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Keeping Quality of Pan Bread Loaves Produced In Hashemite Kingdom of Jordan as Affected by Adding an Oxidant and/or Improving Agent

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Abstract: Various concentrations of ascorbic acid as an oxidant (20, 40 and 60 ppm) in addition to different concentrations (0.2, 0.3 and 0.5%) of (C-2) that used as improver in bread making in Jordan kingdom were used in this study. Rheolagical properties of doughs, sensory evaluation of resulted bread and staling criteria were followed. Data indicated that addition of 40 ppm of ascorbic acid improved stability and weakening of dough during mixing and caused the highest increase in the water absorption of flour. Dough elasticity increased by 2 folds of its original control value when ascorbic acid was added by 40 or 60 ppm and similar trend was also noticed in the strength of dough. Addition of 40 ppm ascorbic acid was significantly improved the symmetry of loaf shape, crust color and crust appearance, while no significant differences in internal characteristics were recorded in resulted bread. Use of (C-2) in the presence of 40 ppm of ascorbic acid exhibited the best external and internal sensory characteristics and loaf measurements. Generally, increasing storage period at room temperature caused an increase in bread staling criteria.

Key words: Ascorbic acid, improvers, oxidants, pan bread, rheological properties

INTRODUCTION

In developing countries, cereals (especially wheat) form a staple food of the majority of people. They provide about 80% of total calories and more than 66% of protein in the diet (Juneja *et al*., 1980). Bread is the major wheat-based foodstuff because of its least price and expensive. Some chemical additives has been used for making bread doughs and baked goods to improve one or more of bakery product characteristics such as mixing tolerance, bread volume, texture, dough strength and softness. Ascorbic acid is one of these additives which plays a role in improvement bread baking quality. The effect of ascorbic acid depends on whether traditional methods or employed modern intense mixing systems (Larsson, 1993).

WiDong (1995) used a dynamic rheometer to characterize the effect of two isomers of ascorbic acid on the rheological properties of wheat flour bread doughs. He found L-threoascorbic acid rheologically more effective than D-erythroascorbic acid owing to the presence of an active glutathione dehydrogenase in wheat flour that is specific for both glutathione and L-threoascorbic acid. The addition of both lecithin (0.25 g kg^{-1} flour) and shortening together with ascorbic acid (75 mg kg^{-1} flour) and amylase (2 mg kg^{-1} flour) improved the quality of the bread rolls (Ozer and Altan, 1995; Hsi and Cheng, 1996). Increasing ascorbic acid level from 100-200 ppm gave no response from Hartog, Banks and Kite flours, but gave a slightly higher loaf volume and a better crumb texture for the commercial flour (Lorenz *et al*., 1995).

Effects on bread quality using various amounts of L-ascorbic acid and varying the mixer speed and fermentation time were followed by Ertugay *et al.* (1997). The best color intensity of bread was obtained following 15 min. of fermentation, a mixer speed of 1500 rpm and 75 ppm of L-ascorbic acid. Regardless of mixer speed, L-ascorbic acid gave the best results when added at 60 ppm. Gambus *et al.* (1994) used commercial improvers (M-Ako and E-Ka-1000) as well as a mixture of milk powder and ascorbic acid for bread making from triticale flour.

Kashlan *et al.* (1992) noted a significant loss in fat content in all types of bread used in Kuwait prepared from wheat flour. On the other hand, Sawaya *et al.* (1984) found that European bread consumed in Kingdom of Saudi Arabia had a protein content with the percent of eight in addition to a high percent of ash content (1-7%). They also showed that lysine is the first limiting essential amino acid in such type of bread.

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This study is one of trials to follow the changes occurred in rheolgical properties as well as to improve keeping quality (staling rate) of pan bread prepared from American wheat flour in Jordan kingdom using an oxidant and/or improving agent.

MATERIALS AND METHODS

Materials: American wheat (70% hard red winter + 30% soft white winter) flour of 72% extraction that represents the ordinary type commonly used in the commercial production of bread in Jordan Kingdom was used.

L-ascorbic acid (Sigma Ultra A 5960) was used in this study as an oxidant. The bread making improver that commercially named in Jordan kingdom as (C-2) was obtained from Backaldrin arab/Jordan Ltd. Alqastal, product No. 2103. It consists of malt flour, sodium phosphate, soy flour, E472e and amylase enzymes.

Treatments: Three designed treatments (T_0, T_1, T_2 and T_3) were suggested to study the effect of adding 0, 20, 40 and 60 ppm of ascorbic acid, respectively on the rheological properties of resulted doughs.

To investigate the effect of commercial improver (C-2) on pan bread quality: 0, 0.2, 0.3 and 0.5% were added to the wheat flour mixed with 40 ppm of ascorbic acid. The corresponding letters were F_0, F_1, F_2 and F_3.

Pan bread making: The traditional method that applied in Jordan for making pan bread dough was considered using the following ingredients: 1000 g wheat flour, 70 g fresh yeast, 15 g sodium chloride, water, 20 g sugar, 15 g full cream milk powder and 25 g shortening. Such ingredients with suggested additives were placed in a mixing bowl at 28-30°C. The dough was rounded manually by folding for 20 times, rest for 10 min then 120 g of dough were placed in a baking pan (5×9×8 cm). Fermentation process (90 min in a cabinet at 30°C and 85% relative humidity) was carried out and after proofing, pans were baked at 250°C for 20 min and cooled at room temperature for 2 h.

Analytical procedures: The water absorption and mixing characteristics of resulted doughs were followed using Brabender farinograph according to the method described in the AACC (1970). Arrival time, dough development time, dough stability and dough weakening were calculated from the farinogram.

Dough extensibility, dough resistance to extension, proportional number and strength of dough were extensographically determined (AACC, 1970).

Bread loaf volume/cm^3 was measured by rape seeds replacement method (Ertugay *et al.*, 1997). Specific volume of bread loaf was calculated by dividing the volume of loaf on its weight (AACC, 1970).

For determining staling rate, alkaline water retention capacity (AWRC) of dried, grounded and sieved bread was measured by the method of Kitterman and Rubenthalor (1971).

Sensory evaluation: The external, internal and physical properties of pan bread were evaluated by 10 members using the following sheet (Ertugay *et al.*, 1997).

		Samples				
Item	Score	1	2	3	4	5
Crust color	5					
Crust appearance	5					
Break and shred	10					
Crumb color	10					
Crumb texture	10					
Shape	10					
Volume	10					
Aroma	20					
Taste	20					
Total score	100					

Statistical analysis: Data expressed to proper statistical analysis of varience according to Snedecor and Cochran (1969).

RESULTS AND DISCUSSION

Rheological properties of doughs: The farinograms that evaluated rheological characteristics of dough mixing and dough behavior as affected by adding ascorbic acid (as an oxidant) with 0, 20, 40 and 60 ppm were illustrated in Table 1. It was clearly noticed that, addition of ascorbic acid markedly increased the farinograph peak time and stability. The dough stability reached to its maximum time (5.90 min) when 40 ppm ascorbic acid was used compared to that of control sample (4.55 min). There was a slight increase in the water absorption of flour, the highest increase was that recorded in sample treated with 40 ppm of ascorbic acid. The arrival time raised with a half minute when 40 or 60 ppm of ascorbic acid was added. Dough development time did not affect significantly using different concentrations of ascorbic acid. On contrary, a noticeable decremental pattern of dough weakening (125 B.U.) in control sample was clearly seemed as higher as concentration of ascorbic acid was used (20 and 40 ppm). These obtained results go in parallel with Moss *et al.* (1984), they reported that addition of different quantities of ascorbic acid led to improve the quality of the dough.

It could be concluded that, addition of 40 ppm ascorbic acid to wheat flour led to improve stability and weakening of dough during mixing. The increased dough stability caused by adding ascorbic acid is due to, more disulfide bonds found in the dough compared with control. The oxidation of SH groups was mainly due to the

Table 1: Farinograph parameters of wheat doughs containing different levels of ascorbic acid

	Ascorbic acid concentration (ppm)			
Rheological properties	0 (control)	20	40	60
Water absorption (%)	57.0	58.50	59.0	59.0
Arrival time (min:sec)	2:00	2:00	2:30	2:30
Dough development time (min:sec)	4:25	4:30	4:50	4:20
Dough stability (min:sec)	4:55	3:40	5:90	3:55
Dough weakening (B.U.*)	125	100	90	110

*Brabender Unit

Table 2: Extensograph parameters of wheat doughs containing different levels of ascorbic acid

	Ascorbic acid concentration (ppm)			
Rheological properties	0 (control)	20	40	60
Extensibility (mm)...a	130	122	120	115
Extensibility at maximum elasticity (mm)	60	85	90	95
Maximum resistance to extension (B.U.)...b	330	540	650	675
Proportional number (b/a)	2.53	4.42	5.41	5.86
Strength of dough (cm^2)	60	76	90	94

enzymatically prooxidized lipids if oxygen from air directly oxidizes SH groups, or by the formation of lipid free radials by lipoxygenase catalysis that oxidizes SH groups. However, increasing the oxidation of this group to disulphide brings may be responsible for the reduction of gliadin due to its aggregation and transformation to glutenine like molecules which increase during mixing of the dough.

Table 2 shows the baking quality of wheat flour as affected by adding different levels of ascorbic acid. Resistance to extension (elasticity) was increased gradually with increasing the ascorbic level acid, it increased by 2 folds of its original control value when ascorbic acid was added by 40 or 60 ppm. On the other hand, extensibility was slightly decreased with increasing the ascorbic acid level. Proportional number increased by adding ascorbic acid with different levels than that of control. These values changed from 2.53 (control sample) to 4.42, 5.41 and 5.86 using 20, 40 and 60 ppm of ascorbic acid, respectively. Also, strength of dough (energy) increased gradually with increasing of ascorbic acid. Maximum value was noticed when the concentrations of 40 or 60 ppm, were used.

Data showed that addition of 40 ppm of ascorbic acid was the most reasonable treatment. These findings confirmed with those obtained by Ozer and Altan (1995). In conclusion, extensograph properties showed some changes in the extensibility, resistance to extension, proportional number and strength of dough. This modification in dough rheological properties might leads to the improvement in gas retention with dough and may consequently improved the baking properties.

Sensory evaluation of pan bread: When the dough is put in the oven after fermentation, a considerable increase in volume occurs the oven spring. The increase in volume considerable stress on the air/water interacts in the dough. This is the most critical point in the bread making process. The volume increase observed during oven spring is a consequence of the increase in temperature, which induces changes in both the dispersed and continuous phases of the dough. These changes result in the volume expansion and the setting of the crumb. The addition of substances that delay the gelatinization of starch could be expected to improve baking performance. Improvers and emulsifiers are examples of such substances (Larsson, 1993).

Fresh loaf samples baked from wheat flour with different suggested concentrations of ascorbic acid as an oxidizing agent were organolyptically tested by ten members to evaluate both of external and internal characteristics of samples. Scores were statistically analyzed and the LSD was given at 5% level. The mean score (Table 3) indicated that adding of ascorbic acid at 40 ppm produced loaves with external properties similar to that of control one. There was no significant difference between control sample and that treated with 40 ppm of ascorbic acid, i.e. no significant difference was noticed when the color of crust was concerned. On contrary, other suggested treatments were significantly differed with the crust color of control as seen in the Table 3. So, it could be concluded that addition of ascorbic acid at 40 ppm significantly improved the symmetry of loaf shape, crust color and crust appearance with mean score values of 7.46, 3.90 and 3.80, respectively compared with control sample, the mean score values were 6.90, 3.20 and 3.20, respectively.

It could be also noticed the internal characteristics, i.e., crumb color, crumb grain, crumb texture, aroma and taste. Generally, there are no significant differences in these characteristics between samples and control one at 5% level of freedom. Only in case of crumb color and taste, a significant difference was detected in taste of control sample and other treated samples

Regarding to the break and shred that given in the Table 3, it could be easily detect the differences that found between control and other treated samples on the other hand, the given data indicate that adding ascorbic acid at concentration of 20 or 60 ppm produced loaves with total score lower than score of loaves produces by adding ascorbic acid at level of 40 ppm. The corresponding score values were 79.45, 80.98 and 82.76, respectively.

I could be concluded that ascorbic acid is important in improving baking potential of pan bread, the improvement effect of ascorbic acid was due to its

Table 3: Effect of ascorbic acid added to American wheat flour (ppm) on sensory characteristic mean scores resulted pan bread

	Properties									
Concentration of ascorbic acid (ppm)	Shape (10)	Crust color (5)	Crust appearance (5)	Break and shred (10)	Crumb color (10)	Crumb grain (10)	Crumb texture (10)	Aroma (20)	Taste (20)	Total score (100)
0 (Control)	6.90	3.20	3.20	6.80	7.90	7.40	6.90	16.5	16.1	74.90
20	7.23	3.50	3.63	7.60	8.15	7.62	7.90	17.2	16.6	79.45
40	7.46	3.90	3.80	7.90	8.60	7.90	8.40	17.7	17.1	82.76
60	7.27	3.75	3.70	7.66	8.45	7.75	8.20	17.4	16.8	80.98
L.S.D*	0.93	0.77	0.66	0.89	1.054	0.91	0.99	0.95	1.28	

Table 4: Effect of ascorbic acid and (C-2) added to American wheat flour on sensory characteristic scores of pan bread

	Properties									
Treatments*	Shape (10)	Crust color (5)	Crust appearance (5)	Break and shred (10)	Crumb color (10)	Crumb grain (10)	Crumb texture (10)	Aroma (20)	Taste (20)	Total score (100)
Control	6.80	3.50	3.50	7.20	7.30	7.30	6.90	15.9	15.9	74.30
F_1	8.00	4.20	4.00	7.80	7.90	8.00	7.80	16.8	16.9	81.40
F_2	8.20	4.50	4.20	8.00	8.20	8.30	8.00	17.0	17.2	83.60
F_3	8.50	4.70	4.50	8.30	8.60	8.50	8.50	17.4	17.7	86.70
L.S.D**	0.99	0.56	0.70	1.05	0.99	1.17	1.11	1.45	1.31	

** At the level of 5%

strengthening the protein phase in the dough, which enhanced its ability to stretch into thin layer and retained more gas during fermentation and baking (Lorenz *et al.*, 1995; Hsi and Cheng, 1996; Ertugay *et al.*, 1997).

The effect of using (C-2) as an commercial improver at levels of 0, 0.2, 0.3 and 0.5% in the presence of 40 ppm of ascorbic acid (the concentration that recorded the best results) on sensory characteristics of pan bread is the second part of this study. Table 4 indicated that loaves baked using such treatments exhibited the best external and internal sensory characteristics compared to the control sample. The best result was that treated by 40 ppm of ascorbic acid and (C-2) at the level of 0.5% which produced pan bread loaves equal in their properties to that of control one.

Loaves produced using 0.5% of (C-2) with 40 ppm of ascorbic acid recorded the highest total score (86.7), while the corresponding scores of other two used concentrations (0.2 and 0.3 ppm of (C-2)) were 81.4 and 83.6. These results are in agreement with WiDong (1995) and Brummer *et al.* (1996), they reported that interactions between improvers and/or emulsifiers and flour components are multifaceted and improved functionality performance of baked products.

The effect of adding suggested concentrations of oxidant (40 ppm) and improver on measurements of baked loaves was given in Table 5 which indicated the higher weights in T_1 and F_1 treatments (218 g). The second ordered of the loaf weight was recorded in case of T_3 and F_3 treatments (215 g).

The loss in dough weight during baking causes by the evaporation of water from its surface during baking as a result of increasing the temperature. It is also attributed to the diffusion of water vapor from the center of the loaf outward during cooling, which is replaced by air flowing inward. This replacement is possible because of the transportation into a sponge structure.

Table 5: Effect of ascorbic acid and (C-2) added to American wheat flour on measurements of pan bread

Treatments*	Weight (g)	Volume (m^3)	Sp. Vol. (cm^3 g^{-1})
Control	190	640	3.37
T_1	218	580	2.66
T_2	210	555	2.64
T_3	215	650	3.02
F_1	218	595	2.73
F_2	214	645	3.01
F_3	215	625	2.91

It is obviously clear that T_3 and F_2 were the most promising treatments to obtain the maximum loaf volume (650 and 645 cm^3, respectively) with corresponding specific volume of 3.02 or 3.01 cm^3 g^{-1}, respectively as compared to 640 cm^3 and 3.37 cm^3 g^{-1}, the obtained values of control loaf.

The increase in loaf volume was explained by the expansion of dough in the oven which caused by continuing the yeast to produce carbon dioxide during fermentation and during the early stages in the oven. The thermal expansion of gases in the cells caused oven rise and increased loaf volume.

The enhancement effect of ascorbic acid and (C-2) in improving loaf measurements compared to the treatments without these agents may be attributed to influence these agents on the physical changes related to the included gas, which caused the increase in loaf volume. This improved may be because of these agents delayed starch gelatinization and prolonged the duration of oven spring and consequently, improved loaves measurements. In addition, their action may also due to their strengthening

Table 6: Effect of mixing American wheat flour with oxidant and improver on pan bread freshness (%) during storage at room temperature (20-25°C)

	Storage period (hours)			
Treatments*	0	24	48	72
Control	100	91.25	68.60	34.30
T_1	100	83.50	54.75	41.20
T_2	100	90.84	61.79	43.65
T_3	100	90.88	61.85	42.81
F_1	100	91.13	68.32	47.16
F_2	100	91.80	69.10	49.30
F_3	100	91.90	70.05	49.25

the memoranes between gas cells by lowering the resistance to expanding gas, so, they delayed capture and loss of gas (Lorenz *et al.*, 1995; Hsi and Cheng, 1996; Ertugay *et al.*, 1997).

Staling of pan bread: When the bread loaf is removed from the oven, a series of changes starts that eventually leads to deterioration of the quality. These changes are collectively termed staling and include all the processes that occur during storage except microbial spoilage. The consumer detects the staling by the change in taste as well as in texture. The aroma of fresh bread is lost and a stale flavor develops with time. These are the retrogradation (recrystalization) of starch and redistribution of water between starch and gluten (Krog *et al.*, 1989).

From data mentioned in Table 6, it was found that freshness values decreased gradually during storage of bread at room temperature in all treatments. Concerning the effect of oxidizing agent on freshness values, it was found that the lowest value were obtained in (T_1) treatment compared to control sample or other treatments after 24 h of storage. On the other hand, the addition of ascorbic acid increased the freshness of bread to be similar to that of control value (91%). At 48 h of storage, freshness was reduced to be about 62-55% for the samples treated only with ascorbic acid. After 72 h of storage, a sharp decrease was noticed in the freshness values but still greater than that of control one showing an improving effect.

Concerning the effect of (C-2) plus ascorbic acid (40 ppm) on freshness of bread during storage at room temperature, the same Table 6 showed that increasing storage period caused increasing of bread staling.

On other hand, the rate of staling in bread in all treatments had the same behavior till 48 h of storage period at room temperature. The obtained results are in conformity with those reported by Mettler and Seibel (1992), Farvili *et al.* (1995) and Brummer *et al.* (1996).

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