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EFFECT OF CHITOSAN ON THE QUALITY OF PAN BREAD

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ABSTRACT: *Chitosan was added to wheat flour (72%) during pan bread making at levels of 0, 0.5, 1.0 1.5 and 2.0%. Also, potassium sorbate and calcium propionate were added at level of 0.5% for the comparison. Rheological properties of doughs, baking quality, color attributes, sensorial properties and freshness of pan bread were evaluated. Moreover, antimicrobial effect of chitosan was investigated. Data revealed slight increase in water absorption and dough stability. Also, dough energy and loaf volume were found to increase as chitosan level was increased. Color was slightly affected. As alkaline water retention capacity revealed, shelf life of pan bread prolonged as a result of adding chitosan. Antimicrobial effect was detected for chitosan in pan bread regarding bacteria, yeasts and molds. Also, strong antimicrobial effect was detected with regard to potassium sorbate and calcium propionate, but they negatively affected the bread quality.*

Key words: *pan bread, chitosan, rheological properties, staling, sensory evaluation.*

INTRODUCTION

Chitosan is a polysaccharide obtained by deacetylation of chitin. Chitin poly. β(1 → 4)-N-acetyl-D-glucoseamine, is a cellulose-like biopolymer distributed through nature especially in marine invertebrates, insects, fungi and yeasts (Austin *et al.*, 1981). Chitin and its deacetylated form, chitosan, have attracted significant interest in view of their proposed novel application. Uses of the two functional polymers, particularly chitosan are readily seen over a broad range of applied scientific areas, including application in biomedical, food and various chemical industries (Knorr, 1984; Rha *et al.*, 1984; Muzzarelli, 1985; Sandford and Hutchings, 1987).

Chitosan is a cationic polysaccharide with a great variety of properties. From a technological point of view, it has been proposed as an antimicrobial, texturizer and binder agent (Hardinge-Lyme 2001). Antioxidant capacity of chitosan also has been reported (Kamil *et al.*, 2002). From the nutritional point of view, chitosan has been considered as a dietary fiber (Deuchi *et al.*, 1984; Kanauchi *et al.*, 1995), and as hypercholesterolemic agent by diminishing bile acids in intestine (Shahidi *et al.*, 1999). To be nutritionally active, chitosan needs to be introduced solubilized in food. Chitosan can be just soluble in food or in the form of powder, which in the stomach becomes soluble with acid pH. In these conditions, it is able to capture the fat by reacting with triglycerides, cholesterol and bile acids and afterwards will form an insoluble complex in the intestine, as a consequence of the alkaline pH, acting as a dietary fiber. Therefore, chitosan can be considered a promising ingredient to develop functional foods (Lopez *et al.,* 2005). Chitosan has been accepted as a natural health food additives based up on its safety for consumption. Reports are increasing on the use of chitosan for medicinal and industrial food purposes (Park and Kim 2003). Chitosan is the deacetylated form of chitin which is N-acetylamine cellulose is considered a fiber of animal origin (Furda, 1983). Hypocholesterolaemic effects of chitosan were detected (Bennekum *et al.,* 2005).

As a natural renewable resource, chitosan has a number of unique properties such as biocompatibility, biodegradability, non toxicity and antimicrobial activity, which have attracted much scientific and industrial interest in such fields as biotechnology, pharmaceutics, wastewater treatment, cosmetics, agriculture, food science and textile (Peng *et al.,* 2005).

Chitosan can be used as a natural antimicrobial coating on fresh strawberries to control the growth of fungi; thus extending shelf life of the fruits (Park *et al* ., 2005). Chitosan has widely been used in antimicrobial films and coatings due to its property of inhibiting the growth of pathogenic bacteria and fungi (Romanazzi *et al.,* 2002). The antimicrobial agents most commonly utilized in edible coatings are sorbic acid, propionic acid , potassium sorbate, benzoic acid, sodium benzoate and citric acid (Quintavalla and Vicini, 2002).

Chitosan has important applications in food industry mainly because of its functional characteristics and non toxic activity. This biopolymer has been demonstrated to have multiple effects in food systems related to some of its properties as a dietary fiber, functional ingredient, microbial deterioration preservation, lipid absorbent and emulsifier (Rodriguez *et al.,* 2003a). Chitosan is also used in food industry as a quality enhancer in certain countries. It used in the production of cookies, potato chips and noodles as a chitosan enriched products. Also, vinegar products containing chitosan are manufactured because of cholesterol lowering ability (Hirano, 1989)

Carboxymethyl chitosan was added to pan bread and extended its shelf life and inhibited baker molds (Lee and Lee, 1997). Also Ann (2002), reported that four different molecular weight of chitosan were added to bread and improved its shelf life as antioxidants during storage, while, inhibition of bacterial growth was found to vary according to chitosan molecular weight. Chitosan is an effective antimicrobial material (Cooksey, 2005). Bread containing 2% chitosan increased HDL-cholesterol and lowered LDL-cholesterol (Ausar *et al* ., 2003). So, the aim of this investigation was to study the effect of adding chitosan on pan bread quality regarding rheological properties, baking quality, color characteristics, organoleptic properties and antimicrobial effect.

MATERIALS AND METHODS

Materials:

Wheat flour, salt and active dry yeast were obtained from a local market, Cairo, Egypt, while, chitosan (highly viscous) was obtained from Fluka company, Switzerland. Potassium sorbate and calcium propionate were obtained from Merck company.

Methods:

Preparation of flour mixtures.

Chitosan was added at levels of 0, 0.5, 1.0, 1.5 and 2.0% (on flour weight basis) while potassium sorbate or calcium propionate was added at level of 0.5% (on flour weight basis)

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).

Microbiological evaluation

Total plat count of bacteria, yeasts and molds was determined according to the method of BAM (1998).

RESULTS AND DISCUSSION

Rheological properties of doughs as affected by chitosan addition

Data presented in Tables 1 and 2 show the effect of chitosan or potassium sorbate and calcium propionate on the rheological properties of doughs. As shown in Table (1), chitosan had very slight effect on water absorption of flour as revealed by farinograph test. The same trend was observed regarding potassium sorbate and calcium propionate (0.5%). Slight increase was detected in regard to arrival time and dough development time when chitosan added up to 2% (on flour weight basis), while, no detectable effect was observed when potassium sorbate or calcium propionate added at level of 0.5%. From the same table, it could be concluded that stability of dough increased as chitosan level was increased. Chitosan effect was more pronounced than propionate and sorbate effect. The added chitosan was highly viscous one, that may affect the viscoelastic properties of dough resulting increase of dough stability.

Table (1): Farinograph parameters of dough as affected by different additives

Treatments	Water absorption (%)	Arrival time (min)	Dough development time (min)	Stability (min)	Weakening (Bu)*
Control	55.0	1	2	3.5	80
Chitosan					
0.5%	55.0	1	2.5	4.5	80
1.0%	55.0	1.5	2.5	4	80
1.5%	55.5	1.5	2.5	6	60
2.0%	55.5	1.5	2.5	8	40
0.5% calcium propionate	53.5	1	3.0	4	40
0.5%potasium sorbate	54.0	1	1.5	5	60

*Bu = Barabender unit

Regarding extensograph parameters, addition of high viscous chitosan affected extensibility of dough (Table 2). Slight increase on dough extensibility due to chitosan addition (0.5%). Also, resistance to extension of dough was affected as a result of addition of high viscous chitosan. The effict of high viscous chitosan addition was more pronounced at levels of 0.5 and 1%. Slight increase was observed in dough extensibility as a result of chitosan addition. Increasing of extensibility and dough energy were more pronounced when chitosan was added at levels 0.5 and 1% than the other levels of addition (Table 2). Regarding addition of potassium and calcium propionate, no clear effect was observed as a result of addition of both materials at a level of 0.5%.

Table (2): Extensograph parameters of dough as affected by different additives.

Treatment	Extensibility (mm)	Resistance to extension (BU)*	Energy (cm^2)
Control	145	360	73
Chitosan			
0.5%	150	360	84
1%	135	340	97
1.5%	120	340	87
2%	110	320	84
0.5% calcium propionate	135	340	75
0.5%potasium sorbate	125	360	70

*Bu = Barabender unit

Baking quality of pan bread as affected by addition of chitosan and fermentation time

Data presented in Table (3) show baking quality of pan bread as affected by addition of chitosan or potassium sorbate and calcium propionate. Loaf volume was increased as a result of adding chitosan, while loaf weight slightly decreased. Increasing of pan bread volume was more pronounced when chitosan was added at levels of 0.5 and 1%. The increasing ratio of volume was decreased with high levels of addition (1.5 and 2%). Knorr (1982) stated that addition of microcrystalline chitin increased loaf volume of white bread and protein fortified bread.

Regarding potassium sorbate and calcium propionate, it could be stated that slight adverse effect was observed as a result of adding 0.5% potassium sorbate or calcium propionate. Antimicrobial and antifungal effects of both materials were recorded. The antifungal effect of propionate and sorbate affected yeast activity, so, loaf volume adversely affected. Also, antimicrobial and antifungal effects of chitosan and its derivatives were recorded. The antifungal effect of chitosan may be clear in specific concentrations. As shown in the table the positive effect of adding chitosan (0.5 and 1%) was more pronounced than the negative effect on yeast activity. The added chitosan might affect the gluten network resulting improving in viscoelastic properties of dough, so, retained gas and loaf volume increased. As chitosan addition level increased, the increasing ratio of volume decreased. That effect may be because the negative effect of chitosan (1.5 and 2%) on yeast activity was more pronounced than the positive effect on viscoelastic properties of dough.

Table (3): Baking quality of pan bread as affected by different additives and fermentation time.

Treatments	Volume (cm^3)	Weight (gm)	Specific volume (cm^3/gm)
	Fermentation time (60 min)		
Control	680	280	2.4
chitosan			
0.5%	700	275	2.5
1%	700	280	2.5
1.5%	700	275	2.5
2%	675	280	2.4
0.5% calcium propionate	675	280	2.4
0.5%potasium sorbate	600	280	2.1
	Fermentation time (90 min)		
Control	725	280	2.6
chitosan			
0.5%	925	275	3.4
1%	900	275	3.2
1.5%	900	275	3.2
2%	725	275	2.6
0.5% calcium propionate	700	280	2.5
0.5%potasium sorbate	625	280	2.2
	Fermentation time (120min)		
Control	1025	270	3.8
chitosan			
0.5%	1200	270	4.4
1%	1150	270	4.2
1.5%	1150	270	4.2
2%	750	275	2.7
0.5% calcium propionate	750	280	2.7
0.5%potasium sorbate	750	275	2.7
	Fermentation time (150 min)		
Control	950	270	3.5
chitosan			
0.5%	1125	270	4.2
1%	925	270	3.4
1.5%	900	270	3.3
2%	825	270	3.1
0.5% calcium propionate	775	275	2.8
0.5%potasium sorbate	675	275	2.4

BU = Brabender Unit

Ausar *et al.* (2003), reported that compressed yeast should be increased from 2.5% to 6% when dough containing 2% chitosan to obtain the same loaf volume to avoid the negative effect of chitosan on yeast activity.Also, Lee and Lee (1997) reported that 0.5% of carboxymetyl chitosan inhibited baker's yeast (*Saccharomyces Cerviseae*) activity by 26% in pure culture.The same table showed that, the best fermentation time to produce high quality pan bread was 120 min. the same trend was observed in all tested samples regardless of the type or the level of additive.

Color attributes of pan bread as affected by chitosan addition

Data presented in Tables (4 and 5) showed the crust and crumb color attributes of pan bread. In regard to crust color, it was clear that addition of chitosan improved crust color characteristics. Chitosan is glucose-amine contains amino groups that react with reducing sugars those produce during fermentation process resulting more golden brown desired crust color of pan bread through Maillard reaction. As chitosan level increased lightness (L-value) of crust color decreased, but, redness(b-value) of crust color increased. That is because the presence of chitosan enhanced Maillard reaction, increasing red color and darkness. Both potassium sorbate and calcium propionate adversely affected yeast activity, resulting in a less amount of reducing sugars consequently poor crust color resulted. The same trend of crust color attributes was detected under all investigated fermentation times.

Regarding crumb color, added chitosan and sorbate and propionate had negligible effect. Also, the same trend of crumb color attributes was detected under all investigated fermentation times.

Sensory evaluation of pan bread as affected by chitosan addition and fermentation time

Data presented in Tables (6 and 7) show the sensory evaluation of pan bread as affected by chitosan or potassium sorbate and calcium propionate additions for different fermentation times. Chitosan addition improved pan bread characteristics at levels 0.5 and 1%. At high levels of addition (1.5 and 2%), the improving effect of chitosan was negligible. The improving effect of chitosan was clear in crust color, break and shred and crumb texture. Chitosan acts as emulsifier, texturizer and binder agent (Hardinge-Lyme 2001; Rodriguez *et al.* 2003a). That is may affect pan bread characteristics resulting improving effect of crumb texture as well as crust color because chitosan is glucoseamine containing amino groups which help Maillard reaction to take place. Consequently, crust color improved. Chung *et al.* (2005) reported that chitosan as glucoseamine react with various sugars through Maillard reaction resulting many water-soluble chitosan derivatives.

Regarding to pan bread taste, it was clear that no significant difference was detected up to 2% of chitosan. That is means chitosan can be added to pan bread up to 2% without any adverse effect in the taste or mouthfeel. As shown in Tables 6 and 7, the best pan bread that received the highest score was that fermented for 120 minutes. That is means 120 min. is the suitable fermentation time under the investigated conditions.

Concerning potassium sorbate and calcium propionate, it was clear that addition of both materials (0.5%) adversely affected pan bread quality regarding sensory evaluation. The same trend was observed under all tested fermentation times.

Table (4): Crust color attributes of pan bread as affected by additives and fermentation time.

Treatments	60 min			90 min			120 min			150 min		
	L	a	b	L	a	b	L	a	b	L	a	b
Control	54.94	15.24	28.03	53.27	16.54	31.95	53.71	15.91	31.50	58.50	13.94	30.79
Chitosan												
0.5%	50.90	17.61	33.56	55.58	18.00	36.49	51.84	17.02	34.55	52.38	14.79	33.79
1%	51.12	18.38	33.39	49.03	18.29	32.52	51.99	16.77	33.08	55.94	10.10	30.87
1.5%	51.15	16.71	34.99	46.84	17.32	31.06	51.05	15.59	33.07	55.45	10.79	31.80
2%	54.40	11.41	31.67	58.56	15.06	33.05	51.37	14.36	30.28	49.03	11.77	29.70
0.5%propionate	70.88	9.12	26.92	73.91	15.02	26.88	73.77	12.56	28.63	70.57	19.24	32.26
0.5% sorbate	66.63	10.86	24.92	71.69	16.28	30.31	65.77	11.70	37.42	68.03	9.02	35.15

Table (5): Crumb color attributes of pan bread as affected by additives and fermentation time.

Treatments	60 min			90 min			120 min			150 min		
	L	a	b	L	a	b	L	a	b	L	a	b
Control	76.24	1.68	19.38	75.17	1.63	20.14	75.75	1.22	19.59	69.89	1.28	19.44
Chitosan												
0.5%	76.18	1.41	17.69	78.67	1.11	17.85	76.20	1.20	18.62	70.57	1.14	18.79
1%	78.03	1.41	18.32	78.02	1.29	19.58	72.57	1.45	19.36	70.88	1.55	20.61
1.5%	78.19	1.28	17.10	78.78	1.13	17.61	70.29	1.15	17.89	70.22	1.13	18.95
2%	77.04	1.50	19.73	74.98	1.42	20.05	72.64	1.66	20.89	69.77	1.54	20.94
0.5%propionate	78.32	2.15	18.96	77.79	1.94	19.12	70.81	1.97	19.56	76.20	1.69	18.79
0.5% sorbate	78.42	1.98	19.20	78.09	1.65	18.01	78.04	1.65	18.41	74.24	1.73	19.00

Table (6): Mean values of sensory evaluation of pan bread as affected by additives and fermentation time.

treatments	Sym. Shape (5)	Crust color (10)	Break & shred (10)	Crumb texture (15)	Crumb color (10)	Aroma (20)	Taste (20)	Mouth feel (10)
Fermentation time (60 min)								
Control	3.40^{a}	6.80^{ab}	7.40^{a}	11.00^{ab}	7.40^{ab}	15.30^{a}	14.50^{a}	6.80^{ab}
Chitosan								
0.5%	3.60^{a}	8.00^{a}	7.70^{a}	11.60^{a}	8.00^{a}	14.00^{a}	14.50^{a}	6.80^{ab}
1%	3.60^{a}	7.50^{ab}	7.10^{ab}	11.20^{ab}	7.90^{a}	13.80^{a}	13.80^{a}	6.40^{ab}
1.5%	3.05^{a}	6.40^{b}	7.40^{a}	11.10^{ab}	7.90^{a}	13.50^{a}	14.60^{a}	6.80^{ab}
2%	2.00^{b}	4.80^{c}	7.00^{a}	9.90^{abc}	7.60^{ab}	11.90^{ab}	13.80^{a}	6.00^{b}
0.5% propionate	1.80^{b}	4.40^{c}	5.20^{b}	8.60^{bc}	6.10^{bc}	8.50^{b}	9.90^{b}	4.40^{c}
0.5% sorbate	1.75^{b}	4.70^{c}	5.40^{b}	7.50^{c}	5.80^{c}	5.50^{b}	8.40^{b}	1.40^{d}
LSD (0.05)	0.699	1.521	1.405	2.627	1.580	4.304	3.596	1.388
Fermentation time (90 min)								
Control	3.20^{abc}	6.30^{ab}	6.80^{ab}	11.80^{a}	7.90^{a}	15.20^{a}	14.30^{a}	7.10^{a}
Chitosan								
0.5%	4.00^{a}	7.50^{a}	7.50^{a}	12.50^{a}	8.30^{a}	16.20^{a}	15.60^{a}	7.70^{a}
1%	4.00^{a}	7.90^{a}	7.30^{a}	11.10^{ab}	8.20^{a}	15.20^{a}	14.90^{a}	7.20^{a}
1.5%	3.90^{ab}	7.60^{a}	7.40^{a}	11.50^{ab}	7.70^{ab}	14.60^{a}	15.20^{a}	7.00^{a}
2%	3.10^{bc}	6.40^{ab}	6.80^{ab}	10.20^{abc}	6.80^{abc}	13.10^{ab}	13.00^{ab}	6.70^{a}
0.5% propionate	2.50^{cd}	5.00^{bc}	5.60^{bc}	8.80^{bc}	6.00^{bc}	9.80^{b}	9.90^{bc}	4.90^{b}
0.5% sorbate	1.90^{d}	4.00^{c}	4.90^{c}	7.40^{c}	5.50^{c}	9.30^{b}	8.40^{c}	4.20^{b}
LSD (0.05	0.833	1.685	1.524	2.946	1.782	4.205	3.893	1.429

Means in a column not sharing the same superscript are significantly different at $P < 0.05$

Table (7): Mean values of sensory evaluation of pan bread as affected by additives and fermentation time.

treatments	Sym. Shape (5)	Crust color (10)	Break & shred (10)	Crumb texture (15)	Crumb color (10)	Aroma (20)	Taste (20)	Mouth feel (10)
Fermentation time (120 min)								
Control	4.90^{a}	9.10^{a}	8.80^{a}	13.70^{a}	9.00^{a}	17.50^{a}	17.10^{a}	8.10^{a}
Chitosan								
0.5%	4.70^{ab}	8.70^{ab}	8.50^{a}	13.50^{a}	8.80^{a}	17.20^{a}	17.20^{a}	8.00^{a}
1%	4.20^{b}	8.40^{ab}	8.20^{a}	13.60^{a}	8.60^{a}	17.10^{a}	16.40^{a}	7.70^{a}
1.5%	4.20^{b}	8.10^{ab}	8.00^{a}	13.40^{a}	8.70^{a}	16.60^{ab}	15.00^{ab}	7.70^{a}
2%	3.30^{c}	6.20^{c}	7.90^{a}	11.10^{b}	8.20^{a}	14.90^{ab}	13.10^{bc}	7.30^{a}
0.5% propionate	4.30^{b}	7.50^{b}	8.10^{a}	11.50^{b}	8.60^{a}	13.60^{bc}	15.80^{ab}	7.30^{a}
0.5% sorbate	2.50^{d}	4.70^{d}	5.80^{b}	7.90^{c}	6.10^{b}	10.60^{c}	10.60^{c}	4.90^{b}
LSD (0.05	0.583	1.285	1.207	1.764	1.307	3.249	3.296	1.552
Fermentation time (150 min)								
Control	3.80	7.90	7.20	12.50^{a}	8.00	16.60	16.30	7.40
Chitosan								
0.5%	3.40	7.70	7.50	12.20^{a}	8.00	16.00	16.20	7.30
1%	2.90	6.70	7.00	12.20^{a}	7.10	15.90	15.70	7.40
1.5%	3.00	6.40	6.80	12.00^{a}	7.30	14.60	15.10	6.90
2%	2.60	6.50	6.30	10.70^{ab}	6.60	13.80	14.50	6.20
0.5% propionate	3.30	6.30	6.20	9.70^{b}	6.40	12.30	12.70	6.40
0.5% sorbate	3.00	5.70	5.50	8.80^{b}	6.00	12.20	11.80	5.90
LSD (0.05	NS*	NS	NS	2.288	NS	NS	NS	NS

Means in a column not sharing the same superscripts are significantly different at $P < 0.05$

*NS = Not Significant

Antimicrobial effect of chitosan

Data presented in Table (8) show the effect of adding chitosan at levels from 0.5 to 2% or potassium sorbate or calcium propionate at 0.5% on the total plate count and yeasts and molds during storage of pan bread up to 15days at a room temperature.

Antimicrobial effect was observed regarding chitosan. As chitosan concentration increased the antimicrobial effect increased. The same trend was observed in bacteria and yeasts and molds.

Rodriguez *et al* (2003b) stated that the use of chitosan in acetic acid (0.079g/100g pizza) as edible coating delayed *Alternaria sp., Penecillium sp.* and *Cladosporium sp.* This behavior was similar compared to the action of calcium propionate (0.103g/100g pizza) and potassium sorbate (0.034g/100g pizza). Also Wang (1992) used chitosan (0.5-2.5%) as antimicrobial agent against five species of foodborne pathogens and reported that the effectiveness of chitosan against *Staphylococcus aureus* was the greatest followed by *Salmonella typhimurium, Escherchia coli* and *Yersinia enterocolitica*. Moreover, the antibacterial activity of chitosan was stronger at pH 5.5 than at pH 6.5. Such findings were also detected by Durango *et al* (2006), as they reported that, the presence of 1-5% chitosan in the coating inhibited the growth of total coliforms and lactic acid bacteria in processed carrots stored at 10°C for 15 days. Growth of microorganisms including bakery molds (*aspergillus, penicilluim*... etc) was significantly inhibited by adding carboxymethyl chitosan up to 0.5% to pan bread (Lee and Lee,1997).

Regarding potassium sorbate and calcium propionate, strongly inhibition effect was observed when both materials were added to pan bread at 0.5% (Table 8). Such findings were also reported by Suhr and Nielson (2004).

Table (8): Total plate count and yeast and molds of pan bread stored at room temperature as affected by additives

Treatments	bacteria			Yeast & Molds		
	Zero time	7 days	15 days	Zero time	7 days	15 days
Control	+	+++	++++++	+	+++++	++++++
Chitosan						
0.5%	+	++	++++	+	++++	+++++
1%	+	++	++++	+	++++	+++++
1.5%	+	++	+++	+	+++	++++
2%	+	++	+++	+	+++	++++
0.5% calcium propionate	+	+	++	+	++	+++
0.5%potasium sorbate	+	+	++	+	++	+++

Freshness of pan bread as affected by chitosan addition

Data presented in Table (9) showed the effect of chitosan on the freshness of pan bread stored at room temperature for 7 days. Chitosan addition improved the shelf life of pan bread. As alkaline water retention capacity test revealed. As chitosan level increased, the shelf life of pan bread increased. Chitosan acts as emulsifier and binder (Hardinge-lyme2001). Emulsifier is characterized by its improving effect of the freshness of bread.

In this respect, Lee and Lee (1997) reported that addition of carboxymethyl chitosan to pan bread extended its shelf life. Such findings were also observed by Ann (2002) as he reported, addition of chitosan to pan bread prolonged its shelf life through acting as antioxidant agents. Regarding potassium sorbate and calcium propionate, no detectable effect was observed concerning the freshness of bread.

Table (9): Alkaline water retention capacity (%) of pan bread as affected by additives and storage time

treatments	Storage time	
	Zero time	7 days
Control	260	80
Chitosan		
0.5%	255	98
1%	260	104
1.5%	258	112
2%	256	122
0.5% calcium propionate	260	78
0.5%potasium sorbate	258	78

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تأثير إضافة الكيتوزان على جودة الخبز الأفرنجي

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تم إضافة الكيتوزان إلى دقيق القمح استخلاص ٧٢% بنسب ٠,٥، ١، ١,٥، ٢% وذلك أثناء تصنيع الخبز الأفرنجي. كما تم استخدام كل من سوربات البوتاسيوم وبروبيونات الكالسيوم بنسبة ٠,٥% للمقارنة.

وتم دراسة تأثير الإضافة على الخواص الريولوجية للعجائن وكذلك جودة الخبيز وتأثير الإضافة على جودة اللون في الناتج النهائي هذا بالإضافة إلى دراسة تأثير الإضافة على الخواص الحسية للخبز الناتج ودرجة البيات في الخبز. كذلك تم دراسة تأثير الإضافة على النمو الميكروبي في الخبز أثناء التخزين لمدة ١٥ يوما على درجة حرارة الغرفة.

وقد أظهرت النتائج المتحصل عليها أن هناك زيادة في نسبة امتصاص الماء ودرجة ثبات العجينة كنتيجة لإضافة الكيتوزان كذلك لوحظ أن هناك زيادة في حجم الرغيف كنتيجة لإضافة الكيتوزان وكانت النسبة الأكثر تأثيرا هي ٠,٥، ١%.

وقد تحسن لون القصرة بينما لم يتأثر كثيرا لون اللبابة بإضافة الكيتوزان حتى ٢% أظهرت نتائج التقييم الحسي دورا محسنا الكيتوزان على الخواص الحسية للخبز خاصة عند مستوى إضافة ١% أيضا أظهرت النتائج أن الكيتوزان أطال درجة بقاء الخبز طازجا.

كما أظهرت النتائج أيضا نشاطا مضادا للميكروبات للكيتوزان حيث ظهر تحسن واضح في العينات المحتوية على كيتوزان مقارنة بالعينات غير المحتوية عليه.

كما لوحظ نشاطا قويا مضادا للميكروبات لكل من سوربات البوتاسيوم وبروبيونات الكالسيوم بنسبة ٠,٥%.

ويمكن التوصية بإضافة الكيتوزان بنسبة ١% كعامل محسن لخبز وذلك طبقا لنتائج التقييم الريولوجي وخواص الخبيز والتقييم الحسي والنشاط المضاد للميكروبات عند التخزين.