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EFFECTS of COMBINING ADDED HYDROCOLLOIDS and SURFACTANT and FROZEN STORAGE on THE BAKING QUALITY of FROZEN BREAD DOUGH

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Abstract

In this study, central composite design according to response surface methodology was constructed to determine the effects of combining hydrocolloids and surfactant added to Type A and Type B wheat flours on the baking quality of frozen dough. With this aim in mind, guar gum, carboxymethylcellulose (CMC) and locust bean gum (LBG) (each with conc., 0%, 0.5%, 1%, 1.5% and 2%) with diacetyl tartaric acid ester of mono-diglycerides (DATEM) (0%, 0.25%, 0.5%, 0.75% and 1%) were added to both types of wheat flours. Then, the effects of these additives on the quality and staling of the bread that were produced from unfrozen (0) and frozen doughs (4, 8 and 12 weeks of frozen storage at -18°C) were determined. According to results, at the end of 12 weeks of frozen storage, the best results among the combinations were generally obtained with 0.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM in the hard wheat flour (Type A) while 1.5% guar gam+1.5% CMC+1.5% LBG+0.75% DATEM in the weak wheat flour (Type B). When compared to the control sample without additives, these combinations were observed to positively affect the loaf volume, specific loaf volume, Dallmann's number and bread staling.

Keywords: Bread quality, frozen dough, hydrocolloids, response surface methodology (RSM), surfactants.

KARIŞIM HALİNDEKİ HİDROKOLLOİDLER ve YÜZEY AKTİF MADDENİN ve DONDURARAK DEPOLAMANIN DONDURULMUŞ EKMEK HAMURUNUN PİŞİRME KALİTESİ ÜZERİNE ETKİSİ

Özet

Bu çalışmada, Tip A ve Tip B buğday unlarına hidrokolloidler ve yüzey aktif madde karışım halinde ilave edilerek katkıların dondurulmuş ekmek hamurunun ekmeklik kalitesi üzerine etkisini belirlemek amacıyla yüzey tepki metoduna bağlı olarak merkezi bileşen deseni oluşturulmuştur. Bu amaçla her iki tip buğday ununa guar gam, karboksimetilselülöz (CMC) ve keçiboynuzu gamı (LBG) katkıları ile (%0, %0.50, %1, %1.5 ve %2) ile monodigliseridlerin diasetil tartarik asit esterleri (DATEM) (%0, %0.25, %0.5, %0.75, %1) ilave edilmiştir. B katkıların dondurulmadan (0) ve dondurularak depolanan (-18C'de 4, 8 ve 12 hafta süreyle) hamurlardan yapılan ekmeklerin kalitesi ve bayatlaması üzerine etkileri belirlenmiştir.

Elde edilen sonuçlara göre, kuvvetli (Tip A) ununda 12 haftalık dondurarak depolamanın sonunda, kombinasyonlar sonunda en olumlu etkiyi %0.5 guar gam+%1.5 CMC+%1.5 LBG+%0.75 DATEM, zayıf (Tip B) buğday ununda ise %1.5 guar gam+%1.5 CMC+%1.5 LBG+%0.75 DATEM göstermiştir. Katkı içermeyen kontrol örneği ile kıyaslanınca bu kombinasyonlar, hacim verimi, ekmeğin özgül hacmi, Dallmann değer sayısı değerleri ile bayatlamayı olumlu yönde etkilediği saptanmıştır.

Anahtar kelimeler: Ekmek kalitesi, dondurulmuş hamur, hidrokolloidler, yüzey tepki metodu, yüzey aktif maddeler

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INTRODUCTION

Frozen bakery products do not require specialized workers and can be transformed easily into newly-baked bread at any time of the day (1, 2). Therefore, the bakery industry has increasingly used the applications of freezing technology (3). However, if the conditions during the freezing process of the dough can't be controlled well, some problems may occur such as lower loaf volume, require longer fermentation might be required and could result in deterioration of the texture of the final product (4). The inclusion of improvers such as hydrocolloids and surfactants in bread formulations can overcome these problems associated with frozen dough. A number of studies have indicated that adding hydrocolloids to frozen doughs can provide significant improvements to bread quality (4, 5-8). Hydrocolloids have also been effective improvers (especially CMC and pectin), in increasing bread volume and increase values of crumb porosity and elasticity of gluten-free breads, due to their incorporation into the dough (9).

Hydrocolloids, which are an important group of polysaccarides and amongst the most extensively used additives in the food industry, have been previously employed for improving the bread volume, get a softer texture and slower staling rate (10-12). In addition, they have been used for various purposes such as thickeners, emulsion stabilizers, film and gel formers, inhibition of ice and sugar crystal formation, improvers of water retention and texture properties, and controll release flavors (5, 13-14). The most widely used hydrocolloids in food applications are tree gum exude (gum arabic), microbial (xanthan), galactomannans (guar gum and LBG), modified celluloses (CMC and hydroxypropylmethylcellulose (HPMC)), seaweed (κ-carrageenan) and modified starch (13, 15, 16). In the frozen bakery industry, hydrocolloids like (HPMC), are of increasing importance as bread improvers as they can decrease the physical damage induced by ice crystals in breads obtained from frozen doughs or partially baked frozen dough (10). These ingredients also permit to minimise the dehydration of the dough by ice coarsening during frozen storage (17).

The addition of emulsifiers such as DATEM, which are anionic oil-in-water emulsifiers that are used as dough strengtheners to improve bread quality, in frozen dough produces bread with lower crumb firmness and increased loaf volume (2, 18). Similar results were obtained by Ribotta et al. (19) which showed that adding DATEM and guar gum to dough improved loaf volume and texture of bread obtained from non-frozen and frozen dough. Kenny et al. (20) indicated that frozen dough with additions of ascorbic acid, sodium stearoyl lactylate (SSL) and DATEM had a positive effect on prof time, loaf volume, and crumb firmness, and all formulations deteriorated in quality during frozen storage.

The quality of bread produced from frozen dough is influenced by dough formulations (8, 21-23), mixing conditions (24), freezing rate and frozen storage (1-3, 17, 23, 25). Koushki et al. (26) mentioned that fast-frozen dough prepared from strong flour can be appropriate alternative for fresh dough for making a type of Iranian flat bread.

Sharadant and Khan (27, 28) mentioned that gums such as LBG, gum arabic and CMC may be used in frozen dough for increasing volume of finished products and delaying drying of bread. Similarly, improvers including hydrocolloids retard staling as it was indicated by a decrease in the retrogradation enthalpy of the amylopectin after the full-baking of part-baked, frozen stored breads (15). Shon et al. (14) found that the mixtures of milk proteins and gums improved baking quality by reducing the deterioration of frozen dough.

Dodic et al. (8) determined that the effects of hydrocolloids (xanthan, κ-carrageenan and CMC) in dough and frozen storage time (0, 7, 14, and 30 d) on the quality of finished bakery product. It was shown that the addition of 0.1%xanthan accomplished the same or higher values for specific fermentation activity, specific volume, and penetrometric's number in the finished bakery product made from frozen dough, compared to the addition of 1.0% κ-carrageenan and CMC that is 10 times higher than xanthan. Kim et al. (29) investigated the combine effects of trehalose, transglutaminase and LBG on rheological fermentation properties, and bread quality of the fresh and frozen dough by using a response surface methodology. It was shown that LBG was affected negatively on CO_2 of the fresh and frozen dough but also reduced hardness of frozen dough.

With regards to frozen storage stability, Mandala et al. (22) studied the effect of dietary fiber and hydrocolloids from different sources on frozen storage stability of dough and semi-baked bread. The formulation was based on HPMC, LBG, commercial soluble fibers and whole oat flour. The study showed that fresh samples containing hydrocolloids, polydextrose or commercial shortening presented similarities.

Matuda et al. (4), investigated the influence of guar gum and xanthan gum and their combined use on dough proofing rate and its calorimetric properties. It was found that minimal changes were observed with these formulations during frozen storage, and the freezing process itself was more detrimental to the proofing rate than the storage time. Leray et al. (23) showed that storage time seemed to have more impact on non-yeasted wheat and gluten-free bread dough than storage temperature.

To our knowledge, there are several researchers who study about frozen dough effects on dough rheology and baking properties but there is limited data for the effects of combination of hydrocolloids and DATEM on the baking quality of frozen dough. Therefore, the aim of this work was to study the quality of frozen dough after frozen storage considering both the formulation and the storage time. The levels of hydrocolloids and DATEM added to Type A (hard wheat flour) and Type B (weak wheat flour) wheat flours were made according to response surface methodology.

MATERIALS and METHODS

Raw Material

In order to observe the effects of hydrocolloids and surfactant on frozen dough, two different flour types were used. Hard wheat dough (Type A, moisture content 13.63%, ash content 0.60%, protein 13.64%, Ankara Flour Industry, Turkey), and weak wheat flour (Type B, moisture content 12.15%, ash content 0.80%, protein 12.98%, Ankara Flour Industry, Turkey) were used. The hydrocolloids was supplied by INCOM Incorporated Company (Mersin, Turkey) contained guar gum, CMC and LBG. The DATEM was supplied by Additive Food (Ankara, Turkey).

Wheat Dough Formulations and Preparation of Fresh Bread Dough (0 days)

As a control bread dough base formulations from two types of flour, including 1000 g of wheat flour (15% mb), 50 g of compressed yeast, 15 g of salt, 10 g of sugar and 10 g of fat (vegetable margarine) were prepared. The used combinations of hydrocolloids and DATEM were used following a central composite design for sampling (Table 1) and were given five levels coded -2, -1, 0, 1 and +2 each corresponding to the increasing hydrocolloid concentrations 0%, 0.5%, 1%, 1.5% and 2% and DATEM concentrations 0%, 0.25%, 0.5%, 0.75% and 1% respectively. The model resulted in 28 different hydrocolloid and DATEM supplemented bread dough's. Four central points were been done to evaluate the experimental error. In the present study, hydrocolloid and DATEM concentrations were chosen by carrying out preliminary baking tests. The amount of water used ranged from 60.6 to 76.6 g/100 g flour (for Type A) and 65.5 to 80.3 g/100 g flour (for Type B). This amount was determined for all formulations so that a dough consistency of 500BU was obtained as measured by a farinograph.

All these ingredients were mixed in a spiral-mixer at a speed of 1400 rpm for 1 min. After being kneaded, it was fermented in a fermentation room at 30 °C and 80-85% relative humidity for 20 min. After the first fermentation, the dough was weighed, rolled and proofed for 10 min. Then the dough was divided into 400 g pieces, hand-molded and sheeted. After this step, it was put into tin pans and fermented for 30 min under the same conditions. The breads were baked in an electric oven for 20

Table 1. Central composite design showing independent variable level combinations (for guar gum, CMC and LBG -2.00: 0.00%, -100:0.50%, 0.00:1.00%, +1.00:1.50%, +2.00:2.00%; for DATEM -2.00: 0.00%, -1.00:0.25%, 0.00:0.50%, +1.00:0.75%, + 2.00:1.00%;)

Experiment number	Guar gum	CMC	LBG	DATEM	Experiment number	Guar gum	CMC	LBG	DATEM
1	-1.00	-1.00	1.00	-1.00	15	1.00	1.00	-1.00	-1.00
2*	0.00	0.00	0.00	0.00	16	-1.00	1.00	1.00	1.00
3*	0.00	0.00	0.00	0.00	17	0.00	0.00	0.00	-2.00
4	1.00	1.00	1.00	-1.00	18	0.00	0.00	0.00	2.00
5	-1.00	-1.00	-1.00	1.00	19	0.00	0.00	2.00	0.00
6	-1.00	1.00	-1.00	-1.00	20	-1.00	1.00	1.00	-1.00
7	2.00	0.00	0.00	0.00	21	0.00	2.00	0.00	0.00
8	1.00	-1.00	-1.00	1.00	22	1.00	1.00	-1.00	1.00
9	-1.00	-1.00	1.00	1.00	23	-1.00	-1.00	-1.00	-1.00
10	0.00	-2.00	0.00	0.00	24	1.00	-1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	25*	0.00	0.00	0.00	0.00
12	1.00	-1.00	1.00	-1.00	26*	0.00	0.00	0.00	0.00
13	1.00	-1.00	-1.00	-1.00	27	-1.00	1.00	-1.00	1.00
14	-2.00	0.00	0.00	0.00	28	0.00	0.00	-2.00	0.00

* : center points

min at 250 °C. After 2 h of cooling at room temperature, the finished breads were evaluated. The weight of bakery products was measured on an automatic technical balance. The volume of the loaf bread was determined by rapeseed displacement. The specific volume was expressed as the volume/mass ratio of finished bread.

SUR penetrometer PNR 6 (SUR Berlin, Germany) with 218 g of total test weight was used to determine the crumb firmness of the finished product as indicated by Ercan (30). The crumb structure, expressed as the Dallmann's number (DN) was determined by comparing the appearance of slices of finished product samples with characterized images of crumbs of finished products according to Dallmann (31). And then the Dallmann's number was found using the Dallmann equation (32). Three replicates were prepared from each treatment for each analysis.

Preparation of Non-fermented Frozen Doughs

As soon as the dough was formed, it was separated in samples of 400 g, which were slightly round shaped by hands. Samples were placed in aluminum bags without being fermented. Fermentation of the dough was not carried out to prevent the negative effects of freezing of dough like damage of yeast cell membranes. But, if yeast cells are activated in dough prior to freezing, they lead to greater freeze-damage such as loss of bread quality (3, 27). Shorter fermentation time (25 vs. 40 min) have also shown to improved the freeze-thaw stability of frozen doughs and increased the loaf volumes on average by 20% (33).

Dough pieces were frozen in a blast air freezer (Frigoscandia Labofreeze Mobile, Sweden) at -35 °C, 2.5 m/s for around 50 min. Dough pieces were withdrawn from the freezer when their core reached temperatures around -5 °C, and then stored in a domestic freezer with a stable temperature control (± 0.5 °C, UDD 600 BK, Turkey) at -18 °C for 4, 8 and 12 weeks.

Thawing

After the corresponding storage time (every 4 weeks), samples were placed into fermentation chamber and then thawed for 1.5 h at 35 °C (75% RH), proofed at 30 °C (80±5% RH) for 1 h, and baked and evaluated as described above.

Results and Discussion

The formulation of dough and frozen storage conditions can be important factors for stability of bread made from frozen dough (3, 22, 23). Table 2 shows the optimum combinations effects on specific volume of breads made from frozen dough stored for 0, 4, 8 and 12 weeks. Specific volume was greatest for the unfrozen bread dough samples and decreased with increasing frozen storage duration (Table 2). The specific volume of the control bread decreased more than the specific volume of bread made with hydrocolloids and DATEM. This is in agreement with the observations of Barcenas et al. (5), who noticed that HPMC reduced the hardness of breadcrumb and inhibited the effect of the frozen storage on bread staling. As expected, specific volume for both types of control breads decreased as the duration of frozen dough storage increased (Table 2). A decrease in specific volume is typically seen in frozen dough (8). A lower specific volume of bread made from frozen dough was reported by Phimolsiripol et al. (3), who noticed that freezing, frozen storage temperature and temperature fluctuations during storage generated lower bread specific volume and increased bread crumb firmness and dough weight loss. However, frozen doughs containing hydrocolloids and DATEM resulted in breads of increased specific volume compared with that of the frozen control sample. These results were generally in agreement with those reported by other investigators; Asgar et al. (6) reported that compared with the control sample after each frozen storage period, addition of gum Arabic and CMC improved loaf volume, internal and external appearance of bread; Dodic et al. (8) reported that with the addition of hydrophilic gums the specific volume significantly increased for all sampling intervals; Shon et al. (14) reported that mixtures of milk proteins and gums provide effective with regard to maintenance of the baking quality of frozen dough.

It has been known that emulsifiers such as DATEM may promote the aggregation of gluten proteins in dough by binding to the protein hydrophobic surface (2) and this produces a strong protein network, which in turn will produce bread with a better texture and increased volume (18). The volume increases observed support the findings of Ribotta et al. (19) working with guar gum and DATEM, where these two additives improved volume and texture of bread obtained from non-frozen and frozen dough. In contrast, Kim et al. (29) reported that LBG did not significantly

Table 2 Effects of optimum combinations on specific volume of breads made from frozen dough stored for 0, 4, 8 and 12 weeks.

Type A Flour			Type B Flour		
Combination	Storage time (weeks)	Specific volume (cm^3/g)	Combination	Storage time (weeks)	Specific volume (cm^3/g)
Control	0	2.9	Control	0	2.6
	4	2.5		4	1.7
	8	2.3		8	1.3
	12	2.0		12	1.1
1%guar gum+1%CMC+ 1%LBG+0.5%DATEM	0	3.9	0.5%guar gum+0.5%CMC+ 0.5%LBG+0.75%DATEM	0	4.1
1%guar gum+1%CMC+ 1%LBG+0.5%DATEM	4	3.3	1%guar gum+1%CMC+ 1%LBG+1% DATEM	4	3.3
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	8	3.0	1.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	8	2.8
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	2.9	1.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	2.2

($P \leq 0.05$) affect specific volume of both fresh and frozen dough breads.

At the end of 12 weeks of frozen storage, the best results among the combinations on specific volume were generally obtained with 0.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type A flour while 1.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type B flour. According to Sharadanant and Khan (27) the increase in resistance to extension values, due to the addition of different levels of gum additives (especially LBG, gum arabic and CMC), suggested the ability of gums to improve the quality of frozen dough by reducing freeze-thaw damage.

Table 3 shows the optimum combination effects on Dallmann's number of breads made from frozen dough stored for 0, 4, 8 and 12 weeks. The crumb structure of frozen dough, expressed as Dallmann's number, was affected by combining hydrocolloids and DATEM. As expected, Dallmann's number for both types of control breads decreased as the duration of frozen dough storage increased (Table 3). According to Mandala et al. (22) relative elasticity of crumb depends on the treatment before storage and the composition of breads. The Dallmann's number for breads formulated with type B flour were lower than the ones formulated with type A flour. This may be explained by the quality of a frozen dough depending on the strength of the flour (34).

However, Dallmann's number of the finished bakery products decreased significantly during frozen storage for the period of 12 weeks and with the addition of hydrocolloids and DATEM. Especially breads formulated with type B flour was significantly higher compared to the control sample. This behavior is in agreement with Dodic et al. (8), who reported that Dallmann's number, as the measure of crumb structure characteristics, for all storage times (0, 7, 14, and 30 d), and all investigated gums (xanthan, κ-carrageenan and CMC) and concentrations (xanthan 0.02%, κ-carrageenan and CMC 0.2%, 0.6%, and 1.0%), had high values, confirming good quality of finished bakery product. On the other hand, Mandala et al. (22) reported that samples of frozen dough had a more elastic crumb than fresh or semi-baked breads, but this depended also on their composition (e.g. dough containing 8 g/100 g flour polydextrose and semi-baked bread containing 8 g/100 g flour polydextrose had the same crumb elasticity). According to Ribotta et al. (19) dough freezing and frozen storage decreases in dough firmness and elasticity and emulsifiers such as DATEM and hydrocolloids such as guar gum improve volume and texture of bread obtained from non-frozen and frozen dough.

At the end of 12 weeks of frozen storage, the best results among the combinations on Dallmann's number were generally obtained with 0.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type A flour while 1.5%guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type B flour. The results obtained with combination supplementation agree with previous findings of Mettler and Seibel (35), who observed a high-quality whole wheat bread could be produced using the calculated optimum formulation which contain

Table 3 Effects of optimum combinations on Dallmann's number of breads made from frozen dough stored for 0, 4, 8 and 12 weeks.

Type A Flour			Type B Flour		
Combination	Storage time (weeks)	Dallmann's Number	Combination	Storage time (weeks)	Dallmann's Number
Control	0	95.9	Control	0	107.5
	4	92.5		4	-5.0
	8	80.3		8	-105.0
	12	9.3		12	-105.0
1%guar gum+1%CMC+ 1%LBG+0.5%DATEM+	0	207.9	2%guar gum+1%CMC+ 1%LBG+0.5%DATEM	0	250.7
1%guar gum+1%CMC+ 1%LBG+0.5%DATEM	4	192.1	1%guar gum+1%CMC+ 1%LBG+1%DATEM	4	187.6
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	8	175.0	1%CMC+1%LBG 0.5%DATEM	8	129.6
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	167.6	1.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	86.7

0.3 parts monodiglyceride (MDG), 0.6 parts DATEM, 0.15 parts guar gum, and 0.5 parts CMC.

The crumb firmness of finished product was expressed as penetrometer values. A decrease in penetrometer values were observed with an increase in frozen storage as shown in Table 4. The firmness of all breads decreased with an increse in frozen storage. This is in agreement with Giannou and Tzia (1) who mention that during the first 2 months of frozen storage samples degraded rapidly. These results were attributed to the reduction of gluten cross-linking caused by ice recrystallization and by relased of reducing substances from yeast and starch retrogradation, which contributed to a progressive firming of the product crumbs (14, 19). Sharadanant and Khan (27) also studied the effect of incorporating gums (CMC, gum arabic, LBG and κ-carrageenan) on ice crystallization and recrystallization in frozen dough. It was shown that LBG was the best hydrophilic gum for improving frozen dough quality, whereas κ-carrageenan was the least desirable gum for frozen dough.

However, with the addition of hydrocolloids and DATEM penetrometer values of finished bakery products increased significantly compared to control sample. For both types, penetrometer values decreased significantly with the time of frozen storage, but this decrease in crumb firmness was less expressed in dough containing hydrocolloids and DATEM compared to the control (Table 4). The lower penetrometer values obtained in this work are agreement with the results obtained by Dodic et al. (8), who observed a decrease with xanthan, CMC and κ-carrageenan addition in frozen dough with the time of frozen storage. Previous studies by Guarda et al. (36) showed a decrease the crumb hardness and given softer crumb than the control when adding HPMC to wheat flour dough and explained these results due to the its water retention capacity and a possible inhibition of the amylopectin retrogradation (37). These results should be similar to those obtained for HPMC and κ-carrageenan, which lead to breads with better specific volume and softer crumb (38). It is known that hydrocolloids are able to reduce the loss of moisture content during bread storage, reducing the dehydration rate of crumb and also the addition of hydrocolloids into frozen products can provide stability during a freeze-thaw cycle (2, 34). In another study, it was found that breads with ascorbic acid, SSL and DATEM were softer than the control for fresh and frozen doughs and the difference in firmness between the control and breads with additives became more pronounced with increasing frozen storage time (20).

At the end of 12 weeks of frozen storage, the best results among the combinations on penetrometer values were obtained with 0.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type A flour while 1.5% guar gum+1.5% CMC+1.5% LBG+0.75% DATEM on the type B flour. A possible explanation to these results is that the effect of different hydrocolloids on the starch properties suggested that only HPMC and pectin meet the advisable viscometric trend to delay bread staling (10).

Table 4 Effects of optimum combinations on penetrometer values of breads made from frozen dough stored for 0, 4, 8 and 12 weeks.

Type A Flour					Type B Flour				
Combination	Storage time (weeks)	Penetrometer Values (1/10mm)			Combination	Storage time (weeks)	Penetrometer Values (1/10mm)		
		24h	48h	72h			24h	48h	72h
Control	0	44.9	32.2	21.9	Control	0	37.3	22.3	17.1
	4	26.6	25.2	17.2		4	21.4	12.5	10.6
	8	24.4	17.0	13.9		8	9.1	8.6	5.9
	12	14.1	8.8	7.1		12	7.3	6.6	5.8
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	0	80.8	60.8	49.5	1%guar gum+1%CMC+ 1%LBG+1%DATEM	0	88.2	69.6	33.7
1.5%guar gum+1.5%CMC+ 0.5%LBG+0.25%DATEM	4	68.0	48.6	31.7	1%guar gum+1%CMC+ 1%LBG+1%DATEM	4	62.6	42.9	32.7
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	8	47.1	37.0	28.8	1%guar gum+1%CMC+ 1%LBG+1%DATEM	8	37.8	35.8	31.9
0.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	44.7	31.2	25.3	1.5%guar gum+1.5%CMC+ 1.5%LBG+0.75%DATEM	12	26.2	21.2	20.5

Conclusion

The quality of breads made from frozen doughs are influenced to different extents by the type of flour and by the type of combinations with hydrocolloids and DATEM added. The baking properties of breads made from frozen dough were lowered with an increase in frozen storage for the period of 12 weeks for all treatments. The inclusion of hydrocolloids and DATEM in bread formulations proved effective with regard to maintenance of the quality of frozen dough.

It has been known that frozen bread quality is influenced by flour type and flour protein quality. On the contrary, in our study for breads formulated with type B flour the baking properties of breads made from frozen dough were better than fresh breads formulated with type A flour.

According to the results, at the end of 12 weeks of frozen storage, the best results among the combinations were obtained with 0.5% guar gum + 1.5% CMC + 1.5% LBG + 0.75% DATEM in the hard wheat flour (Type A) while 1.5% guar gam + 1.5% CMC + 1.5% LBG + 0.75% DATEM in the weak wheat flour (Type B). When compared to the control sample without additives, these combinations were observed to positively affect the loaf volume, specific loaf volume, Dallmann's number and bread staling. The results of the combinations of hydrocolloids and DATEM are determined to improve the quality of frozen bread dough.

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1. Giannou V, Tzia C. 2007. Frozen dough bread: quality and textural behavior during prolonged storage- prediction of final characteristics. *J Food Eng,* 79, 929-934

2. Selomulyo VO, Zhou W. 2007. Frozen bread dough: effect of freezing storage and dough improvers. *J Cereal Sci,* 45, 1-17.

3. Phimolsiripol Y, Siripatrawan U, Tulyathan V, Donald JC. 2008. Effects of freezing and temperature fluctuations during frozen storage on frozen dough and bread quality. *J Food Eng,* 84, 48-56.

4. Matuda TG, Chevallier S, Filho PAP, LeBail A, Tadini CC. 2008. Impact of guar and xanthan gums on proofing and calorimetric parameters of frozen bread dough. *J Cereal Sci* 48, 741-746.

5. Barcenas ME, Benedito C, Rosell CM. 2004. Use of hydrocolloids as bread improvers in interrupted baking process with frozen storage. *Food Hydrocolloids,* 18, 769-774.

6. Asghar A, Anjum FM, Tarıq MW, Hussain S. 2005. Effect of carboxy methyl cellulose and gum arabic on the stability of frozen dough for bakery products. *Turk J Biol,* 29, 237-241.

7. Mandala I, Karabela D, Kostaropoulos. 2007. Physical properties of breads containing hydrocolloids stored at low temperature: I. effect of chilling. *Food Hydrocolloids,* 21, 1397-1406.

8. Dodic J, Pejin D, Dodic S, Popov S, Mastilovic J, Popov-Rallic J, Zivanovic S. 2007. Effects of hydrophilic hydrocolloids on dough and bread performance of samples made from frozen doughs. *J Food Sci,* 72, 235-241.

9. Lazaridou A, Duta D, Papageorgiou M, Belc N, Biliaderis CG. 2007. Effects of hydrocolloids on dough rheology and bread quality parameters in gluten-free formulations. *J Food Eng,* 79, 1033-1047.

10. Barcenas ME, De la O-Keller J, Rosell CM. 2009. Influence of different hydrocolloids on major wheat dough components (gluten and starch). *J Food Eng,* 94, 241-247.

11. Sungur B, Ercan R. 2011. Effects of some hydrocolloids and surfactant on the rheological properties of hard wheat flour dough by using response surface methodology. *GIDA, The Journal of Food,* 36, 77-82.

12. Shittu TA, Aminu RA, Abulude EO. 2009. Functional effects of xanthan gum on composite cassava-wheat dough and bread. *Food Hydrocolloids,* 23, 2254-2260.

13. Nussinovitch A. 2005. Production, properties and applications of hydrocolloid cellular solids. *Mol Nutr and Food Res,* 49, 195-213.

14. Shon J, Yun Y, Shin M, Chin KB, Eun JB. 2009. Effects of milk proteins and gums on quality of bread made from frozen dough. *J Sci Food Agric,* 89, 1407-1415.

15. Mandala IG. 2005. Physical properties of fresh and frozen stored, microwave-reheated breads, containing hydrocolloids. *J Food Eng,* 66, 291-300.

16. Dickinson E. 2009. Hydrocolloids as emulsifiers and emulsion stabilizers. *Food Hydrocolloids,* 23, 1473-1482.

17. Le-Bail A, Nicolitch C, Vuillod C. 2010. Fermented frozen dough: ımpact of pre-fermentation time and of freezing rate for a pre-fermented frozen dough on final volume of the bread. *Food Bioprocess Technol,* 3, 197-203.

18. Kohajdova Z, Karovicova J, Schmidt S. 2009. Significance of emulsifiers and hydrocolloids in bakery industry. *Acta Chimica Slovaca,* 2, 46-61.

19. Ribotta PD, Perez GT, Leon AE, Anon MC. 2004. Effect of emulsifier and guar gum on micro structural, rheological and baking performance of frozen bread dough. *Food Hydrocolloids,* 18, 305-313.

20. Kenny S, Wehrle K, Dennehy T, Arendt EK. 1999. Correlations between empirical and fundamental rheology measurements and baking performance of frozen bread dough. *Cereal Chem,* 76, 421-425.

21. Ribottta PD; Leon AE, Anon MC. 2003. Effects of yeast freezing in frozen dough. *Cereal Chem,* 80, 454-458.

22. Mandala I, Polaki A, Yanniotis S. 2009. Influence of frozen storage on bread enriched with different ingredients. *J Food Eng,* 92, 137-145.

23. Leray G, Oliete B, Sandra M, Chevallier S, Lamballerie M. 2010. Effects of freezing and frozen storage conditions on the rheological properties of different formulations of non-yeasted wheat and gluten-free bread dough. *J Food Eng,* 100, 70-76.

24. Rouille J, Le Bail A, Courcoux P. 2000. Influence of formulation and mixing conditions on breadmaking qualities of French frozen dough. *J Food Eng,* 43, 197-203.

25. Fik M, Surowka K. 2002. Effect of prebaking and frozen storage on the sensory quality and instrumental texture of bread. *J Sci Food Agric,* 82, 1268-1275.

26. Koushki MR, Khoushgozaran AS, Azizi MH. 2011. Effects of flour type, freezing method, and storage time on the quality of barbari bread made from frozen dough. *Iranian J Nutr Sci,* 5, 65-74.

27. Sharadant R, Khan K. 2003a. Effect of hydrophilic gums on frozen dough: I. dough quality. *Cereal Chem,* 80, 764-772.

28. Sharadant R, Khan K. 2003b. Effect of hydrophilic gums on frozen dough: II. bread characteristics. *Cereal Chem,* 80, 773-780.

29. Kim YS, Huang W, Du G, Pan Z, Chung O. 2008. Effects of trehalose, transglutaminase, and gum on rheological, fermentation, and baking properties of frozen dough. *Food Res Int,* 41, 903-908.

30. Ercan R. 1985. Studies on the effect of some additives on physical properties of dough, bread quality and staling. Ph thesis of Recai Ercan, 169 p, Ankara-Turkey.

31. Dallmann MH. 1981. Fortschritte der getreideforschung. Detmold, Germany: Verlag Moritz Schafer.

32. Pelshenke PF., Boilling H, Hampel G, Kampw W, Menger A, Rotsch A, Schulz S, Spincher G, Tegge G. 1964. Standart Methoden fur Getreide Mehl und Brot. 4. Auflage. Im. Verlag Moritz Scheafer. 159 p., Detmold.

33. Rasanen J. 1998. Prefermented frozen lean wheat doughs. *VTT Biotechnol Food Res,* 352, 1-68.

34. Lu W, Grant LA. 1999. Role of flour fractions in breadmaking quality of frozen dough. *Cereal Chem,* 76, 663-667.

35. Mettler E, Seibel W. 1993. Effects of emulsifiers and hydrocolloids on whole wheat bread quality: A response surface methodology study. *Cereal Chem,* 70, 373-376.

36. Guarda A, Rosell CM, Benedito C, Galotto MJ. 2004. Different hydrocolloids as bread improvers and antistaling agents. *Food Hydrocolloids,* 18, 241-247.

37. Collar C, Martinez JC, Rosell CM. 2001. Lipid binding of fresh and stored formulated wheat breads. Relationships with dough and bread technological performance. *Food Sci Technol Int,* 7, 501-510.

38. Rosell CM, Rojas JA, Benedito de Barber C. 2001. Influence of hydrocolloids on dough rheology and bread quality. *Food Hydrocolloids,* 15, 75-81.