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# Effect of Lactic Fermentation (*Lactobacillus plantarum*) on Physicochemical, Flavor, Staling and Crust Properties of Semi Volume Bread (Baguette)

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**Abstract:** In this study, lactic fermentation was used in order to improve the quality of loaf bread (baguette). *Lactobacillus plantarum* was cultivated in a medium composed of wheat flour and water and added in bread dough formulation at 0, 5, 10 and 15% concentration. After baking, Staling, physicochemical (pH and acidity) and organoleptic properties (crust properties, taste and odor) were determined. Results showed that bread acidity increased as the concentration of sourdough in dough formulation increased. Acidity and pH of sample bread that contained 15% sourdough was 6.5 and 4.87 respectively. In addition, in this sample staling and quality changes during storage were at least. Highest score of taste were belonged to sample contained 5% sourdough. Sample contained 15% sourdough gained highest score of odor and crust properties. Finally, it seems optimum concentration for sourdough was 5%.

**Key words:** Baguette · Sourdough · *Lactobacillus plantarum* · Staling · Organoleptic Properties · Shelf Life

## INTRODUCTION

Sourdough is dough which contains active or viable microorganisms for example lactic acid bacteria and yeasts. The continuous propagation of sourdough by back-slopping is leading to a stable microflora, characterized by a high acid tolerance and a metabolism well adapted to the cereal environment [1]. In recent years the traditional sourdough bread production has enjoyed renewed success with the ever increasing demand by the consumer for more natural, tasty and healthy foods [2]. The advantages of using sourdough for wheat bread production are improvement of the dough properties, so the dough is easier to handle by machines in large scale bread production and achievement of a better and more aromatic flavor in the bread. In addition, the shelf-life of the bread can be extended by retarding the staling process and lengthening the mould-free period [3]. Lactic acid bacteria contribute to the production of safer foods by inhibiting the growth of pathogenic microbes or by removing chemicals or toxic contaminants. Certain lactobacillus bacteria, in the process of souring of dough, produce an enzyme that breaks down a protein to be toxic to people with celiac disease [4].

Spontaneous dough fermentation starts by mixing flour with water without adding a starter culture or portion of a preceding sourdough (mother dough). The microflora of such dough depends on the microflora of the raw materials used and the prevailing hygienic conditions and is variable in terms of kind, origin and storage conditions of the flour, as well as the technological parameters of the fermentation process applied [5].

Rural bread-making in Iran is reliant solely on sourdough, which is rich in lactobacilli as well as baker's yeast. However the quality of Iranian breads in urban areas has been compromised by the expansion of semi-automatic fast bakeries, which sometimes use sodium bicarbonate instead of sourdough. This has led to short-

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life bread and a huge waste of bread, equivalent to more than 1 million tons of wheat per year [6]. Most Iranian breads are of flat type but production of volume breads (e.g. baguette) has been increased recently. It seems optimization of such breads especially at large scale would reduce bread waste. In this research effect of sourdough process using lactobacillus plantarum on physiochemical, flavor, crust properties and staling properties of baguette bread has been investigated.

## MATERIAL AND METHODS

**Materials:** Utilized flour was 81 % extracted wheat flour (star flour) and specific for baking of white bread that was provided from Reza flour factory of Ghoochan (east of Iran). Improvers were purchased from Behnan Company.

**Method of Sourdough Preparation:** In order to prepare sourdough, 850 g of flour was poured in a container and 530 ml of water was added and then were mixed gently. It was inoculated with 70 ml of bacterial suspension containing $3.16\times10^9$ cfu/ml and was incubated for 24 h under temperature of 35°C. Bacterial suspension was prepared by activation and multiplication of starter culture in Nutrient Broth medium. After bacteria's growth, centrifuging was applied to separate the cells. McFarland method was used to standardize the numbers of cells.

**Bread Making Process:** The process of bread making involved steps of: mixing (11 min), initial proofing (23 min, 28°C), dough dividing, intermediate proofing (10 min, 33°C), dough rolling, final proofing (40 min, 36°C, 73% relative humidity) and baking (240°C, 12 min). The baked breads was packed in Polypropylene bags in order to, suppress intensively moisture reduction so that breads remain fresh, to preserve aromatic compounds and quality and to inhibit microbial and chemical recontamination.

**Measurement of Moisture:** Moisture content was measured according to National Iranian standard number 2705 (ordinary method for determination of cereals and their products's moisture). Oven's temperature for drying of samples was 103±2°C. Samples were taken out from oven at definite time intervals and weighed after cooling in desiccator. This action was continued until achieving a fixed weight. Finally moisture content was calculated using below equation:

$$\text{Moisture\%} = 100\times Ms / (Mb - Ma)$$

Where Ma and Mb are the weight of container and sample before and after drying respectively and Ms was the weight of sample.

**Acidity:** Acidity was determined by automatic Titroline Alpha 471217 machine. At first 10 g of sample was mixed with 100 ml of distilled water. After stirring and mixing, 30 ml of solution was taken for acidity determination. NaOH solution was used as titrant. The pH of titration end point was set at color change of phenol phetalein that is equal to 8.2. After determination of consumed volume of NaOH solution on the titration endpoint, acidity was calculated using following equation:

$$\text{Acidity} = V\times N\times 28.2/ Va$$

Where V, N and Va are consumed volume of NaOH solution, normality of NaOH and volume of sample respectively.

**pH value:** The pH of breads was determined according to National Iranian standard number 37 (biscuit characteristics). Firstly 10 g of bread was mixed completely with 100 ml of distilled water which was just boiled and then a time of 20 min was given to settle bread particles. Then, pH of upper section of solution was measured by pH meter without filtration.

**Measurement of Staling:** This test was carried out during storage period (one week) using sensory and observational evaluation methods according to staleness of bread-sensory perception test AACC Method 74-30. Sensory and observational evaluation tests were performed by trained and selected panelist with scores ranging between 0-5.

## RESULTS AND DISCUSSION

**Effect of Sourdough Concentration on Titratable Acidity of Final Product (Bread):** The relationship between bread acidity and different concentrations of sourdough has shown in Figure 1. As will be seen, addition of sourdough to dough formulation resulted in linearly increase in acidity of product so that the highest acidity content (6.5%) was observed in sample in which 15% sourdough had been used. The importance of sourdough bacteria is their ability to consume carbohydrates and proteins of

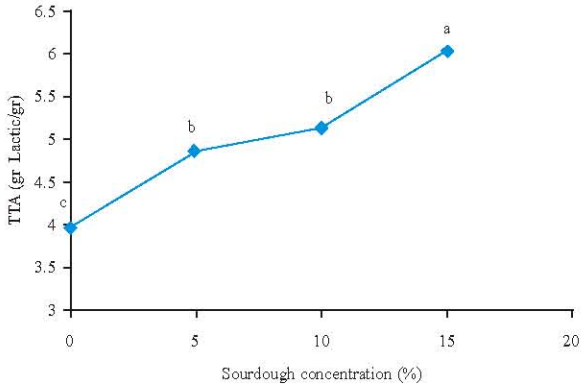


Fig. 1: Relationship between titratable acidity of bread and different concentrations of sourdough

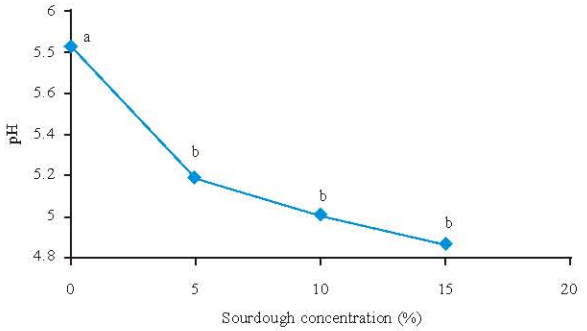


Fig. 2: Relationship between dough pH and sourdough concentration

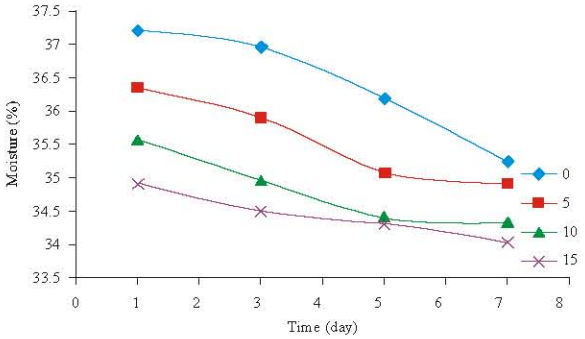


Fig. 3: Moisture content changes versus storage time of product as a function of different sourdough concentrations (0, 5, 10 and 15 indicate sourdough concentration on the basis of weight)

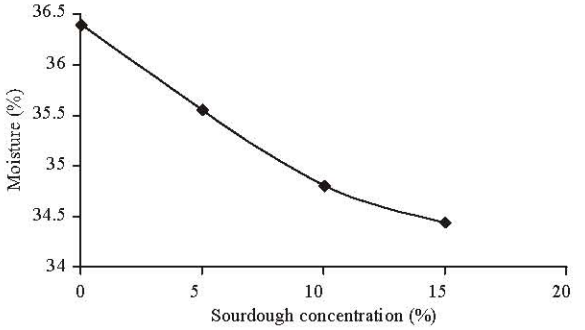


Fig. 4: Effect of different sourdough concentrations on moisture content of final product

flour for their metabolism. In this way they produce acetic and lactic acids which are effective factors on plasticity properties, dough making processes and baking [7-9]. The Ability of lactic acid bacteria in producing acid depends on pH of medium and acid production is usually stopped at pH 4.

Kati Katina showed that, among lactic acid bacteria with homogenous fermentation, *L. plantarum* produced maximum level of acid [8].

**Effect of Sourdough Concentration on pH of Final Product:** Effect of sourdough concentration on pH of bread is shown in Figure 2. As will be seen, pH value, in all of sourdough concentrations is significantly lower than control sample. Although pH value decreased as sourdough concentration increased, but no significant differencedifference (It may be due to buffer effect of system) was observed among different concentrations. Of course, it is observed by comparing products acidity (Figure 1) that there is no significant difference between acidity of samples containing 5 and 10% sourdough, while acidity of the sample containing 15% sourdough is significantly higher than other samples. This result (subject) could be caused by interactions between buffered systems of product [10-13].

**Effect of Sourdough on Bread Moisture Changes:** Moisture changes trend in different treatments during storage time is presented in Figure 3. As observed, moisture content decreased when sourdough concentration and time increased. The difference between various concentrations may be due to different water content of sourdough and paste so various ratio may cause different water content in final formulation. In addition it seems bread has lost water during its storage. Effect of different sourdough concentrations on moisture content of final product is shown in Figure 4.

**Effect of Sourdough on Staling Index:** Bread staling is one of the most important characteristic that affect product acceptance and consumption. Effect of sourdough on

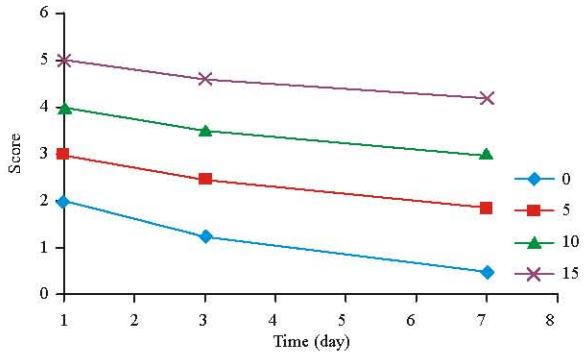


Fig. 5: Evaluation of sourdough effect on staling index in breads prepared with different concentrations of sourdough during time (0, 5, 10 and 15 indicate sourdough concentration on the basis of weight)

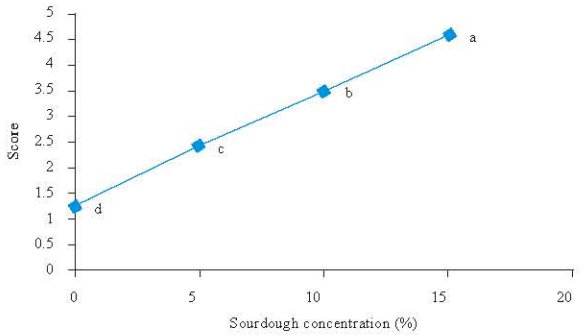


Fig. 6: Effect of different sourdough concentrations on staling index

staling index in bread which was prepared with different sourdough concentration has shown in Figure 5. As it is observed the sample containing 15% sourdough had the least quality changes during storage. Some varieties of lactic acid bacteria in produce exopolysaccharides such as dextran, xanthan, glucan, fructan and levan which have the capability of increasing water adsorption and preventing water transfer from crumb of bread toward its crust [14-17].

Exopolysaccharide content is dependent on used sourdough level (ranging 5%-40%) in formulation. On the other hand, retrogradation of starch to crystalline form is the main factor of bread staling. Sourdough will decompose and convert starch to low molecular-weight dextrins as a result of producing lactic acid and increasing α-amylase enzyme activity. This fact would be effective on decreasing bread staling [18-21]. Effect of different sourdough concentrations on staling index has been shown in Figure 6. Comparison of means demonstrated that different concentrations had significant difference. Score of bread characteristics increased when sourdough concentration increased.

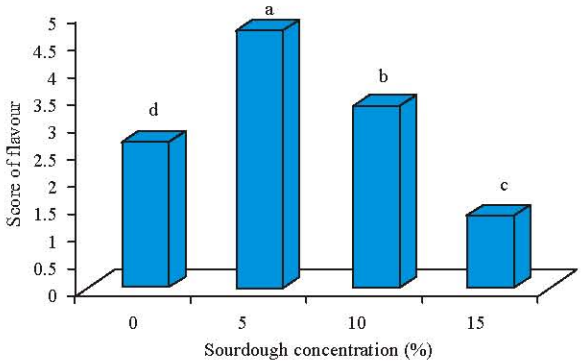


Fig. 7: Effect of different sourdough concentrations on bread flavor

**Effect of Adding Different Percentage of Sourdough on Flavor Desirability:** Results of sensory evaluation of flavor have been shown in Figure 7. Maximum score for flavor accrued to the bread in which 5% sourdough had been used. Score of this treatment was significantly more than other treatments. The score of flavor decreased when sourdough concentration increased, but score of treatment 10% was higher than control sample. It sounds that treatment 15% was undesirable to the consumers as a result of having a sourness aftertaste and consequently lower score than control sample was given to it [22, 23]. Investigations indicated that lactic acid and acetic acid have a positive influence on taste and aroma, but there is an optimum limit for this influence.

If amount of acetic acid increases too much, growth of yeasts present in sourdough is restricted or even stopped but in this condition, bread's taste becomes unfavorable [24].

**Effect of Adding Different Percentage of Sourdough on Aroma:** Results of sensory evaluation obtained for aroma has been shown in Figure 8. These results indicated that the score of aroma increased along with increasing sourdough content, so that the maximum score for aroma and taste was noted in treatment 15%. Score of this treatment was significantly more than other treatments. In addition, score of treatments 5% and 10% were significantly more than control. Presents of proteolytic enzymes in sourdough system leads to decomposition of proteins. Owing to proteolysis, free amino acids are created which are of importance among other factors responsible for aroma and taste production. Of course, free amino acids' being high in amount, alone, can not produce good aroma [25]. Aldehydes and ketones have a determinant role in aromatic compounds of bread and are

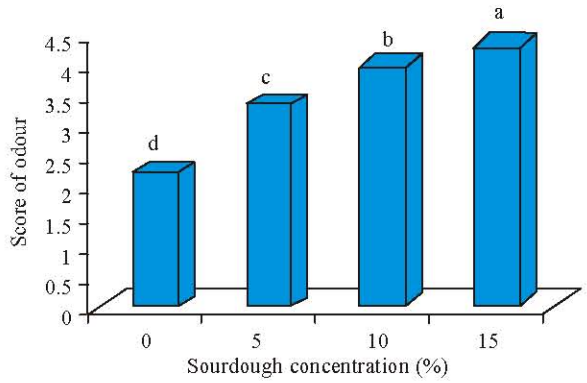


Fig. 8: Effect of different sourdough concentrations on bread aroma

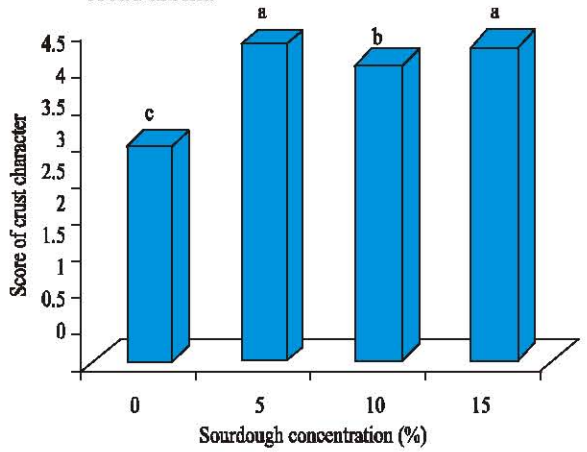


Fig. 9: Effect of different sourdough concentrations on crust properties

known as principle basis for production of aroma. Lactic acid bacteria can produce a wide range of aromatic compounds such as diacetyle, acetaldehyde, hexanal and ethyl acetate. Main characteristics (aroma and taste of sourdough and production of suitable metabolites) are a function of used microbial strains, raw materials, availability of carbohydrates and the way of production process. Researchers have demonstrated that combination of yeast and lactic acid bacteria causes to form higher amount of aromatic compounds [15, 26-29]. Both lactic acid and acetic acid are important aromatic compounds in sourdough, comparing with other products obtained from fermentation. It seems that acetic acid intensifies the effects of other aromatic elements. There are various types of bread aromatic compounds depend on used microbial strain. It is reported that the highest amount of ethanol and ethyl acetate were produced in sourdough which heterofermntative lactic acid bacteria (L.sanferansisco) are used in. Moreover, n-hexanal compound is produced in all sourdoughs [8, 30].

**Effect of Sourdough on Crust Properties:** The result of crust properties evaluation is shown in Figure 9. Mean comparison showed sourdough improved crust properties significantly. There wasn't any pattern between the concentration of sourdough and crust score. Breads with 5 and 15% sourdough gave highest crust score.

## CONCLUSION

Results showed the quality of bread improved by addition of sourdough. Though bread with 15% sourdough had lowest staling index, the taste of product limited the concentration to 5%. So addition of 5% sourdough is recommended to obtain best quality.

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