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SENSORY CHARACTERISTICS OF BREAD PREPARED FROM LACTIC ACID OBTAINED FROM CORN COBS, AN AGRICULTURAL WASTE

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The lactic acid is an organic acid occurring widely in nature. It is a weak acid, which can be broken down easily in water and other solvents. It has long been used by the food industry as an additive for preservation, flavor and acidity. It has pleasant sour taste with little odor, and used for different food applications such as in syrups, jams, jellies and soft drinks. Lactic acid has been considered to be the safe for health because it does not give any residual undesirable element in food. In the present study, the lactic acid obtained from corn cobs (Food waste material) was utilized in different doses and it was found that the sensory characteristics of the bread was not affected. The storage time (0,24,48,72 and 96 hours) and different treatments of lactic acid (0%,0.1%,0.3%, 0.4%) significantly affected the external characters like volume, color of crust, symmetry of form, evenness of bake and character of crust of bread, while their interaction was found to be non-significant for these characteristics. The internal characters like grain, color of crumb, aroma, taste and texture were affected significantly by storage time and some of these characters were significantly affected by the doses of lactic acid. The interaction of both of these parameters was found to be non-significant for the sensory characteristics of bread.
Key words: Corn cobs, lactic acid, bread, sensory characteristics, storage

INTRODUCTION

In food industry the use of lactic acid and lactates is rapidly growing in confectionery, fruits, juices, essences, lemonades, syrups, pickles and also in curing meat. The lactic acid and salts of lactic acid (e.g. Ca, Cu, Fe and Na salts) also used in canned vegetables and fish products animal food remedies, beer, candy, cheese, dried egg white, flavoring extracts, jelly liquid, pectin, olives, soft drinks, soups and sherbets. Calcium lactate is used as a source of calcium in pharmaceutical preparations and is also becoming increasingly important as a food supplement for farm animals and poultry (Anonymous 1952).

The effects of pre-fermentation temperature and time, the type of flour and the combination of lactic and propionic acid bacteria on acid formation and wheat bread properties has been investigated. Furthermore, the function of yeast in dough, as measured by leavening capacity, have also been studied. The acids formed during pre-fermentation typically decreases yeast-leavening capacity, especially in the early stages of leavening. The baking procedure with the pre-ferment results in a slightly sour wheat bread, with a pH of about 5·4 to 6·0, a titratable acidity value of about 3·9 to 5·6 and an acceptable lactic to acetic acid ratio for sour bread baking. Bread mould-free time increases up to 10 days (Javanainen and Linko1993).

Traditional bread (khamir) from sorghum flour has been made from two local varieties, Bayadh and Hamra by mixing the sorghum flour with water and spices (onion, garlic, lemon juice and fenugreek) in a 1:0.8 (w/w) ratio and fermented for 24 h at 30 degrees C. Two other fermentations have been carried out using an inoculum from the previous fermentation. The micro-organisms isolated from different plates using different characterization systems. Both total bacterial populations and lactic acid bacteria increased with fermentation time and reached the highest number at 16 h (first fermentation) and at 8 h (second and third fermentation). The content of lactic acid increases with time to reach 1.2 %, but the increase is higher for the second and third fermentations (1.6 % each). The pH drops with time from 6.77 to 4.35 in the first fermentation and from 6.65 to 4.18, and 6.57-3.93, in the second and third fermentations, respectively (Gassem 1999).

Studies on the effect of different ingredients (sodium chloride, skim milk powder (SMP), fat, lactic acid and sugar) on mixograph and bread making properties of flour using a central composite design have been carried out. Mixograph properties such as mixing time, peak height and mixing tolerance and bread making properties such as volume and firmness were measured. Sodium chloride and lactic acid has the most prominent effect on mixing time and peak height, respectively. Mixing time increased with the

increase in the sodium chloride level but peak height decreased with the increase in lactic acid level. Lactic acid and SMP exhibits a negative effect on bread volume and firmness whereas sugar improves these parameters (Singh *et al.* 2002).
The lactic acid and its salts have improved the sensory characteristics of bread and its storage life as well. The present research has been planned, keeping in view the following objectives:

1. To compare the suitability of lactic acid from different corn cob varieties in bread
2. To evaluate the sensory parameters of bread containing lactic acid
3. To determine the shelf life of bread with lactic acid as preservative

MATERIALS AND METHODS

Production of lactic acid

Lactic acid was produced from two different varieties of corn cobs (Red and White) through the fermentation process. The fermentation medium was inoculated with *Lactobacillus delbruekii* strain and lactic acid contents were identified with HPLC methodology by the procedure given by Bevilacqua and Califano (1989).

Bread preparation

The bread baking was carried out by straight dough method 10-10B of AACC (2000), according to the following formula given in Table 1.

Table 1. Formulation of bread

Ingredient	Grams (g)
Flour	100
Yeast	001
Salt	001
Sugar	003
Shortening	005
Lactic acid	0.1, 0.2, 0.3, 0.4
Water	According to water absorption

The ingredients were mixed for 5 minutes in a Hobart A-200 Mixer to form dough and allowed to ferment at 86 °F (30 °C) and 75% RH. for 180 minutes. First and second punch was carried out after 120 and 150 minutes, respectively. The dough was moulded and panned into 100 g (pup loaf) test pans, and final proofing was done for 45 minutes at 95 °F (35 °C) with 85 % R.H. The bread was baked at 450 °F (232 °C) for 25 minutes.

Sensory evaluation

The sensory scores for external characteristics (volume, crust color, symmetry, evenness of bake,) and internal characteristics (grain, crumb color, aroma, taste, chewability and texture) were recorded for each loaf of bread by a panel of trained judges according to the bread score method developed by the American Institute of Baking, Land and Shaphard (1988).

Statistical analysis

The data obtained for each parameter was subjected to statistical analysis to determine the level of significance and Completely Randomized Design (CRD) was applied and Duncans New Multiple Range test was used to compare the difference among different means by following the methods described by Steel *et al.*. (1997).

RESULTS AND DISCUSSION

Lactic acid production

Corn cobs were investigated as nutrient resources after hydrolyzing them with sulphuric acid for microbial lactic acid production. The corn cob red was found to be suitable for the maximum sugar recovery (39.33%) under hydrolytic conditions of 15% acid concentration at 90^0 C for a period of 120 minutes. The optimum pH for simultaneous saccharafication and selective bioconversion of cellulose to lactic acid by *L. delbruekii* was 6. As for as best fermentation time is concerned 8 days of fermentation resulted in maximum lactic acid recovery. The effect of temperature on lactic acid production was non significant. Overall lactic acid productivity obtained from corn cobs was 56.84% on dry weight basis.

Production of bread

The bread samples were prepared from wheat flour containing different doses of lactic acid and were evaluated for their external as well as internal sensory attributes. The results for different sensory attributes of bread are discussed below.

External Characteristics of Bread

a. Volume

The results in Table 2 indicated that the scores for loaf volume of bread decreased as a function of storage upto 96 hours. The fresh breads got the highest scores followed by the bread evaluated at 24 hours and 48 hours of storage intervals. The breads containing 0.1% lactic acid and control (0% lactic acid) got the highest scores for loaf volume. It is obvious that the breads containing lactic acid were assigned lower scores for loaf volume. These results are in line with the findings of Tarar (1999) who reported slight decrease in loaf volume as the acid proportion was increased in dough. Findings in this study are also in agreement to the findings of Latif *et al.* (2005) who found that zero and second day of storage got the best scores than subsequent storage period as the volume scores decreased during storage.

Table 2. Mean scores of effect of treatment on volume of bread at different storage intervals

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	8.5	8.0	8.2	7.9	7.3	7.98ab
T_1	8.7	8.5	8.4	8.2	8.1	8.38a
T_2	7.8	8.0	7.5	7.2	7.0	7.50b
T_3	8.0	8.0	7.2	7.2	7.1	7.50b
T_4	8.0	8.0	7.2	7.5	7.3	7.60b
Mean	8.20a	8.10ab	7.70abc	7.60bc	7.36c	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

b. Color of crust

Table 3 indicates crust color of breads that was improved by the addition of lactic acid upto 0.2% but a decline in the crust color of bread was observed with further increase in the dose of lactic acid. The fresh bread at 0 hours got significantly the highest scores for crust color followed by the breads evaluated after 24 hours, 48 hours and 72 hours of storage intervals. The effect of storage period was found to be highly significant with respect to control (0% lactic acid). The crust color of bread was affected by storage time. The color of crust of breads was declined as the storage time increased. This trend in color changing may be related to the study of Qamar (1994) and also supported by Tarar (1999) who concluded that acidulants affected the color of the bread significantly. The previous studies carried out by Pyler (1988) and Latif (1996) showed that mainly supplementation in wheat flour improved the crust color; the similar

factor could be related to the present work. The results may also be related to the findings of Latif *et al.* (2005) who found that food additives improved the color of crust of breads and during storage with the passage of time it decreased till the end of the storage.

c. Symmetry of Forms

Table 3. Mean scores of effect of treatment on color of crust of bread at different storage intervals

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	7.0	6.8	6.7	6.2	6.2	6.58bc
T_1	6.8	6.5	6.2	6.2	6.0	6.34c
T_2	7.5	7.3	7.3	7.2	6.7	7.20a
T_3	6.9	6.7	7.0	7.0	6.9	6.90ab
T_4	7.0	6.8	6.9	6.7	6.2	6.72bc
Mean	7.04a	6.82ab	6.82ab	6.66ab	6.40b	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

The factor, symmetry of forms of breads (Table 4) exhibited decline trend with the passage of time. The breads evaluated at 0 hour got significantly the highest scores followed by the breads evaluated after 24 hours and 48 hours of storage time. The variation in lactic acid doses showed significant effect on scores assigned to symmetry of forms of bread. Symmetry of forms of breads containing 0.1% lactic acid got significantly the highest scores. The breads evaluated after 96 hours of storage ranked at the bottom followed by the breads tested after 72 hours of storage.

Table 4. Mean scores of effect of lactic acid doses on symmetry of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	4.0	3.8	3.5	3.3	3.2	3.56b
T_1	4.2	4.1	4.0	3.8	3.5	3.92a
T_2	4.0	3.8	3.6	3.6	3.0	3.60b
T_3	4.3	4.1	3.7	3.5	3.0	3.72b
T_4	4.2	4.1	3.7	3.5	3.0	3.70b
Mean	4.14a	3.98b	3.70b	3.54b	3.14c	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

These findings are in line with those of conclusions given by Tarar (1999) who reported that a combination of lactic acid (0.3%) with calcium propionate (0.2%) was proved to be the best for the symmetry of form of the breads.

d. Evenness of bake

The results (Table 5) revealed that the scores assigned by the judges to evenness of bake of breads declined to a significant level as a function of storage time. The mean values for 0 and 24 hours; 48 and 72 hours were statistically same for their effectiveness. Storage of 96 hours resulted as lower scoring

Table 5. Mean scores of effect of lactic acid doses on evenness of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	3.0a	2.2c	2.1c	2.3bc	2.1c	2.34a
T_1	2.1c	2.5b	2.2c	2.3bc	2.2c	2.26ab
T_2	2.2c	2.2c	2.2c	2.3bc	2.2c	2.22b
T_3	2.1c	2.2c	2.2c	2.2c	2.1c	2.16b
T_4	2.2c	2.2c	2.2c	2.1c	2.1c	2.16b

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

time. The breads containing 0.4 and 0.3% lactic acid got significantly the lowest scores but with non significant difference between each other for evenness of bake. The results obtained for evenness of bake of breads are in close agreement to conclusions drawn by Tarar (1999) who conducted research on shelf life of bread using acidulants and their salts. He concluded that acidulants affected the evenness of bake of the bread significantly. The results are comparable with the findings of Rehman and Mudassar (2003) who studied the effect of CMC (1%) on the shelf life and evenness of bake of bread and found decrease in scores with increase in storage time.

e. Character of crust

Table 6. Mean scores of effect of lactic acid on characteristics of crust of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	3.5	3.4	3.4	3.0	3.0	3.26ab
T_1	3.8	3.7	3.4	3.2	2.9	3.40a
T_2	3.7	3.5	3.5	3.2	3.0	3.38a
T_3	3.7	3.4	3.2	3.2	3.0	3.30ab
T_4	3.5	3.2	3.0	3.0	2.8	3.10b
Mean	3.64a	3.44b	3.30bc	3.12cd	2.94d	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

The scores assigned to character of crust of breads decreased significantly with increase in storage time (Table 6). The breads evaluated at 0 hours were assigned significantly the highest scores followed by the breads evaluated at 24 hours and 48 hours of storage intervals. The results also showed that the character of crust of breads containing 0.1% lactic acid and 0.2% lactic acid got significantly higher scores than breads containing 0.3% and 0.4% lactic acid. The lowest scores were assigned to character of crust of breads tested after 72 and 96 hours of storage. The results of this study are in agreement to the results of Tarar (1999) who concluded that with the increase in storage period, the quality also decreased with respect to character of crust of bread. The present study is also in line with the findings of Latif *et al.* (2005) who found that the different food additives improved the shelf life of breads and storage time influenced the character of crust of bread significantly.

Internal Characteristics of Bread

a. Grain

The scores for grain of breads declined significantly with increment in storage time. The breads evaluated at 0 hours got significantly the highest scores followed by the breads evaluated after 24 hours and 48 hours of storage time. The grain of the breads containing 0.3% and 0.4% lactic acid got significantly the highest scores but with non-significant differences with each other. The significant and the lowest scores were assigned to grain of breads tested at 96 hours (Table 7). The results obtained in this study are in line with the results reported by Tarar (1999) who mentioned that different acidulants imparted most prominent effect on grain of the bread but grain quality deteriorated with the increase in storage time. Crowley *et al.* (2000) conducted studies on "Influence of additives and mixing time on crumb and grain characteristics of wheat bread'' and concluded that inclusion of fat or emulsifiers or extension of mixing time had a significant effect on crumb and grain of wheat bread.

b. Color of Crumb

Table 7. Mean scores of effect of lactic acid on grain of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	13.0	12.7	12.5	12.5	11.0	12.34c
T_1	12.5	12.3	12.0	12.1	12.0	12.18c
T_2	13.7	13.5	13.5	13.2	12.7	13.32b
T_3	13.4	13.3	13.3	12.9	12.2	13.02ab
T_4	14.0	13.9	13.7	13.7	13.0	13.66a
Mean	13.32a	13.14a	13.00a	12.88a	12.18b	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

The scores assigned to color of crumb of bread decreased significantly with the passage of time (Table 8). The breads evaluated at 0 hours got significantly the higher scores followed by the bread evaluated after 24 and 48 hours of storage intervals. The breads evaluated after 96 hours got the lowest scores. The lactic acid doses did not show any significant variation in the scores given to color of crumb. Tarar (1999) reported significant effect due to addition of lactic acid in combination with yeast on crumb color. The findings are in line with those of Clarke *et al.* (2001) who studied the effect of lactic acid bacteria on the shelf life of breads, and concluded that the addition of lactic acid bacteria in sourdough had a positive effect on crumb color of bread. The results of the present study are in line with the findings of Goncharvo and Sokolvo (1977) who claimed that the improvement in the crumb color by the use of Amylolytic lactic acid bacteria is possible.

Table 8. Mean scores of effect of lactic acid on colour of crumb of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	8.5	8.4	8.4	7.4	7.0	7.94a
T_1	8.5	8.4	8.2	7.6	7.0	7.94a
T_2	8.5	8.5	8.5	8.1	7.8	8.28a
T_3	8.7	8.5	8.5	8.0	7.8	8.30a
T_4	8.5	8.5	8.5	7.8	7.4	8.14a
Mean	8.54a	8.46ab	8.42ab	7.78bc	7.40c	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

c. Aroma

The results in Table 9 indicated that the aroma of breads decreased significantly with the increase in storage time. The breads tested at 0 hour got significantly the highest scores for aroma followed by tested after 24 hours storage. The breads evaluated at 72 and 96 hours were ranked at the bottom with respect

Table 9. Mean scores of effect of lactic acid on aroma of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	8.4	8.2	7.2	6.7	6.0	7.30a
T_1	8.3	8.3	7.5	7.0	6.5	7.52a
T_2	8.5	8.3	7.2	6.9	6.9	7.56a
T_3	8.7	8.5	8.0	7.4	6.8	7.88a
T_4	8.7	8.7	8.0	7.4	6.2	7.80a
Mean	8.52a	8.40ab	7.58bc	7.08cd	6.48d	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

to scores assigned to aroma. The variation in lactic acid doses did not show any significant change in the scores assigned to aroma. The aroma of sourdough was affected by the microflra added before and after fermentation (Michael and Peter 2002). These results obtained are in conformity with Latif (1996) and Wilfred (1960) who observed the improvements in taste and aroma of breads by the use of malt. The results similar to present investigation were found by Masood *et al.* (2001) who reported good aroma by the use of additives like calcium propionate (0.15%), lactic acid (0.10%) and ascorbic acid (0.10%).

d. Taste

Table 10. Mean scores of effect of lactic acid on taste of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	16.5	16.5	16.0	14.5	12.0	15.10b
T_1	15.0	15.0	15.0	14.0	12.0	14.20bc
T_2	18.0	17.5	17.0	16.1	14.5	16.62a
T_3	17.2	17.0	16.5	14.8	13.0	15.70a
T_4	16.5	16.3	16.0	14.7	12.9	15.28ab
Mean	16.64a	16.46a	16.10a	14.82ab	12.88b	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid

The scores assigned to taste of bread decreased significantly with increase in storage time (Table 10). The scores for tastes of breads at 0 hours got significantly the followed by the breads evaluated at 24 hours and 48 hours of storage intervals. It is also obvious from the results that the scores assigned to taste of breads were the highest when the breads contained 0.2% and 0.3% lactic but with non-significant differences with each other. The findings are also in line with those of Qamar (1994) who observed the change in the taste of breads by the use of the different levels of preservatives. He observed that the taste of breads became unacceptable after storage of 96 hours. The results obtained by Tarar (1999) showed that taste of breads was affected significantly by storage time with the use of acidulants and their salts in bread.

e. Texture

The scores given to texture of breads (Table 11) decreased significantly during storage and at 0 hour they showed significantly the highest scores followed by the breads tested after 24 and 48 hours. The texture of breads containing 0.4% lactic acid got significantly the highest scores for the texture of bread. The

Table 11. Mean scores of effect of lactic acid on texture of bread during storage

Treatment	0 hour	24 hours	48 hours	72 hours	96 hours	Mean
T_0	11.8	10.5	10	9.8	8.2	10.06c
T_1	12.5	11.5	11	10	8.8	10.76bc
T_2	12.2	11	10.8	10.5	9	10.7bc
T_3	12.5	11.5	11.3	11	9.3	11.12b
T_4	13.8	12.5	12.2	12	9.8	12.06a
Mean	12.56a	11.4ab	11.06ab	10.66bc	9.02c	

The means carrying same letters in a column and row are not significantly different
T_0 = Control 0 % lactic acid
T_1 = 0.1 % lactic acid
T_2 = 0.2 % Lactic acid

results demonstrated that the breads evaluated after 96 hours of storage was ranked at the bottom followed by tested after storage of 72 hours. The breads containing 0.1% lactic acid got significantly the lowest scores for texture with a non significant differences. The findings are in line with those of (Clarke *et al.* 2001) who concluded that chemically acidified breads had the lowest pH and highest titratable acidity and addition of sourdough and lactic acid bacteria had a positive effect on crust and crumb hardness

values over time. Tarar (1999) reported that storage time exhibited significant effect on texture of the bread.

CONCLUSION

On the basis if the findings of the present project, it can be concluded that food grade lactic acid produced indigenously by the bioconversion of agricultural waste is a potential source to improve the quality of bread and can be used as a replacement of traditional bread additives.

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