul), 2% flour treatment agent including emulsifier, alpha amylase, ascorbic acid and citric acid (Pantera, Puratos, Istanbul). The doughs were kneaded for 16 min using Home Bread Machine (Sinbo SBM-4701, Depa Electronic, Istanbul, Turkey).

Resting and baking in microwave: The prepared dough (100 g) was placed in a plastic box and rested in a cabinet at 30°C and 90% rh for 30, 60 and 90 min. Before fermentation and at the each proof time, the width (W) and height (H) of fermented dough was measured and the ratio (W/H) was calculated as an indication of dough spreading. At the end of each proof time the dough was baked for 150 s at the setting of 600 W (obtained from the preliminary study) in a commercial microwave oven (Arçelik, Model MD554, Istanbul, Turkey).

Control bread making: Control bread was prepared using all types of flours with vital gluten and starch according to Dogan *et al.* (1996) with some modifications. Absorption level and mixing time determined according to farinographic absorption and development time, respectively. Salt and yeast were added to the dough the last five and three min of kneading, respectively. The dough was fermented in a proofing cabinet (30°C, 85-90% rh) for 30 min, divided into 400 g portions, rounded and allowed to relax for 10 min. The dough was moulded by hand and finally proofed at 30°C, 90-95% rh for approximately 45 min and scored to give a characteristic shape to the bread. The dough was baked in a convection oven (PS5, Koseoglu, Istanbul, Turkey) at 200°C for 20 min.

Chemical and physical analysis: Moisture, protein, sedimentation value, wet gluten, gluten index, falling number and ash content of the flours were determined according to the approved AACC methods (AACC, 1995). Water absorption and dough development time were determined by the Farinograph instrument (Brabender, Duisburg, Germany) (AACC, 1995). Bread volumes were measured using rape seed displacement method of AACC (1995).

Image acquisition and analysis: Images of the sliced bread were captured using a flatbed scanner (HP Scan Jet 3500c, Hewlett Packard Co., CA, USA) with 600 dpi of resolution and analysed in grey-level image (16 bits). Image analysis was performed using Digital Image Analyses software 7.0 (MCID, 2007). A threshold method was used for differentiating gas cells (pores) and non-cells. Form factors indicating roundness of gas cells and gas cell to the total area ratio (proportion) were recorded.

Statistical analysis: The study was run in duplicate and analyses of variance (a two way completely randomized design) were performed to evaluate the effect of flour types, variations and fermentation times using Stat-Graphics Centrium 15.1 (Stat-Graphics, 2006). LSD (Least Significant Difference) test was used, when ANOVA indicated significant difference in the means of evaluated factors at $P< 0.05$.

RESULTS

Analysis of flour samples: Analysis of the flour samples used for spread test and bread-making are given (Table I). Farinographic parameters like water absorption (percent), dough development time (min), dough stability (min) and degree of softening (BU) were recorded (Table II). The effects of gluten and starch addition to the experimental flour samples were investigated. Water absorption, dough development time and dough stability of especially strong flour samples (F_1 & F_2) significantly decreased, when 12% starch added to the flour samples ($P<0.05$).

Spread ratio (W/H): The effects of flour source, addition of gluten and starch and proof time on the mean spread ratios of dough and microwave-baked bread are presented in Table III. The mean spread ratios at the end of each proof time were ranged from 1.395 to 1.659. Flour combinations and proof time were significantly affected the spread ratios of dough ($P <0.01$ & $P <0.001$), respectively.

The mean spread ratios of microwave-baked bread were ranged from 1.253 to 1.434. Only proof time was significantly affected the spread ratio of bread ($P <0.01$). The microwave-baked bread spread ratio baked at the end of 90 min proof time was significantly higher than 30 and 60 min (Fig. 1). Increasing the starch level i.e., reducing gluten content and longer proof time (90 min) significantly increased the spread ratio ($P <0.05$). Spread ratios of dough were positively and significantly correlated with spread ratios of microwave-baked bread ($r = 0.588$, $P < 0.001$) (Fig. 2).

Specific volume: Dough samples were baked in a microwave at the end of 30, 60 and 90 min proof time. The mean specific volumes of microwave-baked bread were 2.25 mL g^{-1} for 30 min, 2.61 mL g^{-1} for 60 min and 3.52 mL g^{-1} for 90 min of fermentation and bread volumes significantly differed from each other ($P <0.001$). Specific volumes of microwave-baked bread were compared with the specific volume of the control bread and a significant positive correlation was observed. Correlation co-efficients between the control bread and microwave-baked bread were $r=0.597$ ($P<0.01$) for 30 min, $r=0.495$ ($P<0.01$) for 60 min and

Table I: Chemical and physical analysis of experimental flour samples

Flour	Ash (%)	Protein (%)	Sedimentation (mL)	Falling Number (s)	Wet Gluten (g)	Gluten Index (%)
F_1	0.58	12.09	45	436	30.0	87
F_2	0.60	12.50	44	380	31.0	93
F_3	0.64	10.50	24	367	26.0	73

Table II: Farinographic analyses of experimental flour combinations

Flour	Variations	Water Absorption (%)	Development time (min)	Stability (min)	Degree of softening (BU)
	Untreated	67.4 b	7.0 b	11.9 b	46 b
F_1	Starch (12%)	65.1 a	1.8 a	8.6 a	48 b
	Vital Gluten (2%)	67.7 b	6.8 b	16.9 c	32 a
	Untreated	63.2 b	6.5 b	18.5 b	25 a
F_2	Starch (12%)	61.4 a	1.9 a	13.3 a	31 b
	Vital Gluten (2%)	64.0 b	7.2 b	18.5 b	30 b
	Untreated	57.2 b	1.7 a	6.8 b	72 b
F_3	Starch (12%)	55.8 a	1.3 a	2.0 a	104 c
	Vital Gluten (2%)	57.6 b	1.8 a	8.7 c	52 a

Different small letters indicate flour, strength and proof time that are significantly different from each other when compared within each group (by LSD test, P < 0.05)

Table III: The mean spread ratios (W/H) of dough and microwave-baked bread obtained from experimental flour combinations and various proof times

		Dough	Bread (MW)
	F_1	1.603 b	1.351 a
Flour	F_2	1.556 b	1.279 a
	F_3	1.409 a	1.346 a
	Untreated	1.480 a	1.286 a
Strength	Starch (12%)	1.450 a	1.289 a
	Vital Gluten (2%)	1.637 b	1.401 a
	30 min	1.395 a	1.253 a
Proof time	60 min	1.514 a	1.289 a
	90 min	1.659 b	1.433 b

(W/H): Width/Height ratio; MW): microwave-baked; proof time (fermentation time); Different small letters indicate flour, strength and proof time that are significantly different from each other when compared within each group (by LSD test, P < 0.05)

r=0.694 (P<0.001) for 90 min of proof time. Total fermentation time of control bread was approximately 90 min. Therefore, the mean specific volumes of bread after 90 min of proof time were used for comparison with the control bread.

The mean specific volumes of control and microwave-baked bread made with different flours and addition of gluten were shown in Table IV. Only flour source was significantly affected the specific volumes of microwave-baked bread and the control bread (P <0.001). The lowest mean specific volume was obtained with F_2 and no significant difference was observed between F_1 and F_3. As shown in Table I, F_2 had the highest protein content (12.50%) and gluten index value (93%). F_2 also had longer farinographic stability and lower degree of softening (Table II).

Crumb grain: The ratio of pore area to total area (proportions) and form factors of breads as crumb grain attributes were evaluated and are presented in Table V. Only

Table IV: The mean specific bread volumes obtained from experimental flour combinations

Characters	Treatments	Bread (MW)	Bread (Control)
Flour	F_1	3.12 a	6.31 a
	F_2	2.37 b	5.53 b
	F_3	2.90 a	6.52 a
Strength	Untreated	2.83 a	5.99 a
	Starch (12%)	2.74 a	6.12 a
	Vital Gluten (2%)	2.82 a	6.24 a

(MW): microwave-baked; Different small letters indicate flour and strength that are significantly different from each other when compared within each group (by LSD test, P < 0.05)

Table V: The mean proportions and form factors of breads obtained from experimental flour combinations

Characters	Treatments	Bread (MW)		Bread (Control)	
		Proportion	Form factor	Proportion	Form factor
Flour	F_1	0.262 a	0.481 a	0.124 b	0.522 a
	F_2	0.330 a	0.437 a	0.164 a	0.511 a
	F_3	0.421 b	0.447 a	0.132 b	0.488 a
Strength	Untreated	0.323 a	0.452 a	0.113 a	0.499 a
	Starch (12%)	0.342 a	0.458 a	0.152 a	0.516 a
	Vital Gluten (2%)	0.348 a	0.455 a	0.154 a	0.507 a

(MW): microwave-baked; Proportion: The ratio of pore to total area; Form Factor: pore roundness; Different small letters indicate flour and strength that are significantly different from each other when compared within each

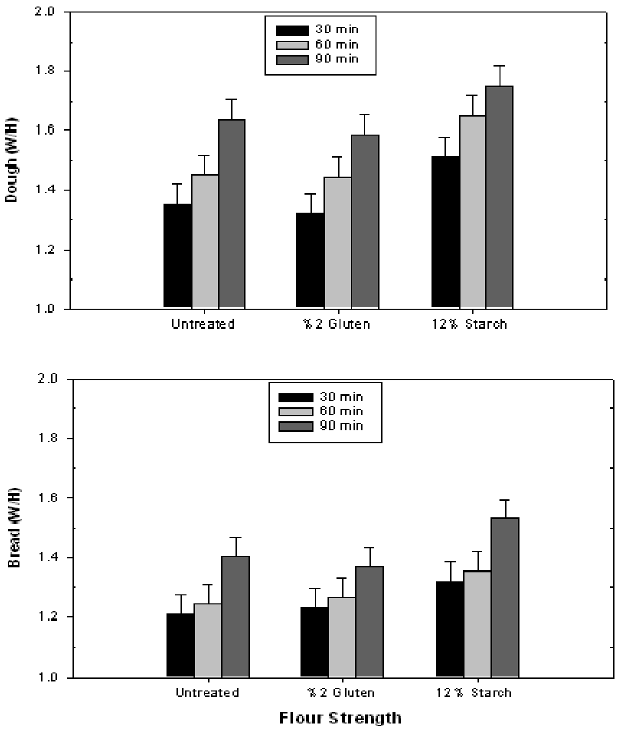
proportions of evaluated breads were found significant (P <0.05). The microwave-baked bread had higher proportion than the control bread and crumbs from microwave-baked bread had larger crumb pores as indicated in the earlier report (Sánchez-Pardo *et al*., 2008). The highest proportion was obtained with F_3 and vital gluten added flour. No significant differences exist between form factors of both microwave-baked and the control bread samples (P > 0.05).

DISCUSSION

Practical and easy-to-apply quality tests for bread flour quality are required to speed up the evaluation process. In this study dough and microwave-baked bread spread ratio test was used to observe the effect of flour strength and fermentation time. The spread ratios of dough and microwave-baked bread were significantly affected by flour source, flour strength and proof time. A significant correlation (r=0.588, P<0.001) between the spread ratio of dough and the spread ratio of microwave-baked bread proves the effectiveness of the test. The higher W/H ratio of dough indicates more spread as a result of viscous flow of fermenting dough. Starch is an interacting ingredient in flour water dough system; therefore, addition of starch, reducing gluten quality increased viscous-flow and gave higher dough spread (Hoseney, 1998). On the other hand, addition of gluten increased elastic properties and reduced spreading.

In earlier studies, strong correlations were observed between protein content and loaf volume, when an optimised baking test was used (Khan *et al*., 1989; Dong *et al*., 1992). It is well known that required protein quality also varies depending on bread types.

Fig. 1: Fermented dough and microwave-baked bread spread ratios (W/H) of experimental flour combinations and various proof times (30, 60 & 90 min) (the results of average of duplicate samples ± S.E.)



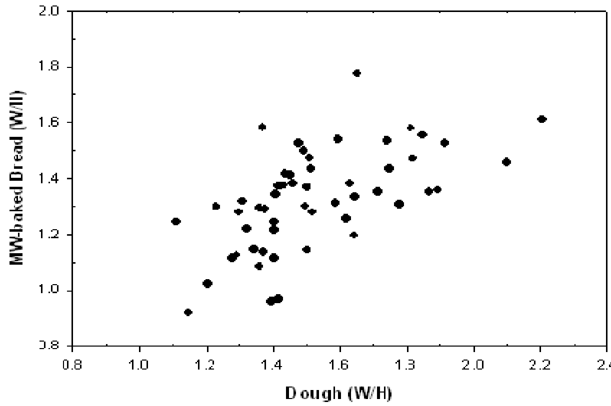
Turkish hearth bread, called Francala, generally made from flour with protein content of 10.5-11.5% (Dogan *et al*., 1996). Flours for bread-making generally require medium strength to yield optimum performance (Bangur *et al*., 1997). This is also more important in the case of heart bread production. As observed in this study, addition of 2% gluten to flour (F_2) resulted in higher elasticity and yielded reduced spread ratio and finally decreased bread volume.

The most important criteria of bread quality may be final bread volume (Bruckner *et al*., 2001). The best bread volumes were obtained with medium strength flour combinations. Increased gluten quality required higher water absorption and yielded tight dough and finally resulted in reduced bread volume in control and microwave-baked bread. The specific volumes of experimental and control breads also were significantly correlated ($r = 0.694$, $P < 0.001$), when fermented dough were baked after proof time of 90 min.

CONCLUSION

A significant relationship between spread ratio of fermented dough and microwave-baked bread and between mean specific volume of control and microwave-baked bread indicates that a practical spread ratio test has potential for evaluation of flour quality for bread-making. Flour types obtained from various regions and a wider gluten quality should be also tested to reach a sound conclusion.

Fig. 2: A relationship between spread ratio of dough and spread ratio of microwave-baked bread (r = 0.588, P < 0.001)



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REFERENCES

AACC, 1995. *Approved Methods of American Association of Cereal Chemists*. AACC, Inc., St. Paul, Minnesota

Bangur, R., I.L. Batey, E. McKenzie and F. MacRitchie, 1997. Dependence of extensograph parameters on wheat protein composition measured by SE-HPLC. *J. Cer. Sci.,* 25: 237–241

Bruckner, P.L., D. Habernicht, G.R. Carlson, D.M. Wichman and L.E. Talbert, 2001. Comparative bread quality of white flour and whole grain flour for hard red spring and winter wheat. *Crop Sci.,* 41: 1917–1920

Dogan, I.S., J.G. Ponte and C.E. Walker, 1996. Effect of formula and process variations on Turkish francala bread production. *Cer. Food World,* 41: 741–744

Dogan, I.S., 2002. Effect of α-amylases on dough properties during Turkish heart bread production. *Int. J. Food Sci. Technol.,* 38: 1–8

Dong, H., R.G. Sears, T.S. Cox, R.C. Hoseney, G.L. Lookhart and M.D. Shogren, 1992. Relationships between protein composition and mixograph and loaf characteristics in wheat. *Cer. Chem.,* 69: 132–136

Hoseney, R.C., 1998. *Principles of Cereal Science and Technology.* American Association of Cereal Chemists, Inc., St. Paul, Minnesota

Khan, K., G. Tamminga and O. Lukow, 1989. The effect of wheat flour proteins on mixing and baking-correlations with protein fractions and high molecular weight glutenin subunit composition by gel electrophoresis. *Cer. Chem.,* 66: 391–396

Matsumoto, H., 1986. Dynamic rheological studies of dough systems. *In:* Faridi, H. and J.M. Faubion (eds.), *Fundamentals of Dough Rheol.,* pp: 87–103. American Association of Cereal Chemists, Inc., St. Paul, Minnesota

MCID, 2007. *MCID Digital Imaging Software Release 7*. Interfocus Imaging Ltd., Cambridge, England

Miralbes, C., 2004. Quality control in the milling industry using near infrared transmittance spectroscopy. *Food Chem.,* 88: 621–628

Sánchez-Pardo, M.E., A. Ortiz-Moreno, R. Mora-Escobedo, J.J. Chanona-Pérez and H. Necoechea-Mondragón, 2008. Comparison of crumb microstructure from pound cakes baked in a microwave or conventional oven. *LWT-Food Sci. Technol.,* 41: 620–627

Stat-Graphics, 2006. *Stat Graphics Centrium Release 15.1*. Warrenton, Virginia: Statpoint Inc

Sumnu, G., 2001. A review on microwave baking of foods. *Int. J. Food Sci. Technol.,* 36: 117–127

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