Turkish Journal of Biology

Volume 29 | Number 4 Article 8

1-1-2005

Effect of Carboxy Methyl Cellulose and Gum Arabic on the Stability of Frozen Dough for Bakery Products

ALİ ASGHAR

MUHAMMAD WASEEM TRAIG

FAQIR MUHAMMAD ANJUM

SHAHZAD HUSSAIN

Turk J Biol
29 (2005) 237-241

Effect of Carboxy Methyl Cellulose and Gum Arabic on the Stability of Frozen Dough for Bakery Products

Ali ASGHAR, Faqir Muhammad ANJUM, Muhammad Waseem TARIQ, Shahzad HUSSAIN
Institute of Food Science and Technology University of Agriculture, Faisalabad, PAKISTAN

Received: 08.06.2005

Abstract: Extended storage of frozen dough resulted in changes in rheological properties, which cause increasing proofing time and ultimately lower loaf volume of bread. The main causes of these changes are ice crystallization, which damage the gluten network. The major objective of this research was to reduce ice crystallization in frozen dough by incorporation of hydrophilic gums such as carboxymethylcellulose (CMC), and gum arabic at different levels. The doughs were stored frozen up to 8 weeks. Bread characteristics were analyzed after every 15 days for specific loaf volume, external and internal characteristics. Specific loaf volume increased significantly with the addition of different levels of gums compared with the frozen control. Although the external and internal characteristics of bread deteriorated with storage time, addition of gum arabic and CMC improved the characteristics of bread as compared to control after each storage period.

Key Words: Frozen Dough, Gums, Bread Quality, Arabic Gum, CMC

Introduction

It is believed that there is no substitute for fresh baked goods. But after some hours of baking, the crust of bread becomes moist, a leathery texture develops and the soft crumb becomes firm and dry. The fresh flavor is also lost within hours of baking, which has made bakers work midnight or early morning to provide the consumer with fresh product. Frozen dough was suggested as solution to this problem (1). The use of frozen doughs, now, is becoming popular in bakeries and restaurants, as it allows easier and more profitable baking. Fresh products from frozen doughs are available around the clock, labour costs are reduced, production costs are lower, and transportation is facilitated.

Despite these advantages, quality is often poorer in baked goods prepared from frozen doughs than those from fresh baking, as well as loaf volumes, are usually reduced (2). Moreover, the physical state changes of frozen doughs during frozen storage may contribute to the quality of baked bread (3). The basic problem encountered in the commercial development of frozen dough technology are variable ability of the gluten network to retain CO_2 and frozen storage affecting the viability of the yeast and its subsequent gassing power (4). Ice crystal formation is a natural phenomenon in frozen dough with an appreciable amount of water that deteriorate the gluen network ultimately changing the rheological properties of dough (5). Gums are a group of naturally occurring polysaccharides. They have water holding capacity and retard moisture migration in the dough (6). They have further suggested that gums improve the quality of frozen dough and the final baked product. The objective of this study was to determine the effect of hydrophilic gums on bread making quality of frozen doughs.

Materials and Methods

Raw Materials

The wheat flour for this study was generously supplied by the Pizza Hut Pakistan; compressed yeast was procured from time to time from fleishmann's yeast limited and gums from Pak chemicals Lahore, Pakistan.

Composition of flour

The chemical analysis of flour was carried out for moisture, crude protein, crude fiber, crude fat, nitrogen free extracts, total ash as well as gluten content SDS value and Pelshenke value as described in AACC (7).

Gum Treatment

Two gums used in this study were Arabic Gum and Carboxymethylcellulose (CMC). These are used in different proportions and their levels used are shown in Table 1.

Table 1.Treatments used for preparation of frozen dough.

Treatment (%)	Arabic Gum (%)	Carboxymethyl cellulose (%)
T_0	-	-
T_1	1.0	-
T_2	1.5	-
T_3	2.0	-
T_4	2.5	-
T_5	3.0	
T_6	-	1.0
T_7	-	1.5
T_8	-	2.0
T_9	-	2.5
T_{10}		3.0

T_0 = Acts as control

Preparation of Frozen Dough Bread:

Recipe

1. Flour	100 g
2. Active dry yeast	3 g
3. Sugar	4 g
4. Salt	1 g
5. Ascorbic acid	100 ppm
6. Shortening	5 g
7. Gums	As per treatment
8. Water	According to water absorption capacity

The straight no time dough formulation procedure of Inoue and Bushuk (1) with 3% yeast, 2.5% sugar, 1.5% shortening 1% salt, 100 ppm of ascorbic acid and optimum amount of water based on farinographic absorption was used for the preparation of frozen dough.

After mixing, the dough was rounded, and rested in a fermentation cabinet for 10 minutes at 30 ºC and 70-75 % relative humidity. Then the dough was molded manually and immediately wrapped with polyethylene zip bags and stored in freezer at 10 ºC.

After every 15 days, thawing of the dough was carried out by keeping the dough at room temperature for 45 minutes. Then mixing of thawed dough was done for 1-1.5 minutes in order to homogenize the dough. After molding, the dough was shifted into the greased pans and placed in a proofer at 30 ºC and 85% relative humidity until a definite loaf height was obtained. The proofed loaves were transferred to the oven for baking at 220 ºC for 15-20 minutes.

Sensory evaluation

Sensory evaluation of bread was done by a panel of five judges for external and internal characteristics as described by Pyler (8).

Statistical analysis

The data obtained from sensory evaluation of bread were subjected to statistical analysis to determine the level of significance between quality parameters of different treatments by using completely randomized design and means were compared according to the appropriate methods described by Steel et al. (9).

Results and Discussion

The chemical analysis of wheat flour used in this study is shown in Table 2 and results show that the flour used in this study was strong and rich in gluten value which is the requirement of the good quality frozen dough production as Inoue and Bushuk (1) stated that the quality of bread from frozen dough depends on the strength of the dough. They suggested that strong flour would give better result than weaker flour.

Table 3 shows the mean treatments values while Table 4 shows the storage mean at different days of frozen storage of doughs. The mean scores indicated that loaf volume of bread was significantly affected by the

Table 2. Composition of wheat flour.

Characteristics	%
Moisture	11.20
Crude Protein	12.38
Ash	0.50
Crude Fiber	0.54
Fat	0.97
Nitrogen free extracts	74.41
Wet gluten	31.13
Dry Gluten	9.84

Table 3. External characteristics of bread prepared from frozen dough containing gums.

Treatments (% gum)	Volume	Crust color	Symmetry of form	Evenness of bake
T_0	5.52g	4.64g	2.60d	1.40c
T_1	6.44f	5.24ef	2.88cd	1.80bc
T_2	6.84def	5.48def	2.92bcd	1.96abc
T_3	7.40cd	5.8bcde	3.08abcd	2.16ab
T_4	8.00b	6.16abc	3.36abc	2.32ab
T5	8.60a	6.56a	3.6a	2.52a
T_6	6.28f	5.04fg	2.8cd	1.80bc
T_7	6.60ef	5.36def	2.96bcd	1.96abc
T_8	7.12cde	5.68cde	3bcd	2.12ab
T_9	7.6bc	5.88bcd	3.28abc	2.28ab
T_{10}	8.16ab	6.28ab	3.52ab	2.44ab

Mean values for treatments carrying same letters in a column are not significantly different

Table 4. Effect of storage on external characteristics of bread prepared from frozen dough containing gums.

Days	Volume	Crust color	Symmetry of form	Evenness of bake
0 day	8.56a	7.11a	4.20a	2.54a
15 day	8.11a	6.76b	3.76a	2.25ab
30 day	7.55b	6.16b	2.96b	2.09abc
45 day	6.35c	4.94c	2.49bc	1.87bc
60 day	5.15d	3.25d	2.03c	1.58c

Mean values for treatments carrying same letters in a column are not significantly different

addition of gums. The maximum score for volume was recorded in T_5 (3% arabic gum) while the minimum score was obtained at T_0. The mean scores for volume of breads ranged from 5.52 to 8.60 among different treatment and the mean scores across different storage intervals varied from 5.15 to 8.56. The scores for crust colour of breads ranged from 4.64 for control (T_0) to 6.56 for 3 % arabic gum (T_5) among different treatment, while scores at different intervals of 60 days of storage varied from 3.25 to 7.11 Different treatments significantly affected the symmetry of form.

The mean values for T_5 (3.60) was ranked at the top followed by T_{10} (3.52) while T0 with a mean score of 2.60 was placed at the lowest position. The mean score for storage up to 60 days ranged from 2.03 to 4.20. The scores for evenness of baked breads ranged from 1.40 to 2.52 among treatment. However, scores for evenness of bake varied from 1.58 to 2.54 for storage of dough. Maximum mean score was obtained for T_5 containing 3% arabic gum while the lowest score was obtained for T_0. Table 5 shows the mean scores of treatments for internal characteristics, while Table 5 indicates the different mean scores at different storage intervals. It is obvious the scores for aroma of breads ranged from 6.12 to 8.28 among different treatment.

However the score varied from 6.20 to 7.91 across different storage intervals. T_5 containing 3% arabic gum got significantly highest score followed by T_{10} while the

Table 5. Internal characteristics of bread prepared from frozen dough containing gums.

Treatments	Aroma	Grain	Crumb color	Taste	Texture
T_0	6.120g	9.96e	6.08c	14.36b	10.2f
T_1	6.920ef	10.96e	6.48abc	14.84ab	11.0cde
T_2	7.160def	11.24cde	6.52abc	15.00a	11.28bcde
T_3	7.48bcde	11.6bcd	6.64abc	15.12a	11.52abc
T_4	7.84abc	12.04ab	6.84ab	15.28a	11.76ab
T_5	8.28a	12.52a	6.96a	15.32a	12.0a
T_6	6.72f	10.76e	6.24bc	14.88ab	10.68ef
T_7	7.04def	11.04de	6.32abc	15.04a	10.88de
T_8	7.32cdef	11.32cde	6.44abc	15.12a	11.12cde
T_9	7.68abcd	11.72bc	6.64abc	15.16a	11.36bcd
T_{10}	8.04ab	12.2ab	6.76ab	15.32a	11.6abc

Mean values for treatments carrying same letters in a column are not significantly different

Table 6. Effect of storage on internal characteristics of bread prepared from frozen dough containing gums.

Treatments	Aroma	Grain	Crumb color	Taste	Texture
0 day	7.91a	12.96a	7.40a	16.56a	13.03a
15 day	7.94a	12.40b	6.83b	15.98b	12.43b
30 day	7.70a	11.76c	6.69b	15.58b	11.23c
45 day	6.87b	10.69d	6.09c	14.03c	10.45d
60 day	6.20c	9.16e	5.67c	13.04d	8.92e

Mean values for treatments carrying same letters in a column are not significantly different

lowest score were obtained by T_0. The results for grain indicated that T_5 scored best throughout the 60 days of frozen storage with mean value (12.52) followed by T_{10} and the least score for grain was found to be (9.96) forT_0. The mean score for storage intervals ranged from 9.16 to12.96. Statistical analysis on the crumb color revealed significant effect of treatment on scores where T_5 containing 3% arabic gum showed the best color of crumb followed by T_4 containing 2.5% arabic gum, while T0 obtained lowest mean score. Mean score ranged from 6.08 to 6.96 for treatments while for storage it ranged from 5.67 to 7.20. With respect to taste, the results were non significant for all treatments except T_0 which got lowest scores from all other treatments. Mean scores ranged from 14.36 to 15.32 while it ranged from 13.03 to 16.56 for different storage intervals of 60 days. The mean scores for texture ranged from 10.20 to 12.00 among treatments and 8.92 to 13.03 for storage up to 60 days of frozen storage. T_5 (3% arabic gum) followed by T_4 (2.5% arabic gum) ranked at the top with highest mean scores respectively while T_0 remained at lowest position with lowest scores. These results agree with results reported earlier by Sharandant and Khan (5).

Conclusion

Gum additives do not completely counteract the negative effects of frozen storage. However, gum arabic and CMC improved loaf volume, internal and external appearance of bread. Although the specific loaf volume decreased for all the gum treatments from day 0 to 8 weeks of frozen storage, the addition of different levels of both gums significantly increased the loaf volume compared with the control when evaluated after day 0 and after every 15 days up to 8 weeks of frozen storage. Gum Arabic gave the better results than CMC. Frozen storage deteriorated the external and internal characteristics of bakery products. However, compared with the control after each storage period, addition of gum arabic and CMC improved these characteristics.

References

1. Inoue Y. and Bushuk W..Studies on frozen doughs.1. Effects of frozen storage and freeze thaw cycles on baking and rheological properties. Cereal Chem. 68: 627-631, 1991.
2. Inoue Y. and Bushuk W.. Effects of freezing, frozen storage,and thawing on dough and baked goods. p. 367-400 in: Freezing Effects on Food Quality. L. E. Jeremiah, ed. Marcel Dekker: New York; 1996.
3. Berglund PT, Shelton DR, and Freeman TP.Frozen bread dough ultrastructure as affected by duration of frozen storage and freeze-thaw cycles. Cereal Chem. 68: 105-107, 1991.
4. Rasanen.J, Laurikanen T, and Autio K.Fermentation Stability and Pore Size Distribution of Frozen Prefermented Lean Wheat Doughs. Cereal Chem. 74(1): 56-62, 1997.
5. Sharadanant R and Khan K. Effect of hydrophilic gums on frozen dough. Cereal Chem. 80(6): 773-78, 2003.
6. Ward F and Andon S. The use of gums in bakery foods. Am. Institute of Baking Tech. Bull. 15: 1-8, 1993.
7. AACC. 2000. Approved Methods of the American Association of Cereal Chemists.
8. Pyler EJ. Baking Science and Technology. Vol.II 3rd ed. Sosland Publishing Co. 9000 W. 67th street Merriam, Kansas 66202; 1988.
9. Steel RGD, Torrie JH and Dickey D.Principles and procedures of statistics: a biometrical approach, 3rd ed. McGraw Hill Book Co. Inc., New York; 1997.