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Baking Process in Oven and Microwave-oven in Sourdough Enriched with Chickpeas and Dietary Fiber of Prickly pear and Oats

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ABSTRACT

The bread is a basic article dating from the Neolithic era, where it was baked in ovens outside. The first bread was prepared around the year 10.000 b. C. or what is 12.000 years in the past, where should be discovered by experiment with water and flour grains. This first bread was prepared on the basis of toasted seeds and water. The dough was formed and then warmed up on rocks. It was a kind of cake that, without a doubt, was welcomed by the first settlers of the land. The sample added whit oat an increase of crust in 21.25 to 49.25 % compared to the base. On the other hand, samples added whit prickle pear increase relative was 32.25 %. The combined treatment (Microwave (MW) –convection oven), the best result is the samples with fiber oats, increased more than the negative control (51 to 63 % of difference); besides the employment of mucilage of prickle pear provides a green color to the final product.

Keywords – baking bread, dietary fiber, microwave, oatmeal, prickle pear

I. INTRODUCTION

The baked goods are one of the most consumed foods in the world. In this particular case, in the whole world the consumption of bread is one of the most extensive food products, with close to 20 billion pounds of product annually consumed [1].

The bread is essentially a mixture of flour, water, yeast and salt, in the appropriate proportions, correctly mingled, fermented and cooked in the oven. And, almost certainly, it was precisely because of its simplicity, and at the same time, although it may seem paradoxical, by its wealth in terms of nutrients. Has been considered since the most ancient times and by many civilizations, the food par excellence. Their name indicates: First Natural Food [2].

Around a third of the population consumes several types of breads. Typically these are baked in a traditional oven, but is limited to the knowledge about conditions of cooking and type of oven, where the produce it designates an empirical operation and not necessarily optimal in terms of energy consumption and quality in the products of baking [3].

Baking is a complex process that brings a series of physical changes, chemical and biochemical product in a dough crude to a bread baking, which is palatable and aromatic, which produces changes in the number of phenomena that occur from the inside of the product including volume expansion, evaporation of water, the formation of pores and crust, inactivation of yeast and enzyme activities, coagulation and gelling of starch and reactions of browning [4].

The microwave heating in the food is a heat treatment that offers many advantages in the processing, including less time to start up, heating faster, energy efficiency, space-saving, accurate of a process control, selective heating and a final product with a quality nutritious perfected [5,6].

However the use of microwave energy has been limited due to the poor quality of the final product compared to the traditional baked by the use of conventional energy sources. The causes of these differences in quality are not yet fully understood. But it is thought that the specific changes that occur in the starch granules generally help contribute to a poor texture compared to a conventionally baked product [5].

The dietary fibers are a remnant of the edible part of the carbohydrates and similar plants that are resistant to digestion and absorption in the small intestine of humans, with a complete or partial fermentation in the large intestine. This includes polysaccharides, oligosaccharides, lignins, among others. The dietary fiber affects the blood, dilutes the cholesterol and glucose in the blood. The functional properties of the fibers depend on the source, the type and degree of processing [7].

A large number of sources of dietary fibers are available for pastries today. The presence of fractions soluble dietary fiber (SDF) in dietary fiber

may provide perfections in physiological functions in addition to the functional effects conferred by the fractions of the insoluble dietary fiber (IDF). Many authors have studied the use of high percentages of different types of dietary fibers in the baked but usually are important status corresponded to the kneading of the dough and quality of the bread. The main problem with the addition of dietary fiber in baking, it is the reduction of a large volume in the loaf of bread and the differences in texture of the breads obtained [8].

This work is aimed at harnessing the combination of different heating mechanisms (MWs and convection) in the quality of a product of baking enriched with chickpeas and dietary fibers of prickly pear and oats.

II. MATERIALS AND METHODS

2.1 Dough preparation

Mother dough was developed with 33 % of wheat flour, 2 % of dehydrated yeast, 1 % of sugar, 13 % of the produced yogurt and 12.72 % of the chickpea paste. This was fermented for 24 hours at 3± 1 °C. The preparation for the base of the sourdough was: 24.58 g of wheat and rye flour, 0.35 g of dehydrated yeast, 1 g of starter cultures, 1.11 g of sucrose, 0.55 g of salt, 2.33 g of milk and 4.46 g of edible oil. Baking was carried out only with the samples in which it was obtained a higher concentration of lactic acid in previous studies, which were marked as FO_1(base+ 32.17 g of water, 2.03 g of fiber and 14.51g of mother dough) and FO_2 (base+ 32.88 g of water, 2.74 g of fiber and 13.09g of mother dough), on the part of the containing oats and the FPP1 (base+ 30.75 g of water, 2.74 g of fiber and 15.22g of mother dough) at 24 h fermentation and FPP2 (base+ 30.75 g of water, 4.87 g of fiber and 13.09 g of mother dough) at 48 h fermentation, which contain mucilage of prickle pear. The dough which was left standing in cold.

2.2 Baked

Once the dough had its fermentation time, proceeded to making series for your baking, where the base (control sample (Ctl neg) which was made without the addition of fibers from oats and mucilage of prickle pear , and the samples FO_1, FO_2, FPP_1 and FPP_2. Which were baked in the oven stove at a temperature of 180 °C. On the other hand was performed a second set of samples to which gave them an initial treatment with microwave (Daewoo, KOR-63D5, 1000 W) of 45 seconds per every 250 g of sample, which were the same as in the baked by convection, just add the pre-treatment of microwave (MW) by what are identified as CTL-MW, FO_1MW, FO_2MW, FPP_1MW and FPP_2MW. All samples were baked at 180 °C for 30 minutes, and samples were taken at intervals of 10 minutes.

2.3 Volume

It is conducted by means of the technique of displacement of water following the methodology reported by AOAC [9].

2.4 Crust

Each sample had the crumbs removed, and the crust was measured in three points, one central and two sides with a digital vernier caliper.

2.5 Crumbs

It carried out a cross cut to each sample and took a photo with a 7.1 megapixel camera (Canon PowerShot A470) at a distance of 10 cm, in controlled conditions of light, and was processed in the ImageJ software version 1.42

2.6 Color and moisture

It was taken with a colorimeter brand model PCM Colortech C04190, and the moisture was measured gravimetrically [9].

III. RESULTS AND DISCUSSIONS

Samples Ctl Neg, FO_1, FO_2, FPP_1 and FPP_2 baked by the simple method (convection oven) where the samples that were developed with fiber from oats presented an increase of approximately double the thickness of the crust (3 mm) relative to the negative control (Ctl Neg; 1.5 mm) in the first 10 minutes of baking (Fig. 1), however at the end of the cooking (30 min) the negative control came to measure 4 mm of thickness of crust, while the sample of FO_1 obtained 4.85 mm (an increase of 21.25 % compared to the Ctl Neg) and for FO_2 was increased to 5.97 mm (49.25 % more than the negative control and 23 % more than the sample FO_1).

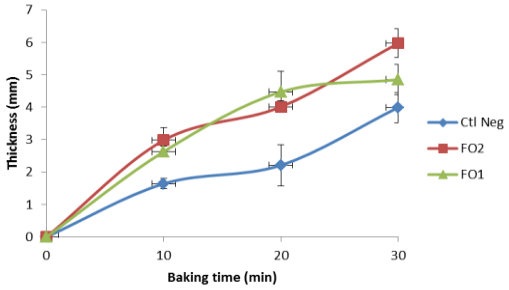


Figure 1. Crust thickness in a sample supplemented with oats during the baking time.

This phenomenon may be due to the water content within the samples, since the sample FO_2 presents the greatest amount of water the rest of the samples, It begins to evaporate forming cells in the interior and with the increase in temperature, these cells collapse causing the formation of the crust, [3], mentioned that the water begins to emigrate from the inside of the bakery product toward the outside, what gives the formation of cells, and when you get to the part more external, evaporation is faster causing the collapse and the compaction of the cells, this process starts at the beginning of the process of baking, where the CO_2 produced by the yeast, inactive as the cooking temperature to what originates in addition that the CO_2 that is dissolved in the water of the dough insolubilize forming gas in accordance with begins to increase the temperature, which is related to the formation of the crust [10].

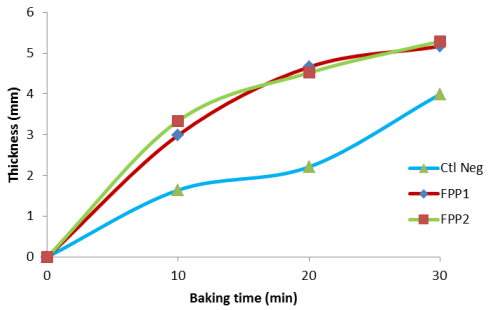
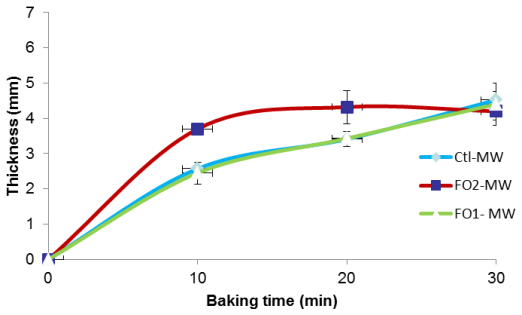


Figure 2. Crust thickness in a sample supplemented with mucilage during the baking time

On the other hand will have the samples prepared with mucilage of prickle pear (FPP), where you can see in Fig. 2, that the samples baked to 10 min was found an approximate increase of 100 % for both samples (FPP_1 and FPP_2) And for the time of 30 min the increase relative to the negative control was 32.25 %. In the case of the samples with mucilage, the values of the two samples are very similar to each other, which might be due to the fact that when you add the mucilage, it traps water and instantly of baking, The evaporation of the water is slower, which has a direct effect on the formation of the crust, since the use of the prickle pear products, there is a tendency to increase the toughness, adhesion and firmness of the dough by which decreases its elasticity [11], which is related to greater increase of fiber is affected the formation of crust [12].

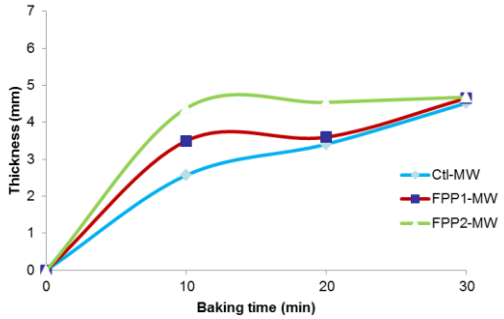
In the case of the combined treatment (Microwave (MW) -convection) is that the samples with fiber from oats, the Control-MW increased more than the negative control (63% of difference), but taking into account the sample FO_1-MW, There is a significant change from the Ctl-MW, only in the FO_2-MW was observed (Fig. 3) an increase of 51% compared to the other samples by means of the combined treatment to the 10 min of baking, being that after 30 minutes of cooking for the three samples (control sample and oats samples) ended in the same thickness of 4.4 mm of crust, there is no significant



difference between them.

Figure 3. Crust thickness in a sample supplemented with oats and treated with microwave oven.

The behavior of the combined treatment was very similar to that submitted the samples prepared with mucilage of prickle pear (Fig. 4), can bestow to achieve 4.6 mm of thickness of crust. The physico-chemical changes and interactions of the majority of the ingredients occur in the oven in a process of slow baked in conventional systems, but when carried out with short periods of baked in oven, the products have quality problems, as is the insufficient gelatinization of the starch, that induces changes in the gluten, and causes a rapid formation of gas and steam [6], to leave quick escape from these gases, is not given



opportunity to build a thicker crust.

Figure 4. Crust thickness in a sample supplemented with mucilage and treated with microwave oven.

The quality of the bread made from dough is influenced by the formulation of the dough, that during baking, the loses moisture, and produces products below the weight used and produces a very

dry crust, this can be seen clearly in Fig. 1 and 2 , where the percentage of initial moisture ranged in the 45 %, but when it is heated up in convective system began to decrease rapidly with the exception of the sample FO_2 that was maintained until after 10 min of baking (Fig. 5), this may be due to the fact that the formulation has a higher amount of fiber in oats, and the content of β-glucans retained a greater time to water until the temperature is increased, this effect is caused by the incorporation of fibers from oats (β-glucans), affecting certain characteristics in the baked as is the volume and the color of the crust [7].

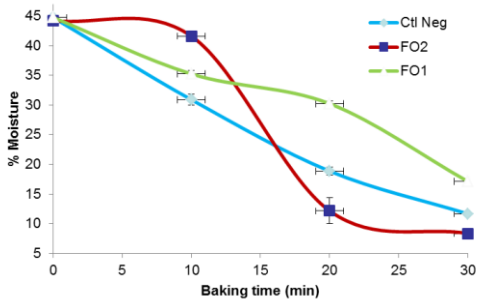


Figure 5. Decline of the percentage of moisture in the crust with samples added with oats during the baking process.

Similar effect presented sample FO_2 with the sample FPP_2, since within the formulation contains the greatest amount of mucilage that sample FPP_1, so that the mucilage still in greater quantity catches more water, so avoids rapid evaporation affecting the crust (Fig. 6)

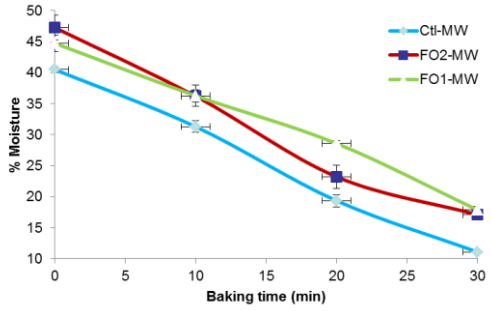
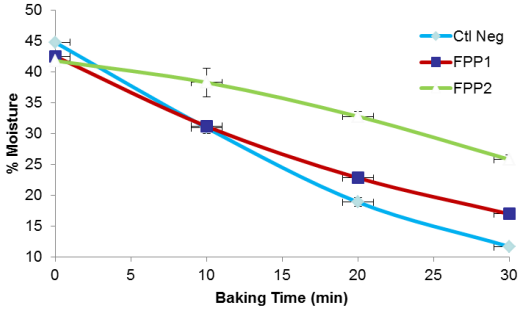


Figure 6. Decline of the percentage of moisture in the crust with samples added with mucilage during baking process

In Fig. 7 and 8 is observed as the development of the behavior of the loss moisture inside the crust with the system combines baking, where it is appreciated that the loss moisture is in a linear movement far below the 20 % of moisture, except for FPP_2-MW, where the mucilage exerts force to prevent the evaporation of the water in the baking in the maximum time. When the surface temperature exceeds 100 °C, is explained by the changes in the content of water between the surface and the center, since the surface water evaporates more quickly than that which is being transported from the center to the



surface, which affects the formation of crust [13].

Figure 7. Decline of the percentage of moisture in the crust with samples added with oats during the baking process by microwave oven.

In the process of baking, to modify the ingredients of the mixture by the addition of fibers, it modifies the absorption of water, mixing time and volume. The formation of the bread crumbs and the increase of the volume, depend on the mobilization of the water from the center toward the walls during heating. Gluten is a polymer of protein fractions as glutenins and gliadins. These form the roughness and gumminess of dough that finally is hydrated, where the gliadins produce viscosity, when dough is hydrated. The gluten, for this, it gives cohesiveness, elasticity and viscosity.

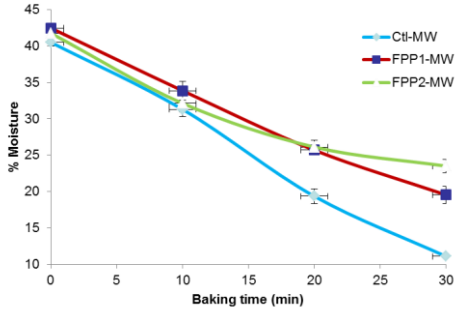


Figure 8. Decline of the percentage of moisture in the crust with samples added with mucilage during baking process by microwave oven.

The gluten in itself, it is a structural protein of the baking process. The property of gluten apparently is to hydrate for flour, granting extension to the dough, with a good retention of gas, and a good crumb structure in the breads baked. The absence of gluten will result in liquid dough, whose product will

have poor baking characteristics of crumb, and color, among other defects.

By increasing the concentration of fiber, it increases the absorption of water and this often causes a strong link between water and the fibers, retaining water, avoiding that migrate to the outside and will expand to increase the volume with the size of the crumb, The long times of mixed can be due to the dilution of the gluten and the difficulty of mixing fibers to obtain a mixture completely homogenous [14]. Where the lower end of the volume is given by the dilution of the gluten, as a result of the interaction between the gluten and fibers [15], by what in the volume within the samples there is no variation between them, as shown in Fig. 9.

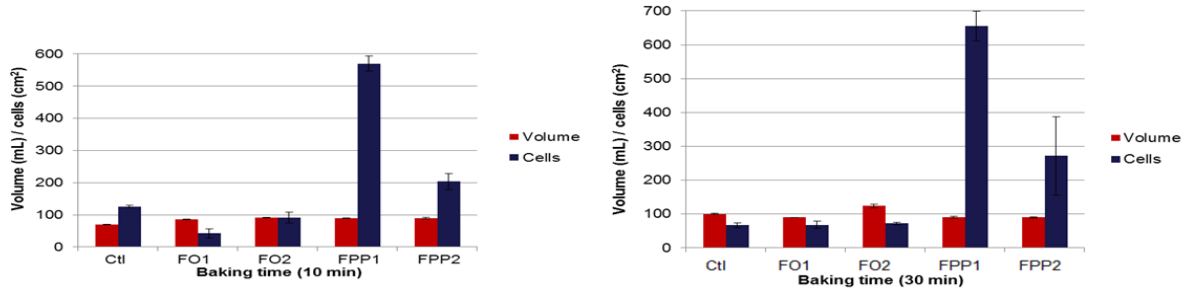


Figure 9. Behavior of the volume of cells and formation of gas in the crumb during baking in oven.

While the formation of the crumb, begins with increasing temperature, the external surface loses elasticity, and form a cover with brown coloration, to further increase the temperature, the reactions are maximized, including the evaporation of moisture, gelatinization of the starch and protein coagulation, where dough is transformed into crumb by the formation of internal structures, called cells [16]; causes to increase the size of the cell and set the volume, by which the variation in the amounts of the components of the mixture will affect the formation of crumb (Fig. 10).

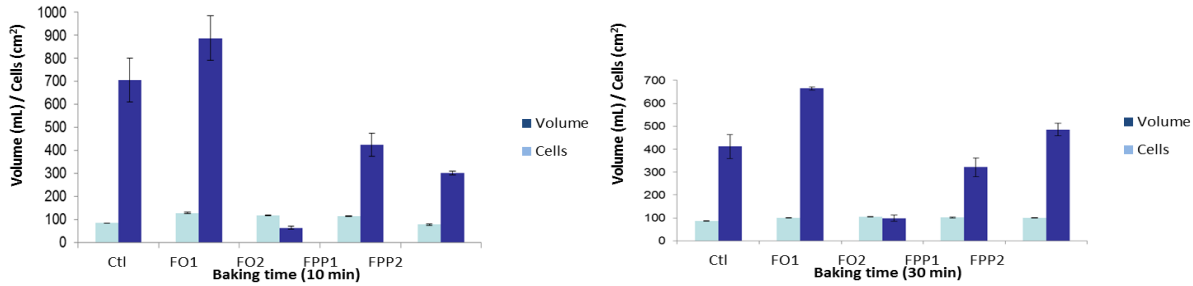
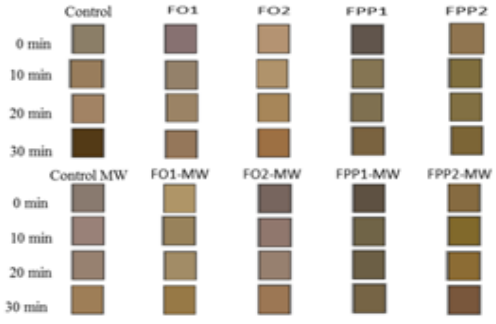


Figure 10. Behavior of the volume of cells and formation of gas in the crumb during baking in microwave-oven

Cooking with a microwave tends to have modifications in the heating in the process of transporting the internal pressure. This shows that the pressure is driven by the migration of moisture during the heating, giving a greater loss of moisture, due to the interaction gluten-moisture, because the oven begins to carry out an internal heating, so that evaporation is faster, but does not form a good crust, so the seal does not happen and the moisture escapes more rapidly [17].The biggest difference between a traditional baking and one microwave, is that the microwave discourages the formation The browning, does not produce the characteristic color (Fig. 11), because the inside of the microwave the external ambient temperature is colder than the internal temperature, compared with a traditional baking, the outer layer begins to seal which increases the retention of gas by dehydration, it is for this reason that the samples made with a combination of



microwave don't produce much volume or reactions from browning.

Figure 11. Color changes during baking time

IV. CONCLUSION

The formation of crust, benefits when baking with the simple method with the combined system (Simple-MW), in addition to the use of fiber in oats alveoli form of greater size, that when applied mucilage of prickle pear, microwave increases the number of alveoli, but not its size, in terms of the volume was not affected markedly with the two methods of baking. The employment of mucilage of prickle pear provides a green color to the final product.

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