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IMPROVING QUALITY OF HIGH FIBER PAN BREAD

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ABSTRACT: *Gum Arabic, carboxymethyl cellulose (CMC) and Carrageenan at levels of 0, 0.5, 1.0 and 1.5% (flour basis) were used to improve quality of high fiber pan bread containing 10% potato peels. Rheological properties, baking quality, color attributes, organoleptic properties and freshness of pan bread were evaluated. The obtained results showed that, adding of potato peels (10%) decreased dough stability, extensibility, energy and loaf volume. Also dark color and staling rate increased as a result of adding potato peels. Negative effect was observed regarding sensorial characteristics.*

All tested hydrocolloids improved quality parameters of produced pan bread. Dough stability, extensibility, energy and loaf volume were increased, while staling rate decreased as a result of adding hydrocolloids. The most effective hydrocolloid was Carrageenan especially as antistaling agent. Slight improvement was observed in crumb texture as a result of adding hydrocolloids. Acceptable high fiber pan bread could be produced using 10% potato peels with 1% of gum arabic or CMC or Carrageenan which was the best.

Keywords: *pan bread, gum Arabic, CMC, κ-carrageenan, rheological properties, baking, color attributes, staling.*

INTRODUCTION

Bread is one of the most widely consumed food products in the world and breadmaking technology is one of the oldest known technologies. The technology has evolved continuously over the yeas as new materials, ingredients and equipment have been introduced to produce better quality bread while, research has generated steady and impressive progress in bread making. The major ingredients for bread making are flour, water, salt, fat and sugars. Leavening agents (micro-organisms or chemical), improvers a generic term for a wide range of additives used in bread formulations that include stabilizers, emulsifiers, oxidants, gums and supplementary enzymes (Gujral and Singh 1999).

The loss of freshness is paralleled by an increase in crumb hardness and decrease in flavor and aroma, leading to loss of consumer acceptance. In the baking industry, hydrocolloids are of increasing importance as bread improvers, as they can induce structural changes in the main components of wheat flour systems along the breadmaking steps and storage (Appelqvist and Debet, 1997). Such structural changes modify the selectivity of some enzymes and change the technological quality of dough and bread (Armero and Collar, 1997). Hydrocolloids affect the baking performance of dough and

also the shelf life of stored bread (Armero and Collar, 1998; Davidou *et al.*, 1996). The presence of hydrocolloids influences melting, gelatinization, fragmentation and retrogradation processes of starch (Fanta and Christianson, 1996; Kokini *et al.*, 1992). These effects were shown to affect the pasting properties and rheological behavior of dough (Rojas *et al.*, 1999). CMC and guar gum have been added to rye bread recipe to improve the quality of that bread (Metller and Seibel, 1995). CMC and hydroxypropylmethyl cellulose (HPMC) or alginate were added to bread dough and found to be anti-staling agents and retarded crumb firming (Guarda *et al.*, 2004).

Gum Arabic readily dissolves in water to give clear solutions ranging in color from very pale yellow to orange –brown and with a pH of 4.5. The highly branched structure of the gum gives rise to compact molecules with a relatively small hydrodynamic volume and as a consequence gum solutions become viscous only at high concentrations (Williams and Phillips, 2000).

K-carrageenan is a sulfated polysaccharide extracted from certain red algae. Specifically, it is a high molecular weight linear polysaccharide comprising repeating galactose and 3,6-anhydrogalactose units, both sulfated and non-sulfated joined by alternating (1-3)ά and (1-4)-β glycoside links. K-carrageenan contains approximately 25% ester sulfate and 34% 3,6 anhydrogalactose (Imerson, 2000) when used as a dough additive, κ-carrageenan has an ability to improve the specific volume of bread due to its interactions with gluten protein (Leon *et al.*, 2000).

So, the present work was carried out to improve the quality of high fiber bread containing 10% potato peels through adding hydrocolloids (gum Arabic, carboxymethyl cellulose or K-carrageenan). Rheological properties, baking quality, sensory evaluation, color attributes and staling test were evaluated.

MATERIALS AND METHODS

MATERIALS:

Wheat flour 72%, salt and active dry yeast were obtained from a local market, Cairo, Egypt, while, gum Arabic, carboxymethyl cellulose and carrageenan were obtained from Fluka company Switzerland.

Methods:

Preparation of flour mixtures.

Wheat flour was replaced by 10% potato peels and hydrocolloids (gum Arabic, CMC or carrageenan) were added at levels of 0.0, 0.5, 1.0 and 1.5%. Control sample (100% wheat flour 72%) was used for comparison.

Rheological properties

Rheological properties were evaluated by using a Brabender farinograph and Brabender extensograph as described by AACC (1983).

Baking tests:

Baking test was performed to manufacture pan bread as described by AACC (1983).

Color analysis:

Color attributes of pan bread were evaluated by using a spectro-colorimeter with CIE color scale (Hunter, Lab Scan XE), USA.

Sensory evaluation:

Sensory evaluation of pan bread was performed as described by Kulp *et al.* (1985).

Statistical analysis:

Data of sensory evaluation of pan bread were subjected to analysis of variance and LSD calculated according to the method described by McClave and Benson (1991).

Freshness of bread:

Pan bread freshness was tested after wrapping in polyethylene bags and storage at room temperature (0 and 7 days) using Alkaline Water Retention Capacity (AWRC) according to the method of Yamazaki (1953), as modified by Kitterman and Rubenthaler(1971).

RESULTS AND DISCUSSION

Rheological properties of dough as affected by potato peels and hydrocolloids

Data presented in Tables (1and 2) show the effect of replacing wheat flour using 10% of potato peels and adding hydrocolloids on the rheological properties of dough. As shown in table (1), water absorption increased as a result of replacing wheat flour by potato peels or adding gums. Carboxymethyl cellulose (CMC) was found to be the most effective gum regarding increase water absorption as Farinograph test revealed. The most effective gum was K-carrageenan regarding dough stability, while, CMC effect was negligible. Stability of dough which reflects the flour tolerance to mixing was clearly affected by some hydrocolloids, guar gum and K-carrageenan as shown by Shalini and Laxmi (2007). Such findings were also obtained by Rosell *et al* (2001). So, the adverse effect of potato peels can partially overcome by adding hydrocolloids.

Table (1): Farinograph parameters as affected by adding potato peels and hydrocolloids

Treatments	Water absorption (%)	Dough development time (min)	Stability (min)	Weak ening (BU)
100% wheat flour	61.5	2.0	3.5	120
1o% potato peels				
0% gum	67.5	5.5	2.5	140
0.5% gum arabic	67.3	4.0	7.5	120
1.0% gum arabic	67.3	4.5	7.5	140
1.5% gum arabic	67.3	4.5	7.0	160
0.5% CMC*	67.3	5.5	4.5	140
1.0% CMC	70.3	5.0	5.0	140
1.5% CMC	72.5	5.5	5.5	120
0.5% κ. carrageenan	67.0	5.0	8.5	20
1.0% κ. carrageenan	67.0	3.5	7.5	20
1.5% κ. carrageenan	68.0	4.5	8.0	40

*= carboxymethyl cellulose

In regard to Extensograph parameters (Table 2), the presence of potato peels decrease extensibility and dough energy, while, adding gum Arabic or CMC or K-carrageenan improved dough quality. The tested hydrocolloids partially improved all extensograph parameters through increasing extensibility and dough energy. Extensibility was also increased as a result of the presence of guar gum, CMC and K-carrageenan as known by Shalini and Laxmi (2007). The presence of potato peels diluted the gluten of dough and hydrocolloids enhanced dough quality.

Table (2): Extensograph parameters as affected by adding potato peels and hydrocolloids

Treatments	Elasticity (min)	Resistance to extension (Bu)	Energy (cm^2)
100% wheat flour	100	220	55
1o% potato peels			
0% gum	60	300	44
0.5% gum arabic	70	320	48
1.0% gum arabic	70	340	49
1.5% gum arabic	70	360	47
0.5% CMC*	70	360	46
1.0% CMC	70	360	49
1.5% CMC	70	340	48
0.5% κ. carrageenan	60	600	38
1.0% κ. carrageenan	60	600	42
1.5% κ. carrageenan	40	300	35

*= carboxymethyl cellulose

Baking quality of pan bread as affected by potato peels and hydrocolloidsData presented in table (3) show the effect of replacing wheat flour by 10% potato peels and adding hydrocolloids (gum Arabic, CMC or K-carrageenan) on baking quality of pan bread. The presence of 10% potato peels led to decrease loaf volume and increase loaf weight compared to control sample.

The most effective gum was CMC followed by K-carrageenan regarding loaf volume. Potato peels dilute gluten and adversely affect the gluten network, consequently, loaf volume decreased.Theaddition of hydrocolloids enhanced gluten network and more gas can be retained, resulting loaf volume increase. Consequently, specific volume increased. Adding hydrocolloids were found to increase loaf volume and specific volume, as reported by Bell, 1990; Hoseney, 1990 and Rosell *et al* 2001).

Table (3): Baking quality of pan breadas affected by adding potato peels and hydrocolloids

Treatments	Fermentation time					
	90 min			120 min		
	Volume (cm^3)	Weight (g)	Specific volume (cm^3/g)	Volume (cm^3)	Weight (g)	Specific volume (cm^3/g)
100% wheat flour	775	256	3.03	725	253	2.9
1o% potato peels						
0% gum	575	265	2.2	550	260	2.1
0.5% gum Arabic	500	264	1.89	575	260	2.2
1.0% gum Arabic	450	262	1.7	525	260	2.01
1.5% gum arabic	650	263	2.5	575	260	2.2
0.5% CMC*	675	260	2.6	600	258	2.3
1.0% CMC	625	266	2.3	600	264	2.3
1.5% CMC	675	263	2.57	675	263	2.6
0.5% κ. Carrageenan	550	270	2.04	600	269	2.2
1.0% κ.Carrageenan	525	269	1.95	625	268	2.3
1.5% κ.Carrageenan	500	268	1.86	550	267	2.1

*= carboxymethyl cellulose

Color attributes of pan bread as affected potato peels and hydrocolloids Data presented in Tables (4and 5) show the effect of replacing wheat flour 72% using 10% potato peels and adding hydrocolloids on crust and crumb color of pan bread. As shown in the tables the presence of potato peels increased darkness of bread, hence (L value) decreased. The maximum value

for lightness indicates white color. The increase in (b) value means that there is an increase in yellowness and the increase in (a) value indicates more redness. As shown in the tables, all tested gums in all tested concentrations had no clear effect regarding crust color. Slight effect was observed as more darkness or yellowness as a result of using hydrocolloids. The major effect of color changes was potato peels effect. The produced bread containing potato peels was darker. Slight increase in (b) value was observed by Shalini and Laximi (2007) as a result of adding hydrocolloids (CMC and K-carrageenan) to Indian bread (chapatti).

In regard to crumb color the same trend was observed in all tested samples. Gum Arabic, CMC or K-carrageenan had no clear effect regarding crumb color. The main effect on crumb color is referred to potato peels that increased dark color. The same trend was observed in crust and crumb color under two fermentation times.

Table (4): Crust color parameters as affected by adding potato peels, hydrocolloids and fermentation time.

Treatments	90 min			120 min		
	L	*a*	*b*	*L*	*A*	*b*
100% wheat flour	71.93	7.64	22.85	70.33	4.76	20.79
1o% potato peels						
0% gum	55.28	6.76	21.19	52.76	7.47	23.50
0.5% gum arabic	61.1	5.39	23.71	51.71	7.37	22.54
1.0% gum arabic	56.93	6.63	21.41	51.58	7.67	23.47
1.5% gum arabic	51.66	5.72	22.95	50.80	6.96	18.17
0.5% CMC*	58.2	6.57	21.7	52.05	7.95	24.13
1.0% CMC	54.01	9.75	26.53	52.04	7.35	22.87
1.5% CMC	52.03	7.75	20.61	52.01	8.08	24.34
0.5 κ. carrageenan	52.4	8.61	25.05	52.09	7.77	23.95
1.0%κ.carrageenan	51.62	8.04	23.49	52.04	7.87	23.89
1.5% κ. carrageenan	51.36	7.5	22.37	51.62	7.33	22.93

*= carboxymethyl cellulose

Table (5): Crumb color parameters as affected by potato peels, hydrocolloids and fermentation time

Treatments	90 min			120 min		
	L	*a*	*b*	*L*	*a*	*b*
100% wheat flour	74.21	5.02	18.34	70.63	2.29	18.53
10% potato peels						
0% gum	54.09	5.62	18.09	54.75	5.25	17.76
0.5% gum arabic	52.57	5.51	17.54	52.75	5.43	17.61
1.0% gum arabic	51.93	6.63	21.41	50.98	5.69	18.17
1.5% gum arabic	51.79	5.30	17.82	50.41	5.53	18.44
0.5% CMC*	54.05	5.81	18.77	50.94	8.87	19.11
1.0% CMC	52.53	5.80	18.68	50.23	6.06	18.87
1.5% CMC	51.77	5.59	17.95	50.14	5.35	18.44
0.5% κ. carrageenan	53.72	5.56	18.02	52.25	6.07	18.58
1.0% κ. carrageenan	52.86	5.22	17.36	52.16	5.87	18.65
1.5% κ. carrageenan	50.38	5.81	18.63	50.77	6.03	19.01

Sensory evaluation of pan bread as affected by potato peels and hydrocolloids:

As shown in table (6), potato peels (10%) adversely affected crumb color, crust color and crumb texture but it had no significant effect on symmetry of shape, aroma and taste. Also, data in the same table revealed no significant differences between samples containing hydrocolloids and those hydrocolloids free.

From table (6), it could be noticed that the main effect on sensory properties is referred to potato peels that affected color and texture of produced bread. In regard to crumb texture, replacing wheat flour by 10% potato peels adversely affected crumb texture. Also, K-carrageenan improved break and shred of bread as shown in the same table.

Freshness of pan bread as affected by adding potato peels and hydrocolloids:

Data presented in table (7) showe that the added hydrocolloids had positive effect on the freshness of bread containing 10% potato peels, while adding 10% potato peels only had negative effect on the freshness of pan

Table (6): Sensory evaluation of pan bread as affected by adding potato peels and hydrocolloids

Treatments	Sym. Shape (5)	Crust color (10)	Break & shred (10)	Crumb color (10)	Crumb texture (15)	Aroma(20)	Taste (20)	Mouth feel (10)
100% wheat flour	4.00	7.8[a]	7.7[a]	7.9[a]	11.4[a]	15.3	15.2	8.3[a]
1o% potato peels								
0% gum	2.6	5.5[b]	5.2[c]	5.5[b]	8.7[c]	11.7	12.5	6.2[b]
0.5% gum arabic	3.00	5.9[b]	5.1[c]	5.6[b]	10.2[b]	11.6	11.7	6.0[b]
1.0% gum arabic	3.2	5.8[b]	5.3[c]	5.2[b]	10.3[b]	10.5	10.8	5.9[b]
1.5% gum arabic	2.9	5.7[b]	5.2[c]	5.7[b]	10.4[b]	12.0	10.7	5.7[b]
0.5% CMC*	3.2	5.6[b]	5.3[c]	5.4[b]	10.3[b]	13.1	12.0	5.6[b]
1.0% CMC	2.6	5.7[b]	5.2[c]	5.2[b]	10.1[b]	12.8	12.0	5.8[b]
1.5% CMC	3.0	5.8v	5.3[c]	5.3[b]	10.2[b]	13.0	11.2	5.7[b]
0.5% κ.carrageenan	3.2	5.7[b]	6.3[b]	5.3[b]	10.3[b]	12.1	11.1	5.2[b]
1.0 κ. carrageenan	2.8	5.6[b]	6.5[b]	5.7[b]	10.3[b]	11.0	9.7	5.3[b]
1.5 κ. carrageenan	3.2	5.8[b]	6.6[b]	5.4[b]	10.2[b]	13.0	11.6	5.6[b]
LDS (0.05)	NS	1.0124	0.912	2.135	1.124	NS	NS	1.645

*= carboxymethyl cellulose

although some hypothesis have been proposed. It seems that hydrocolloids have weakening effect on the starch structure that provokes better water distribution and retention and also a decrease in the crumb resistance (Armero and Collar, 1998).

As alkaline water retention capacity showed (Table, 7). The presence of all tested gums improved the shelf life of produced bread. All added gums found to overcome the adverse effect of potato peels regarding staling test. Breads containing hydrocolloids showed lower loss of moisture content, therefore higher water retention in the crumb was reported compared to the control. Hydrocolloids addition reduced the dehydration rate of crumb during storage (Guarda *et al.*, 2004).

From the above-mentioned results high fiber acceptable bread can be produced using 10% potato peels with 1% of gum Arabic or CMC or K-carrageenan. The more effective gum was K-carrageenan under investigated conditions.

Table (7): Alkaline water retention capacity (AWRC) % as affected by adding potato peels and hydrocolloids

Treatments	Alkaline water retention capacity (AWRC) %	
	Zero time	7days
100% wheat flour	303.8	267.6
1o% potato peels		
0% gum	290.7	173.6
0.5% gum arabic	314.5	277.8
1.0% gum arabic	3.19.7	289.4
1.5% gum arabic	321.4	291.6
0.5% CMC*	302.2	215.5
1.0% CMC	304.5	205.6
1.5% CMC	3.5.6	201.4
0.5% κ. carrageenan	313.7	279.5
1.0% κ. carrageenan	322.5	284.1
1.5% κ. carrageenan	327.4	296.5

*= carboxymethyl cellulose

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تحسين خواص جودة الخبز الغني بالالياف

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قسم الصناعات الغذائية – المركز القومي للبحوث بالدقي – الجيزة – مصر

الملخص العربى

تم استخدام كل من الصمغ العربي وهيدروكسي ميثيل سيليلوز وصمغ الكاراجينان بنسب (صفر، ٠,٥، ١، ١,٥%) وذلك بهدف تحسن جودة الخبز الافرنجي عالي المحتوى من الالياف والمحتوي على ١٠% من قشور البطاطس كمصدر للالياف.

وقد تم تقييم كل من الخواص الريولوجية واختبارات الخبيز وجودة اللون والخواص الحسية واختبارات البيات في الخبز الناتج.

وقد اظهرت النتائج المتحصل عليها ان اضافة قشور البطاطس بنسبة ١٠% تؤدي الى تدهور في خواص الخبز الناتج.

بينما ادت اضافة الصموغ الثلاثة منفردة الى تحسين خواص الخبز حيث زادت ثبات العجينة وزاد حجم الرغيف وطالت مدة الطزاجة.

وقد اظهرت الصموغ الثلاثة تاثيرا محسنا لمعظم الخواص التي تم تقييمها وكان اكثر الصموغ تاثيرا هو صمغ الكاراجينان.

ويمكن التوصية بانه يمكن انتاج خبز عالي الالياف مقبول الخواص باستخدام ١٠% قشور بطاطس مع ١% من الصمغ العربي او هيدروكسي ميثيل سيليلوز او الكاراجينان ويفضل الكاراجينان.