544 Egypt. J. Chem. Vol. 68, No.11, pp. 595 - 605 (2025)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Effect of chitosan addition on the physicochemical, sensory, and shelf life properties of pan bread

Fatma M.Abdo El-Saied*, Gehan A. El-Shorbagy, Abbas O. Toliba and Norhan Rabie

Food science Department, Faculty of Agriculture, Zagazig University

Abstract

In order to improve pan bread quality, chitosan powder (CP)was assessed at fourlevels (0.5, 1.0, 1.5, and 2.0% w/w) of addition with strong wheat flour (SWF). Rheological property of Farinograph showed that increasing percentage of chitosan in wheat flour led to improve all quality paramters of Farinograph especially formula of 1% chitosan. Also, Extensograph and RVA parameters confirmed that, the ideal amount of chitosan in bread dough was 1.0 and 1.5%. Therefore, the obtained formula could be accepted to prepare pan bread and could be accepted by consumer. All accepted flour formulas were used to prepare pan bread, after which they evaluated their chemical quality and different properties that could be attractive for consumer i.e. baking quality, colour quality, sensory properties, texture profile properties and freshness. Baking quality showed that there were no significant difference in weight and specific volume in ban bread of all tested samples, while volume was decreased slightly in pan bread of 1.5 and 2% chitosan. Also, Hunter colour parameters indicated that there were slight differences between the colour of crust and crumb of all tested samples. The obtained result of texture profile analysis indicated that it could be recommended to preparing pan bread of 1% chitosan for its higher texture properties. Moreover, sensory evaluation agreed with the obtained result of Hunter color and Texture analysis. Therfore, it could be predicting high consumer acceptability for pan bread at 1% chitosan. From other hand, freshness result of pan bread was increased as the percentage of chitosan increased either in zero time or during storage periods at room temperature.

Keywords: Chemical, rheological, color attributes, baking quality, sensory qualities, stalling and pan bread

1. Introduction

The production of bread is a multi-step, intricate process, and it goes through a dynamic, multi-stage staling process while being stored. After baking, bread has a continuous elastic network made up of polymeric starch molecules, usually amylose, crosslinked gluten protein, complex and noncomplex polar lipid molecules, and an irregular section of gelatinized, expanded, deformed starch particles contained in the matrix. Complex interactions between macromolecules determine the look of dough in addition to the gluten and other protein content of wheat flours[1]. Since ancient times, dietary fibers have been a part of the diet and are known to provide health benefits without adding calories. Dietary fiber consumption provides protection against cancer, cardiovascular disease, constipation, hemorrhoids, diverticulitis, and a decrease in blood serum cholesterol and blood glucose levels [2]. Chitosan, the most common natural aminopolysaccharide, is poly-(1-4)-2-amino-2-deoxy-b-D-glucan, a nontoxic, hydrophobic, and biocompatible substance. It is created by deacetylating chitin that is extracted from prawn and crab shells. It has a chemical structure with cellulose and is not broken down by human digestive enzymes. In acidic conditions, chitosan's single amino group per residue results in large positive-charge densities. Applying chitosan as a natural food additive would fully satisfy its microbiostatic (against bacteria like salmonella, listeria, fungi, and yeast), emulsifying, fat, protein, and polysaccharide binding, cholesterol-lowering, prebiotic, and health-promoting qualities, which include preventing coronary heart disease, colon cancer, diabetes, and gastrointestinal disorders. [3]. Although there is a wealth of published data on the nutritional and physiological advantages of chitosan, there is little data on how to enrich food with chitosan, optimize dose in bread, and understand its rheological behavior, gelatinization kinetics, and staling kinetics. Bread experiences physical, chemical, and microbiological changes during storage that reduce its quality and limit its shelf life. The bread's freshness is diminished by physical and chemical changes, causing the crumb to progressively solidify and the flavor to decline. Toxins with peculiar tastes that have an adverse effect on people's life and health can be produced by microbial spoiling brought on by bacteria, yeast, and molds [4]. Therefore, stale bread is a problem as it leads to both customer and baking company financial losses and human illness from fungus-induced fungal toxin contamination [5]. The baking industry has been putting a lot of effort into finding ways to prolong bread's shelf life and shield it from physical and chemical changes in order to address this issue of food safety and

*Corresponding author e-mail: fatma.frekha1993@gmail.com ; (Fatma M.Abdo El-Saied),
Receive Date: 25 December 2024, Revise Date: 21 February 2025, Accept Date: 23 March 2025
DOI: 10.21608/ejchem.2025.347778.11049

economy. This will help to improve the safety of bread consumption by limiting changes in the bread's organoleptic quality. Investigating the effects of chitosan as a dietary fiber on the rheological, physicochemical, textural, and sensory characteristics of chitosan-containing bread was the goal of the study.

MATERIALS AND METHODS:

Materials:

Powdered chitosan was procured from Fluka, Germany. Its moisture level was less than 10%, and its deacetylation degree was 96%. The following items were acquired from the local market in Cairo, Egypt: dry yeast, sugar, corn oil, salt (sodium chloride), and strong wheat flour (SWF) was obtained from Amoun for milling Co. Giza, Egypt.

Methods:

Preparation formula of chitosan pan bread flour:

Pan bread formula of control sample was prepared and mixed with chitosan powder (CP) at different concentration (0.5, 1.0, 1.5, and 2.0%). Then, they were stored at 3-5ºC in sealed container up tell use.

Rheological properties:

Flour of pan bread control and chitosan formula were evaluated its acceptability for bread making through using Farinograph, Extensograph, and rapid viscoanalyzer (RVA) accordance to AACC guidelines [6].

Preparation formula of pan bread:

According to Hussein *et al*. [7] at Dokki, Egypt's National Research Centre (NRC) pilot facility, pan bread was prepared. One gram of salt (sodium chloride), five grams of sugar (sucrose), two grams of maize oil, one and a half grams of instant active dry yeast, 100 grams of mixed flour, and water (enough to reach 500 Brabender Units of consistency) were the ingredients for the pan bread. The process for making pan bread involved physically combining the dry ingredients in a broad bowel before adding them to a mixing bowl. All of the components were combined with water and shortening. Using a low-speed electric mixer, the components were thoroughly combined for two minutes. After two minutes of lowering the speed to medium, the speed was raised to high for eight minutes. After dividing the dough into hand-rounded pieces, it was let to rest for ten minutes. The dough was formed, panned, and fermented in a fermentation cabinet for 60 minutes at 30°C and 86% relative humidity. In an electric oven, the proofed pieces were roasted for 21 minutes at 250°C. Before being utilized for further testing, the baked bread samples were put in polyethylene bags and allowed to cool at room temperature (30°C±2) for an hour.

The chemical makeup of pan bread:

The contents of pan bread were tested for moisture, ash, crude protein, fat, and crude fiber using the procedures described in AOAC [8]. The following formula was used to calculate the amount of carbohydrates: Carbohydrates are equal to 100 minus the amount of protein, fat, ash, and crude fiber.

Quality of pan bread baking:

Using the AACC [6] approach, the weight, volume, and specific volume of the bread samples was determined.

Colour determinations:

An objective color evaluation was measured for pan bread. Hunter's a*, b*, and L* parameters were measured using a spectro-colorimeter (Tristimulus Colour Machine) in the reflection mode and the CIE lab color scale (Hunter, Lab Scan XE - Reston VA, USA). Using the white Hunter Lab Colour Standard tile (LX No. 16379), the instrument was consistently standardized with the following values: Z = 88.14, Y = 81.94, and X = 72.26 (L* = 92.46; a* = -0.86; b* = -0.16).

Texture properties of pan bread:

Using a texture meter (Brookfield model-CT3-10 kg, USA) fitted with a fixture (TA-SBA), the textural properties of pan bread were assessed. We looked at the following textural attributes: hardness, deformation at hardness, hardness work, load at target, peak stress, fracture ability, and fracture load drop off. 2.5 mm/sec was the test speed, and the trigger load was 9.00 N.

The pan bread's sensory qualities

The sensory characteristics of the pan bread samples that were evaluated were taste (20), fragrance (10), symmetry (10), crumb gr ain texture (20), crumb color (20), crust color (20), and overall acceptability (100).

Freshness of bread:

Before their freshness was evaluated, the pan bread loaves were packed in polyethylene bags and kept at room temperature for one, three, and five days. The Alkaline Water Retention Capacity Test (AWRC), which Kitterman & Rubenthaler [9] adapted in accordance with Yamazaki's [10] technique, was used to determine it.

Statistical analysis:

The obtained results were statistically analyzed using analysis of variance (ANOVA), Duncan's multiple range test and least significant difference (LSD) at $p<0.05$ by SPSS statistical package (Version 20) according to Rattanathanalerk et al. [11].

Table 1: lists the composition of the raw materials used in the pan bread recipe

Ingredients	Pan bread samples				
	Control (100% SWF)	1	2	3	4
Strong wheat flour (SWF) (g)	100	99.5	99	98.5	98
Chitosan powder (CP)	--	0.5	1.0	1.5	2.0
Water(ml)	59	61	63	64.2	57
Dry yeast (g)	1.5	1.5	1.5	1.5	1.5
Corn oil (ml)	2	2	2	2	2
Sugar (g)	5	5	5	5	5
Salt (g)	1	1	1	1	1

1. Results and Discussion

Rheological property of ban bread formula

- Farinograph parameters

Pan bread formula flour of different samples were evaluated to produce bread through determination water absorption, arrival time, dough development time, dough stability, and dough weakening by using Farinograph. The obtained results were clearly shown in Table (2) and Fig. (1). Results indicated that, chitosan addition improve the quality of wheat flour, where adding 1% chitosan increased water absorption, arrival time, dough development time and dough stability 63%, 1.5min, 2 min, 4 min, 90, BU, respectively and decreased dough weakening to 90 BU. Dough stability of 1% chitosan was decreased if chitosan in dough increased to 1.5 and 2%. This result could due to the effect of dilution on disrupting the gluten's continuity, which decrease dough stability **[12]**. The increase of mixing tolerance index in 1.5 and 2% chitosan was also outcome from diluted gluten in the formed flour, which also reduced the relationship between gluten and starch**[13, 14]**. Therefore, Farinograph parameters showed that flour formula of 1% chitosan was the best formula to prepare pan bread.

Table 2: Effect of adding CP with SWF (72%) on farinograph parameters of Pan bread samples

Blends	Water absorption (%)	Arrival Time (min)	Dough development time(min)	Dough stability (min)	Mixing tolerance index (BU)	Dough weakening (BU)
Control (SWF 72%)	59	1.0	1.5	2.5	70	80
99.5 %SWF +0.5%CP	61	1.25	2.0	2.5	100	120
99.0 %SWF +1.0% CP	63	1.50	2.0	4.0	90	90
98.5 %SWF +1.5% CP	64.2	1.0	1.5	3.5	90	100
98.0 %SWF +2.0% CP	57	1.0	1.5	3.0	60	80

Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

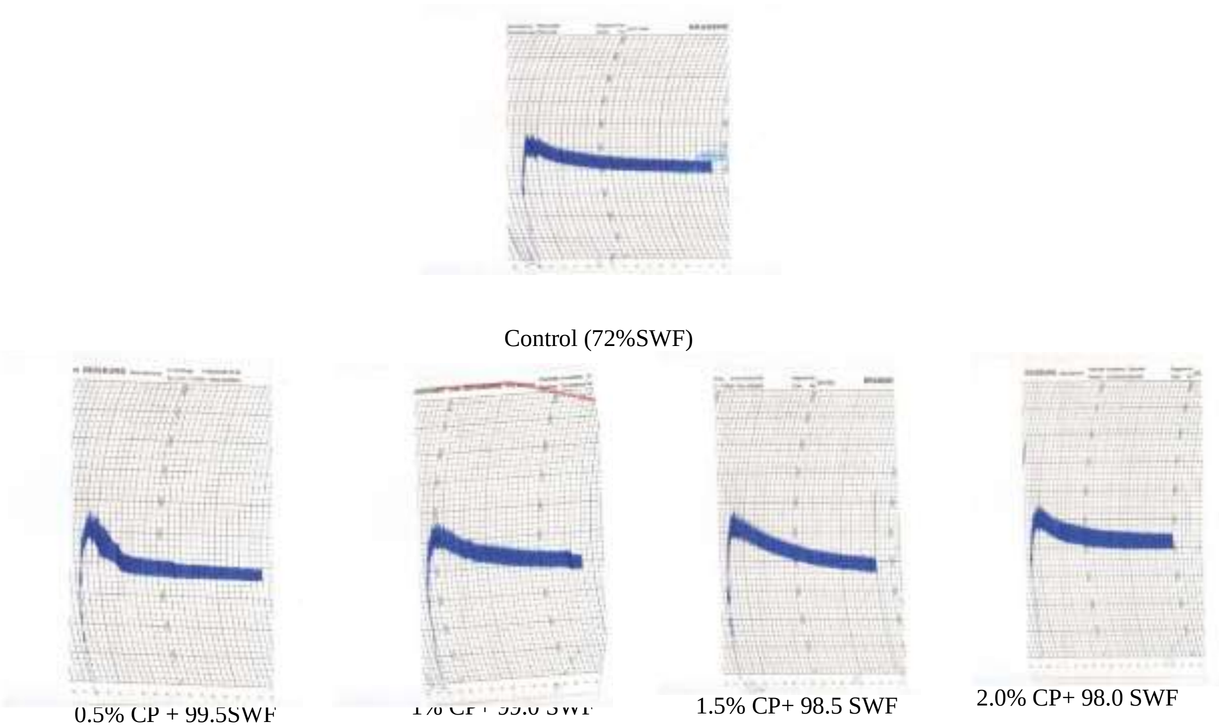


Fig.1. Characteristics of farinograph of the dough sample supplemented with different levels of chitosan powder

Extensograph characteristics

Pan bread formula flour was evaluated also through determination dough energy, extensibility, resistance to extension, maximum resistance to extension and proportional number using Extensograph. The obtained results presented in Table (3) and Fig. (2). Results confirmed that 1 and 1.5% chitosan was the most accepted formula. This result due to higher resistance to extension (755 & 760 BU) and lower extensibility (200 & 190 BU) in formula of 1 and 1.5% chitosan, respectively. The same trend was found also in the tow samples of 1and 1.5 % where, chitosan maximum resistance to extension (360 &400 BU), proportional number (1.8 & 2.11 R/E), dough energy (174 &178cm^2). The obtained extensograph parameters demonstrated that, the ideal amount of chitosan in bread dough was 1.0 and 1.5% [15-17].

Table 3: Effect of adding CP with SWF (72%) on extensograph parameters of dough Pan bread.

Samples	Extensibility (E) (cm)	Resistance to extension (R) (BU)	Maximum Resistance to extension (BU) (after 5 min)	Proportional number (R/E)	Dough energy (cm2)
Control (SWF 72%)	220	625	300	1.36	143
99.5 %SWF +0.5% CP	210	645	340	1.62	140
99.0 %SWF +1.0% CP	200	755	360	1.8	174
98.5 %SWF +1.5% CP	190	760	400	2.11	178
98.0 %SWF +2.0% CP	245	625	250	1.02	169

Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

Control (SWF 72%)

99.5 %SWF +0.5% CP

99.0 %SWF +1.0% CP

98.5 %SWF +1.5% CP

98.0 %SWF +2.0% CP

Fig .2. Supplementary dough sample extenograph parameters with different levels of chitosan powder

Pasting profile (RVA)

Furthermore, pasting properties of pan bread flour samples were evaluated using rapid viscoanalyzer (RVA). The obtained results presented in Table (4) and Fig. (3). Results confirmed also that, flour formula of 1 and 1.5% chitosan represent the most accepted formula. This result due to the higher peak value (highest viscosity), higher break down, higher final viscosity and set back in 1 and 1.5 % chitosan, where they reached to (2560 & 2463 CP), (1444 & 1309 CP), (2140 & 2530 CP) and (695.6 & 1200 CP), respectively. The obtained RVA results agreed with several authors **[18-21].**

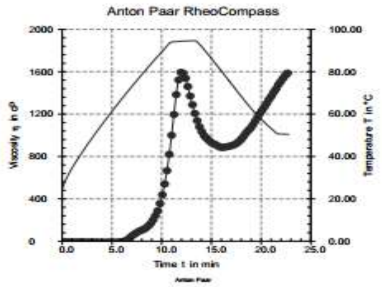
From other hand, the obtained results of Farinograph, Extensograph and RVA showed that all tested formula of chitosan were accepted if compared with control sample, but the formula of 1 and 1.5 % chitosan were more accepted. Therefore, the obtained formula could be accepted to prepare pan bread and could be accepted by consumer.

All accepted flour formulas were used to prepare pan bread, after which they evaluated their chemical quality and different properties that could be attractive for consumer such as: baking quality, colour quality, sensory properties, texture profile properties and freshness.

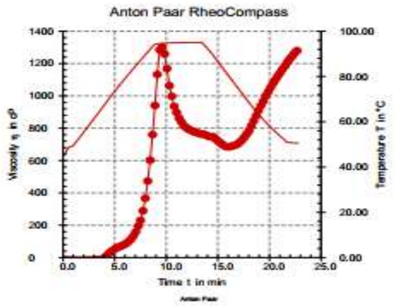
Table 4: Effect of SWF supplementation with CP at different level on pasting properties (RVA)

Additives	**Peak Vis. (CP)**	**Trough1 (CP)**	**Break down (CP)**	**Final Vis. (CP)**	**Setback (CP)**	**Peak Time (Min)**	**Pasting Temp. (ºC)**	**Peak Temp. (ºC)**
Control (SWF 72%)	1600	884	715.8	1606	890.5	12.0	94.4	94.4
99.5 %SWF +0.5% CP	1319	684..2	635.1	1287	651.8	9.5	72.9	94.6
99.0 %SWF +1.0% CP	2560	1115	1444	2140	695.6	9.57	74.1	94.6
98.5 %SWF +1.5% CP	2463	1155	1309	2530	1222	9.6	77.8	94.6
98.0 %SWF +2.0% CP	2471	1100	1371	2052	680.2	9.63	75.7	94.6

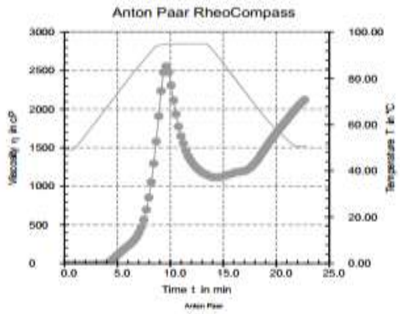
Where: SWF: Strong Wheat Flour; CP: Chitosan Powder



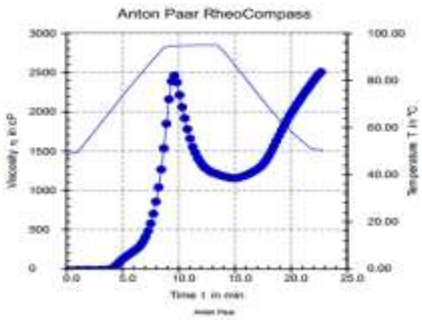
Control (SWF 72%)



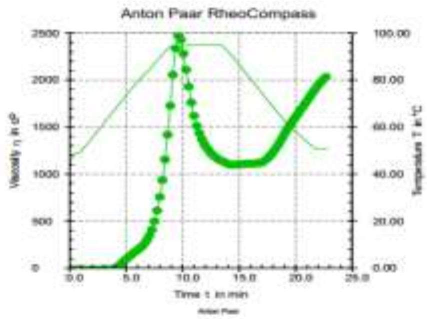
99.5 %SWF +0.5% CP



99.0 %SWF +1.0% CP



98.5 %SWF +1.5% CP



98.0 %SWF +2.0% CP

Fig. 3. RVA of dough SWF (72%) with chitosan powder (CP) added at different levels

Chemical analysis of pan bread

The chemical composition of pan bread in different tested formula is clearly shown in Table (5). The obtained result showed that there were slight difference between pan bread of control sample and pan bread of chitosan sample at different assessed level. This result could due to slight chitosan level that used to improve the quality and shelf life of pan bread.

Table 5: Chemical analysis of pan bread samples (on dry weight basis)

Pan bread from	Approximate chemical composition of pan bread					
	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)
Control (SWF 72%)	24.50e± 1.05	1.3d±0.05	12.20a±0.35	3.2b±0.30	1.2c±0.09	82.10±1.11
99.5 %SWF +0.5% CP	25.60d± 1.18	1.6c±0.10	11.85c±0.40	3.7a±0.36	1.5b±0.08	81.35±1.65
99.0 %SWF +1.0% CP	26.75c± 1.25	1.7ab±0.11	11.90bc±0.31	3.8a±0.30	1.5b±0.11	81.10±1.25
98.5 %SWF +1.5% CP	27.85b± 1.30	1.8a±0.06	11.95b±0.23	3.8a±0.46	1.7a±0.16	80.75±1.42
98.0 %SWF +2.0% CP	28.00a± 1.45	1.6bc±0.07	11.92bc±0.20	3.7a±0.31	1.6ab±0.08	81.18±1.35
LSD at 0.05	0.150	0.182	0.0762	0.230	0.182	NS

Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

Baking quality of pan bread

Baking quality in different tested samples was estimated by using weight, volume and specific volume of pan bread after baking. The obtained result tabulated in Table (6). Result showed that there were no significant difference in weight and specific volume in ban bread of all tested samples, while volume was decreased slightly in pan bread of 1.5 and 2% chitosan. This result could due to increasing fibre content of chitosan, consequantly water holding ability increased as suggested by **Kerch*et al* [22]and Kohajdová *et al* [23].**

Table 6: Physical properties of pan bread

Samples	**Baking quality of bread**		
	Weight (g)	**Volume (cm^3)**	**Specific volume (cm^3/g)**
Control (SWF 72%)	84.25^{a}±0.65	251.25^{a}±1.15	2.98^{a}±0.22
99.5 %SWF +0.5% CP	84.55^{a}±0.39	235.00^{ab}±1.26	2.78^{a}±0.35
99.0 %SWF +1.0% CP	84.75^{a}±0.49	217.5^{ab}±1.50	2.69^{a}±0.11
98.5 %SWF +1.5% CP	85.05^{a}±0.52	215.00^{b}±1.42	2.65^{a}±0.19
98.0 %SWF +2.0% CP	85.65^{a}±0.45	210.00^{b}±1.18	2.45^{a}±0.19
LSD at 0.05	6.303	31.589	0.366

Mean values in each column having differentsuperscript (a, b, c, d and e) are significantly different at P < 0.05.
Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

Color quality of pan bread

Colour of the final product is one of the most important factors that affects on consumers' decisions. Hunter color parameters (L*, a* and b*) were used to evaluate the quality of pan bread color after baking. The obtained results are clearly shown in Table (7). Results showed that there were slight significant difference between crust and crumb of all tested samples as affected by percentage of chitosan, where whiteness (L*) and yellowness (b*) were slightly decreased as chitosan increased; and in contrast redness (a*) was increased as chitosan increased. This result is in agreement with consumer demand. The obtained redness could due to fibre content of chitosan which accelerates the baking process and produce more Maillard reaction products**[24]**.

Table 7: Color measurement of pan bread samples

Pan bread from	Crust color			Crumb color		
	L	a	b	L	a	b
Control (SWF 72%)	52.07^{a}±0.40	14.81^{e}±0.11	30.72^{b}±0.15	72.58^{a}±0.77	1.48^{e}±0.01	19.89^{e}±0.10
99.5 %SWF +0.5% CP	50.77^{b}±0.36	15.44^{d}±0.15	31.27^{a}±0.32	71.91^{b}±0.65	2.76^{d}±0.03	22.28^{a}±0.15
99.0 %SWF +1.0% CP	47.84^{c}±0.32	16.14^{c}±0.19	30.36^{c}±0.19	67.63^{c}±0.60	3.16^{c}±0.05	21.55^{b}±0.19
98.5 %SWF +1.5% CP	44.80^{d}±0.29	16.69^{b}±0.26	25.85^{d}±0.28	63.01^{d}±0.52	3.47^{b}±0.03	20.84^{c}±0.22
98.0 %SWF +2.0% CP	39.35^{e}±0.44	17.05^{a}±0.39	23.22^{e}±0.35	61.15^{e}±0.44	3.65^{a}±0.02	20.11^{d}±0.25
LSD at 0.05	0.0881	0.0891	0.0719	0.0622	0.0354	0.229

Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

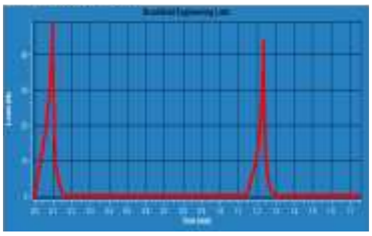
Texture properties of pan bread

Texture analyzer apparatus was used to evaluate the quality of pan bread texture. This apparatus is primarily concerned with measurement of the mechanical properties of food or food products, where it related to humans sense. This test is depending on applying controlled forces to the product and recording its response in the form of force, deformation and time.Texture profile analysis (TPA) was used to evaluate the texture of all pan bread tested samples. Table (8) and fig.(4) indicated that hardness, adhesiveness, Gumminess, chewiness, springiness of pan bread was increased gradually with increasing gradually the level of chitosan. While, cohesiveness and resilience were gradually decreased as percentage of chitosan increased. These results agreed with those reported previously by several author [25 - 29]. From the previous finding it could be recommend to preparing pan bread of 1% chitosan for its higher texture properties.

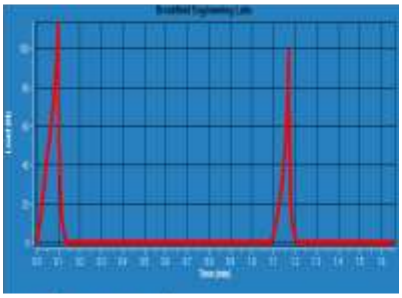
Table 8: Texture profile analysis of pan bread

TPA	Pan bread from				
	Control (SWF 72%)	99.5 %SWF +0.5% CP	99.0 %SWF +1.0% CP	98.5 %SWF +1.5% CP	98.0 %SWF +2.0% CP
Hardness cycle 1 (N)	6.23	6.21	10.66	9.92	27.51
Resilience	0.25	0.26	0.21	0.21	0.13
Adhesiveness (mJ)	0.10	0.10	1.00	0.10	1.30
Hardness cycle 2 (N)	5.82	43.90	9.39	8.98	0.00
Cohesiveness	0.73	0.74	0.63	0.65	0.00
Gumminess (N)	4.56	4.61	6.72	6.42	0.00
Chewiness (mJ)	87.90	89.80	125.10	122.70	0.00
Springiness (mm)	19.28	19.48	18.61	19.12	17.95

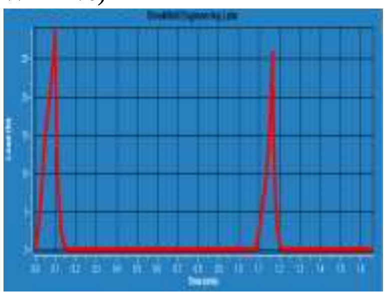
Where: SWF: Strong Wheat Flour; CP: Chitosan Powder



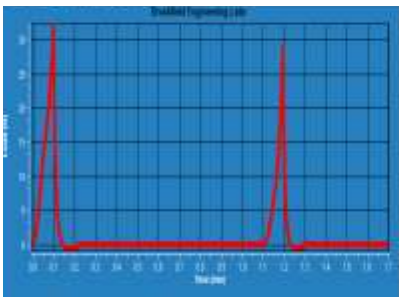
Control (SWF 72%)



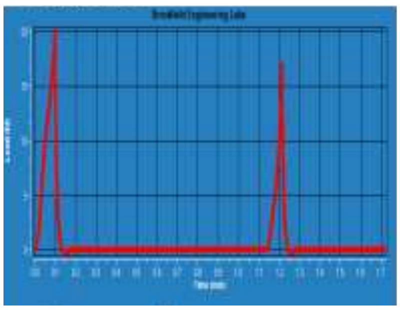
99.5 %SWF +0.5% CP



99.0 %SWF +1.0% CP



98.5 %SWF +1.5% CP



98.0 %SWF +2.0% CP

Fig .4.Texture profile of pan bread supplemented with chitosan at different levels

Sensory quality of pan bread

It is well known that sensory properties is one of the most important factor that affecting consuming any food product. Therefore, sensory properties of tsted pan bread were evaluated and tabluated in Table (9) and fig. (5). Results showed that color quality was affected and decreased significantly in crust and crumb color of pan bread at 1.5 and 2 % chitosan. This result agreed with the obtained redness by using hunter color apparatus. The same trend was noticed also in score of overall acceptability of 1.5 and 2 % chitosan, where they were decreased to 84.60 and 77.70, respectively. Also, results confirmed that acceptability score of aroma, taste, crumb grain texture and shape symmetry of all tested samples were slightly decreased. From the obtained sensory evaluation results it could be predicting higher consumer acceptability for pan bread of 1% chitosan

Fig.5. photo of pan bread produced from SWF with CP

Table 9: Scores for sensory attributes of pan bread samples

Pan bread from	Sensory attributes						
	Crust color (20)	Crumb color (20)	Crumb grain texture (20)	Symmetry of shape (10)	Taste (20)	Aroma (10)	Overall acceptability (100)
Control (SWF 72%)	19.30^{a}±0.10	18.50^{a}±0.22	18.90^{a}±0.12	9.30^{a}±0.05	19.00^{a}±0.22	9.50^{a}±0.11	94.50^{a}±0.62
99.5 %SWF +0.5% CP	19.10^{a}±0.15	18.30^{a}±0.29	18.55^{a}±0.15	9.30^{a}±0.07	19.10^{a}±0.19	9.00^{b}±0.09	93.35^{a}±0.59
99.0 %SWF +1.0% CP	17.50^{b}±0.17	18.10^{a}±0.35	18.30^{a}±0.18	9.20^{a}±0.09	19.30^{a}±0.15	8.80^{b}±0.15	91.20^{b}±0.72
98.5 %SWF +1.5% CP	15.20^{c}±0.21	16.20^{b}±0.40	17.60^{b}±0.22	9.00^{a}±0.13	18.50^{a}±0.12	8.10^{c}±0.18	84.60^{c}±0.69
98.0 %SWF +2.0% CP	13.40^{d}±0.27	14.30^{c}±0.42	16.40^{c}±0.30	9.00^{a}±0.17	17.00^{b}±0.25	7.60^{d}±0.13	77.70^{d}±0.88
LSD at 0.05	1.322	1.658	0.982	0.824	1.025	0.415	2.641

Where: SWF: Strong Wheat Flour; CP: Chitosan Powder

Staling rate of bread

Staling is one of the more problems facing bread freshness. Therefore staling rate was evaluated using alkaline water retention capacity (AWRC) method, and presented in Table (10). This method is depending on the fact that greater AWRC values represent the higher freshness. So, this study aimed to evaluate effect of using chitosan to improve freshness of pan bread during storage at room temperature for three days. Table (10) showed that freshness of pan bread was increased as the percentage of chitosan increased in zero time of storage. The same trend was noticed in pan bread of chitosan at different concentration during storage at room temperature. This result could due to higher moisture content. Similar results were noted by several authors [30-32], where they noticed that using barley flour with wheat flour to prepare Balady bread led to increase its freshness, where its fibre increased and consequently its moisture content increased.

Table 10: Staling of pan bread supplemented with different levels of Chitosan powder

Pan bread from	Zero Time	After 24 hour	After 48 hour	After 72 hour
Control (SWF 72%)	296^e±1.11	268^d±2.15	240^c±3.15	190d±1.60
99.5 %SWF +0.5% CP	310^d±2.15	280^b±3.10	250^b±2.60	205c±1.45
99.0 %SWF +1.0% CP	320^c±2.60	285^a±2.50	260^a±2.20	215a±1.75
98.5 %SWF +1.5% CP	325^b±3.15	280^b±3.50	250^b±1.95	210b±1.35
98.0 %SWF +2.0% CP	332^a±1.65	275^c±2.65	240^c±2. 15	205c±1.80
LSD at 0.05	1.819	3.848	1.819	3.638

Results are presented as means for triplicate analyses ± standard deviation (SD). Means within column and row with different letters are significantly different ($P \leq 0.05$)

Conclusion:

Rheological properties confirmed the suitability of using chitosan at four levels (0.5, 1.0, 1.5, and 2.0% w/w) of addition with wheat flour to prepare pan bread. Chemical content, baking quality, colour quality, sensory properties, texture profile properties and freshness in pan bread were accepted at 1, 1.5% chitosan. Therefore, it could be predicting high consumer acceptability for pan bread at 1% chitosan. From other hand, freshness result of pan bread was increased as the percentage of chitosan increased either in zero time or during storage periods at room temperature.

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