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Quality Improvement and Shelf Life Extension of Bread

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ABSTRACT

Breads prepared from wheat flour by adding different additives were evaluated during 10 days of storage at interval of alternate days. Wheat flour was also chemically analyzed and results depicted 12.1% moisture, 11.8% crude protein, 0.52% ash and 1.3% crude fat. For study of shelf life breads were analyzed for moisture and yeast and mould count. The results for moisture analysis showed that it was in range of 16.75 – 37.13% and T_6 having 0.32% suhanjna, 3% lecithin and 0.1% ascorbic acid retained maximum moisture at the end of storage. The studies on colony count in breads at different storage intervals showed that treatment containing 0.32% suhanjna, 3% lecithin and 0.1% ascorbic acid proved to be most effective against control of count. Most mould isolated belonged to the genera *Aspergillus, Pencillium* and *Actinomycetes.*

Key Words: Quality; Shelf life; Bread

INTRODUCTION

The research on improvement in quality and shelf life of bread has always been an area of interest. Some stabilizers have extended the shelf life of bakery bread by two days, retain the sensory properties (Staszewska & Janik, 1977) and improve water retention capacity, modify texture, volume and cell structure of the products (Brummer, 1977). The shelf life of breads produced now days have a very short shelf life of about three days. Keeping in view the current status of bread industry the present study was designed to compare the effect of different food additives on the quality of bread and to access the suitability among the tested additives to extend the shelf life of bread.

MATERIALS AND METHODS

All the research work was carried out in Department of Food Technology, University of Arid Agriculture, Rawalpindi.

Collection of raw materials. All the raw material was purchased from the local market of Rawalpindi. It included wheat flour, yeast, sugar, salt, shortening, stabilizers, and preservatives. The chemical composition of wheat flour with respect to protein, fat, ash and moisture was estimated according to AACC (1983) methods.

Preparation of bread. Bread was prepared according to the methods as described in AACC (1983). Different preservatives, stabilizers and their combinations were used to extend the shelf life of the bread. The treatments are elaborated in Table I.

Chemical analysis. Breads were analyzed for moisture content, crude protein percentage, crude fat percentage and ash according to AACC (1983) methods.

Microbial analysis and bread quality evaluation. The mould growth on crust and crumb of breads were examined visually and counted by modified method of Fox (1993).

Sensory evaluation. A panel of five judges carried out sensory evaluation. A nine point hedonic scale was used for sensory evaluation as described by Larmond (1977).

Statistical analysis. Data obtained for given parameters were statistically analyzed using the Analysis of Variance (ANOVA) technique and the Least Significance Difference (LSD) to compare the means according to Steel and Torrie (1980).

RESULT AND DISCUSSION

The results regarding different chemical and sensory characteristics of flour and bread prepared by using different additives at different levels have been described under the following section.

Chemical analysis of wheat flour and bread. The mean values for wheat flour and breads analyzed for moisture, crude protein, ash and crude fat are given in Table II. The results of wheat flour analysis negate the findings of Qamar (1994) who used the flour of particular variety i.e. Inqlab in his research. The breads were also chemically analyzed for moisture, fat, protein and ash contents. The results revealed that moisture, crude protein, crude fat and ash of breads ranged from 36.57- 40.41, 6.12 – 8.84, 2.47 – 2.94 and 1.02 -1.85, respectively. The best treatment was T_6 that had 40.41, 8.84, 1.85, 2.94% moisture, crude protein, ash and crude fat, respectively because of the best combination of additives used for this treatment. These results of chemical composition of bread are in line with those of Rehman and Mudassar (2003) who studied the effect of CMC and Carrageenan gum on shelf life of bread.

Moisture percentage. There was a continuous decrease in moisture content with the passage of time (Table III). Moisture content of the control treatment T_0 was measured up to 4^{th} day of storage at ambient temperature later on it was spoiled. Maximum moisture content was obtained when Suhanjna (0.32%) was used with the combination of lecithin

(3%) and ascorbic acid (0.12%) in T_6.

Storage intervals also effect the treatments (Table III). Maximum value was obtained at zero day of storage while minimum value was observed in 10th day of storage and there was a significant difference among all storage intervals. These results are in accordance with findings of Rehman and Mudassar (2003) who had reported that with the use of additives CMC (1%) and Carrageenan gum (0.1%), the moisture content of bread ranges from 31.14 - 35.83%.

Yeast and mould count. The results for mould colonies during storage at ambient temperature have shown that there is a large variation among different treatments (Table IV). Yeast and Mould Count increases with the passage of time mould colonies appeared on treatments T_4, T_5, T_6 and T_7 at 4th day storage of storage. The highest Yeast and Mould Count was found in T_0 followed by T_2 and T_1, while T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) superceded all other treatments with least Yeast and Mould Count 10th day of storage. Also the results are in line with findings of Masood *et al.* (2001) who observed the maximum number of colonies 2 x 10^2cfu/gm with the use of additives like Calcium propionate (0.15%), Lactic acid (0.10%) and Acetic acid (0.10%).

Sensory Evaluation of Bread

Volume of bread. The comparison of arithmetic means for volume of breads depicts that there was a positive effect of additives (Suhanjna, CMC, Calcium Propionate, Lecithin, Bran and Ascorbic acid) on volume (Table V). Minimum value (2.900) was found in T_0 while maximum (6.933) in T_6 followed by T_7 (6.833), T_4 (6.767) and T_5 (6.733). It is clear from table that there is non significant difference among T_6, T_7, T_4 and T_5 but these differ significantly from others. Storage also effects the treatments as D_1 (zero day) and D_2 (2nd day) show best score than D_6 (10th days) that was least (Table V). The storage means decreased with the increase of storage period. Maximum values were observed at zero and 2nd day of storage. These results are in agreement with those of Pyler (1988) who had studied the effect of ascorbic acid, amylase, lecithin sugar and skimmed milk.

Colour of crust. Comparison of the means of the different treatments showed that the maximum value for colour of crust is obtained in T_6 (6.750) followed by T_7 and T_4 while minimum value was observed in T_0 (control) (Table VI). Table further revealed that T_6 significantly differs from other treatments but there is non significant difference among T_4, T_5 and T_2, T_1. Storage intervals also effect the treatments as D_1 (zero day) show highest result and D_6 (10th day) remained least (Table VI). The values for the colour of crust of control and treated samples revealed that the values of all treatments decreased significantly at 4th and 6th day of storage as compare to T_6 that's value decreased slowly till the end of the storage. The previous studies carried out by Pyler (1988) and Latif (1996) showed that malt supplementation in wheat flour improved crust colour so the improvements in crust colour in present study is in

Table I. Elaboration of Treatments

Treatment	CMC	Calcium Propionate	Bran	Suhanjna	Lecithin	Ascorbic Acid
T_0	_	_	_	_	_	_
T_1	0.5%	0.15%	_	_	_	_
T_2	_	0.15%	3%	_	_	_
T_3	0.15%	_	_	0.32%	_	_
T_4	_	0.15%	_	0.32%	3%	0.1%
T_5	0.5%	_	_	0.32%	3%	0.1%
T_6	_	_	_	0.32%	3%	0.1%
T_7	0.5%	0.15%	_	0.32%	3%	0.1%

Table II. Proximate analysis of flour and breads having different levels of additives

Characteristics (Percentage)	Flour	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Moisture	12.1	36.57	38.25	37.54	41.17	39.81	38.45	40.41	39.54
Crude protein	11.8	6.12	6.12	7.41	8.22	8.41	8.05	8.84	8.63
Ash	0.52	1.02	1.26	1.37	1.19	1.13	1.54	1.85	1.76
Crude fat	1.3	2.47	2.76	2.58	2.41	2.07	2.61	2.94	2.33

* All values are the mean of three replications.

Table III. DMR test for treatments and storage intervals in case of Moisture Content

Treatments	Means	Storage Intervals	Means
T_0	16.75e	zero day	38.97a
T_1	23.39d	2nd day	37.47b
T_2	22.54d	4th day	34.45c
T_3	28.97c	6th day	28.96d
T_4	34.58b	8th day	20.30e
T_5	35.38b	10th day	15.65f
T_6	37.13a		
T_7	35.67b		

Table IV. Effect of additives on the yeast and mould count of bread

Treatment	Storage time (days)					
	0	2nd	4th	6th	8th	10th
T_0	90	1.27 x 10^2	5.37 x 10^2	0	0	0
T_1	87	92	2.57 x 10^2	3.15 x 10^2	0	0
T_2	94	1.14 x 10^2	2.71 x 10^2	3.32 x 10^2	0	0
T_3	0	1.08 x 10^2	2.49 x 10^2	3.05 x 10^2	3.50 x 10^2	0
T_4	0	0	54	1.09 x 10^2	1.78 x 10^2	2.27 x10^2
T_5	0	0	48	97	1.72 x 10^2	2.05 x 10^2
T_6	0	0	24	83	1.48 x 10^2	2.03 x 10^2
T_7	0	0	37	93	1.67 x 10^2	2.24 x 10^2

***** All values are the mean of three replications.

Table V. DMR test for treatments and storage intervals in case of Volume

Treatments	Means	Storage Intervals	Means
T_0	2.9d	zero day	7.287a
T_1	4.3c	2nd day	7.200a
T_2	4.467c	4th day	6.650b
T_3	5.433b	6th day	5.438c
T_4	6.767a	8th day	3.787d
T_5	6.733a	10th day	2.950e
T_6	6.933a		
T_7	6.833a		

Table VI. DMR test for treatments and storage intervals in case of Colour of Crust

Treatments	Means	Storage Intervals	Means
T_0	2.483f	zero day	6.113a
T_1	3.183e	2nd day	5.963b
T_2	3.267e	4th day	5.613c
T_3	4.7d	6th day	4.787d
T_4	5.817c	8th day	3.475e
T_5	5.750c	10th day	2.787f
T_6	6.750a		
T_7	6.367b		

conformity with previous ones.

Evenness of bake. Table VII revealed that T_6, T_7, T_5 and T_4 are statistically similar but maximum values were observed in T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) followed by T_5, T_7, and T_4, while all these are significantly different from others and minimum values were observed in control and T_1. There was also a significant effect of storage on the treatments and in this regard D_1 (zero day) and D_2 (2^{nd} day) show maximum score. While minimum value of storage intervals mean was observed in D_6. These results are comparable with findings of Rehman and Mudassar (2003) who studied the effect of CMC (1%) and Carrageenan gum (0.1%) on shelf life and evenness of bake of bread.

Symmetry of form. Maximum value was observed in T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) followed by T_5, T_4, and T_7 and T_6 got top position (Table VIII). The minimum value was observed in the control. There was a non significant difference among T_4 and T_7 but were significantly different from others. Moreover all other treatments showed a significant difference. The best score in case of storage intervals effect was found in D_1 (zero day) and D_2 (2^{nd} day) (Table VIII) and this score decreases with the increase in storage period. Similar results were reported by Taboada and Santiesteban (2000) who stated that bread having 1 percent CMC gave better symmetry of form.

Character of crust. The comparison of mean values indicates that highest value was obtained by T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) then comes T_7, T_4, T_5, T_3 and T_2 (Table IX). All values fell statistically in different groups except T_4 and T_5 yet T_6 is better than all. Storage intervals also effect the treatments and Table revealed that intervals D_1 (zero day), D_2 (2^{nd} day) and D_3 (4^{th} day) had highest score with respect to the storage interval (Table IX). Minimum value was obtained in D_6 (10th day) that was the end of storage.

These results are comparable with the findings of Rao (1985) who reported that guar gum can improve the character of crust.

Break and shred. Table X represents the means with respect to treatments and storage intervals. This revealed that the results of all treatments are significantly different among each other except T_6, T_7 and T_5. Means of these treatments were non significant with each other and were better as compared to other treatments. Maximum value (2.933) was in T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid), while minimum in control.

Time interval of storage also affected the break and shred. It was excellent at D_1 (zero day) and D_2 (2^{nd} day) while later on it reduced gradually during storage A gradual decrease was observed in all treatments throughout the storage period of 10 days at ambient temperature. These results are comparable with findings of Pyler (1988) who narrated the effect of preservatives and malt supplementation on bread break and shred of bread.

Grain of bread. The arithmetic means are in range of 3.333 to 7.750 (Table XI). The comparison of means indicated the highest scores were given to T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) while control T_0 showed a minimum value. The difference between T_6, T_7 and T_5 is non significant while these differs from other treatments significantly. The score for bread grain decreased with the storage period. The deterioration rate was lower among D_1 (zero day), D_2 (2^{nd} day) and D_3 (4^{th} day) but greater in D_6 (10^{th} day). These results are in line with the findings of Ozer and Altan (1995) who reported that ascorbic acid, potassium

Table VII. DMR test for treatments and storage intervals in case of Evenness of Bake

Treatments	Means	Storage Intervals	Means
T_0	0.750e	zero day	2.100a
T_1	0.933d	2^{nd} day	2.100a
T_2	1.283c	4^{th} day	1.862b
T_3	1.567b	6^{th} day	1.637c
T_4	2.133a	8^{th} day	1.188d
T_5	2.136a	10^{th} day	0.977e
T_6	2.133a		
T_7	2.217a		

Table VIII. DMR test for treatments and storage intervals in case of Symmetry of Form

Treatments	Means	Storage Intervals	Means
T_0	0.850g	zero day	2.350a
T_1	1.083f	2^{nd} day	2.350a
T_2	1.433e	4^{th} day	2.162b
T_3	1.817d	6^{th} day	1.913c
T_4	2.267c	8^{th} day	1.350d
T_5	2.467b	10^{th} day	1.063e
T_6	2.733a		
T_7	2.267c		

Table IX. DMR test for treatments and storage intervals in case of Character of Crust

Treatments	Means	Storage Intervals	Means
T_0	0.750g	zero day	2.137a
T_1	1.167f	2^{nd} day	2.141a
T_2	1.310e	4^{th} day	2.112a
T_3	1.619d	6^{th} day	1.862b
T_4	2.200c	8^{th} day	1.311c
T_5	2.150c	10^{th} day	1.100d
T_6	2.683a		
T_7	2.367b		

Table X. DMR test for treatments and storage intervals in case of Break and Shred

Treatments	Means	Storage Intervals	Means
T_0	1.250e	zero day	2.844a
T_1	1.717d	2^{nd} day	2.819a
T_2	1.750d	4^{th} day	2.715b
T_3	2.208c	6^{th} day	2.313c
T_4	2.683c	8^{th} day	1.675d
T_5	2.861a	10^{th} day	1.362e
T_6	2.933a		
T_7	2.900a		

Table XI. DMR test for treatments and storage intervals in case of Grain of Bread

Treatments	Means	Storage Intervals	Means
T_0	3.333e	zero day	7.625a
T_1	4.500d	2^{nd} day	7.406ab
T_2	4.750d	4^{th} day	7.250b
T_3	6.000c	6^{th} day	6.344c
T_4	7.417b	8^{th} day	4.563d
T_5	7.667b	10^{th} day	3.688e
T_6	7.750b		
T_7	7.750a		

bromate, alpha amylase enzyme and lecithin have remarkable improving effect on grain of bread.

Colour of crumb. Table XII depicts the both treatment and storage means. This explains that T_6 (0.32 percent Suhanjna, 3 percent lecithin, 0.1 percent ascorbic acid) got maximum score of 8.833 followed by T_5 and T_7 and minimum was observed in control. Although time intervals were significant but D_1 (zero day) and D_2 (2^{nd} day) showed some better results as compared to D_3 (4^{th} day) and D_4 (6^{th} day) while D_5 (8^{th} day) and D_6 (10^{th} day) remained at least. The decrease of score in T_1 is sharp at 4^{th} day of storage, while all other treatments exhibit a gradual trend of decrease. The results of present study are in line with the findings of Goncharov and Sokolov (1977) who reported the improvement in crumb colour by the use of Amylolytic lactic acid bacteria.

Taste. Both treatment and storage interval means is given in Tables XIII. This order shows that T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) having mean score of 12.67 got top position. Table further revealed that T_6, T_7, T_4 and T_5 are non significant to each other while these differ significantly from other treatments. Time intervals also affect the storage of bread. The taste score was maximum at D_1 (zero day) and lowest at D_6 (10^{th} day). These results are supported by Tarar (1999) who noted the improvement in bread taste by using acidulants and their salts.

Mastication. Treatments T_6 and T_5 have highest score yet T_6 retained maximum score till 10^{th} days storage (Table XIV). The treatment and storage interval means (Table XIV) shows that T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) got maximum score of 9.333 for mastication followed by T_5 and T_7 while least score was observed in control (T_0).

It further revealed that T_6 and T_5 fell statistically in same group but these differ from others. The mastication of bread was significantly better upto D_3 (4^{th} day) after that deterioration rate was very fast. The mastication score of all treatments decreases with the increasing storage period except T_6 which value decreased only at 8^{th} day of storage. The results are in close agreement with those reported by Latif (1996) who investigated that addition of malt improves the chewiness and mastication of breads.

Texture. The means are arranged in descending order in Table XV (treatment means and storage interval mean). Comparison of the means of the different treatments showed that the maximum value for texture is obtained in T_6 followed by T_5 and T_7 while minimum value was observed in T_0 (control). Tables further revealed that T_6 significantly differs from other treatments but there is non significant difference among T_6, T_5, T_7, and T_4. The top score was found in T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) that has value of 14.17. Storage intervals also effect the treatments as D_1 (zero day) show highest result and D_6 (10^{th} day) remained least.

The previous studies carried out by Milatovic and Martinek (1971), Kventnyi *et al.* (1974) and Ferrara (1988) reported similar results when calcium propionate, ascorbic acid and calcium acetate were used as preservative.

Aroma. The Table XVI shows that the aroma of treatment T_6 (0.32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) remained good and acceptable upto 10^{th} day of storage at ambient temperature. It is evident from table that T_6 (32% Suhanjna, 3% lecithin, 0.1% ascorbic acid) having mean score of 8.833 got top position. Table further revealed that T_7 and T_5 are non significant to each other while these differ significantly from other treatments, rest of the treatments

Table XII. DMR test for treatments and storage intervals in case of Colour of Crumb

Treatments	Means	Storage Intervals	Means
T_0	3.000d	zero day	8.063a
T_1	4.667	2^{nd} day	7.875a
T_2	4.583c	4^{th} day	7.625b
T_3	6.000b	6^{th} day	6.750c
T_4	8.583a	8^{th} day	5.125d
T_5	8.667a	10^{th} day	4.250e
T_6	8.750a		
T_7	8.667a		

Table XIII. DMR test for treatments and storage intervals in case of Taste

Treatments	Means	Storage Intervals	Means
T_0	5.000d	zero day	11.73a
T_1	6.667c	2^{nd} day	11.75a
T_2	7.333c	4^{th} day	11.50a
T_3	9.333b	6^{th} day	9.938b
T_4	12.00a	8^{th} day	7.250c
T_5	12.25a	10^{th} day	6.000d
T_6	12.31a		
T_7	12.67a		

Table XIV. DMR test for treatments and storage intervals in case of Mastication

Treatments	Means	Storage Intervals	Means
T_0	3.917f	zero day	8.813a
T_1	5.333e	2^{nd} day	8.688a
T_2	5.583e	4^{th} day	8.500a
T_3	7.000d	6^{th} day	7.438b
T_4	8.583c	8^{th} day	5.513c
T_5	9.000ab	10^{th} day	4.354d
T_6	9.333a		
T_7	8.722bc		

Table XV. DMR test for treatments and storage intervals in case of Texture

Treatments	Means	Storage Intervals	Means
T_0	6.167d	zero day	13.60a
T_1	8.500c	2^{nd} day	13.50a
T_2	8.333c	4^{th} day	13.13a
T_3	10.83b	6^{th} day	11.63b
T_4	13.67a	8^{th} day	8.500c
T_5	14.00a	10^{th} day	6.875d
T_6	14.17a		
T_7	13.97a		

Table XVI. DMR test for treatments and storage intervals in case of Aroma

Treatments	Means	Storage Intervals	Means
T_0	3.417g	zero day	8.000a
T_1	4.917e	2^{nd} day	7.938a
T_2	4.500f	4^{th} day	7.667b
T_3	6.333d	6^{th} day	6.875c
T_4	7.833c	8^{th} day	5.063d
T_5	8.556b	10^{th} day	4.125e
T_6	8.833a		
T_7	8.500b		

exhibit significant difference. Time intervals also affect the storage of bread. The taste score was maximum at D_1 (zero day) and D_2 (2^{nd} day) and minimum at D_6 10^{th} day). These results are in line with the results of Latif (1996) Wilfred (1960) who observed the improvements in taste and aroma of bread by the use of malt. Similar results were found by Masood *et al.* (2001) who reported to had good aroma by the use of additives like Calcium propionate (0.15%), Lactic acid (0.10%) and Acetic acid (0.10%).

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