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MIXOLAB® rheology of enzymatic flour and validation of baking performance

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Abstract
The purpose of this research is to justify the way in which flour is added to obtain a quality product, quality seen from the perspective of bakers. Because bakers want to have good and consistent flour, many tests are done in the mills for the addition of flour, tests that are correlated with baking samples. In this study, analyzes are based on the use of enzyme mixtures with influences on the rheology of the flours and the organoleptic properties of the bread resulting from the baking test. For a better image of the results, constant percentages of enzymes were used: xylanase, lipase and different percentages of alpha-amylase were used. This decision was based on the fact that there were periods when the falling index exceeded the value of 350 s. Xylanase and lipase were used in percentages of 5ppm. The percentage of alpha-amylase was in the range of 1-10 ppm. The flour added with enzymes was analyzed from a rheological point of view with the help of the Chopin Mixolab. Baking samples were made from the added flour, which were analyzed objectively, by laser scanning, using the Volscan device. By means of the Volscan device, the quality parameters of the bread were obtained, such as: volume, specific volume, density, maximum H/D ratio, and yield in flour.
Based on the experimental data, correlations were made between the results obtained from the flour analysis and those from the bread analysis, with the aim of establishing an optimal profile of the flour from the point of view of the rheological characteristics, but which would lead to obtaining a product with parameters as better.
The analysis of the experimental data allowed the realization and validation of an optimal profile of the flour, for the situation where the falling index is greater than 350 s. The analysis of the experimental data allowed the creation of an optimal profile of the flour, for the situation where the falling number is greater than 350 s.

Keywords: bread, flour, Mixolab Chopin, Volscan Profiler, enzymes

1. Introduction

Although there are numerous studies that deal with the characteristics of wheat, implicitly flour, due to the increasingly frequent occurrence of gluten intolerance among the population, studies from the applicability of other cereals in panification have gained momentum. The determination of the rheological properties of wheat flour dough as well as dough from other raw materials (rice, corn, buckwheat, amaranth and soy) was carried out by Mixolab. According to the results obtained through Mixolab measurements, the flours from different raw materials presented Mixolab profiles that differ greatly from the profile of wheat flour. However, since there was no tested material that exactly mimics the properties of wheat flour dough, it was concluded that their mixtures would give the optimal rheological profile [1]. However, traditional bakers still produce bakery products from wheat flour and

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look for the best variants. That's why mills that grind wheat are still concerned with obtaining optimal flour from a qualitative point of view. In this sense, numerous tests are carried out with enzyme additions, knowing their effects on the rheological properties. There are studies that demonstrate that additions of different percentages of xylanase can modify the CH of the flour and improve the workability of the dough [2]. The rheological parameters of flour are not sufficient for the prediction of baking tests. Wheat varieties with different ripening qualities show a specific starch rheology. The starch rheology of individual varieties deepens their mutual differences. Only starch rheology can be used to predict bread height and aspect ratio. Starch rheology can also be used to improve cookie quality estimation [3].

In order for the mills to be able to objectively analyze the flour and establish effective additives, they had to purchase various laboratory devices. One such device is the Chopin Mixolab, which is mentioned in many specialized studies, as an aid in checking the rheology of doughs with various destinations and various additives. Thus, there are studies that reveal the use of Mixolab in the study of dough rheology with buckwheat additions [4] or hemp [5]. The researchers' imagination goes towards interesting studies of the use of various ingredients in doughs. For example, the influence on the rheology of the use of pumpkin in dough was studied [6]. The size of starch particles in flour has significant influences on dough rheology [7]. Other studies establish by their content the differences in results between mixolab and farinograph, the first being more sensitive in predicting some characteristics of doughs through the parameters it determines [8]. According to the Chopin protocol, Mixolab 2 simulates the constraints that the dough undergoes during the production process. By working on a representative dough, Mixolab 2 allows to get as close as possible to the real conditions of how flour will be used in bakery products. The instrument measures dough consistency and analyzes protein and starch quality. But all these tests on Mixolab were correlated with baking tests, most of them on bakery products. The samples were analyzed from an organoleptic point of view, either through simpler analyzes or with the help of modern infrared devices or laser scans.

2. Materials and methods

2.1. Materials

In order to obtain some available data it was used wheat flour types 650 (0, 65% ash), provided by MP Baneasa –Moara SA Ilfov, Romania. The analytical flours quality was determined according to the international standard methods (ash content – ICC104/1, rheological parameters with Mixolab -ICC 173-1). The moisture content of the wheat flour were determined by oven drying at 130 ºC for 1 hour. It was made determination of technological and rheological properties through Mixograph method based on Chopin protocol. The white flour had a 380 second Falling Number index (Ic) and the and the following rheological parameters, on Mixolab: stability 9,6s, CH 57,5%, C1 1,029Nm, C2 0,34Nm, C3 1,544Nm, C4 1,69Nm, C5 2,88Nm, α -0,114Nm/min, β 0,362NM.min, ϒ -0,02Nm/min. Index 4 41 478. The first test consisted of the addition of xylanase and lipase at a same percentage of 5 ppm, in the control sample, marked P1. For the other samples, the constant addition of xylanase and lipase of 5 ppm was kept, but the percentage of alpha-amylase was changed, like this 5 ppm for sample P2 and 10 ppm for sample P3. For each sample, M, P1, P2 and P3, the flour was analyzed in a mixolab, and the Falling Number index was determined. For each test, 3 repetitions were performed and an average was made. To validate the used enzyme mixtures, baking samples were made and analyzed by laser scanning, with the Volscan device. The Volscan Profiler is a benchtop laser-based scanner that measures the volume, density and dimensional profiles of solid products. The experiments are made in the research laboratory of Stefan cel Mare University of Suceava, Faculty of Food Engineering.

2.2. Methods

The doughs were also obtained from the starting flour, control (M control to which the xylanase and lipase enzymes were added at a percentage of 5 ppm, for sample P1). For the other samples P2 and P3, 5 ppm and 10 ppm alpha-amylase were added respectively, keeping the addition of xylanase and lipase

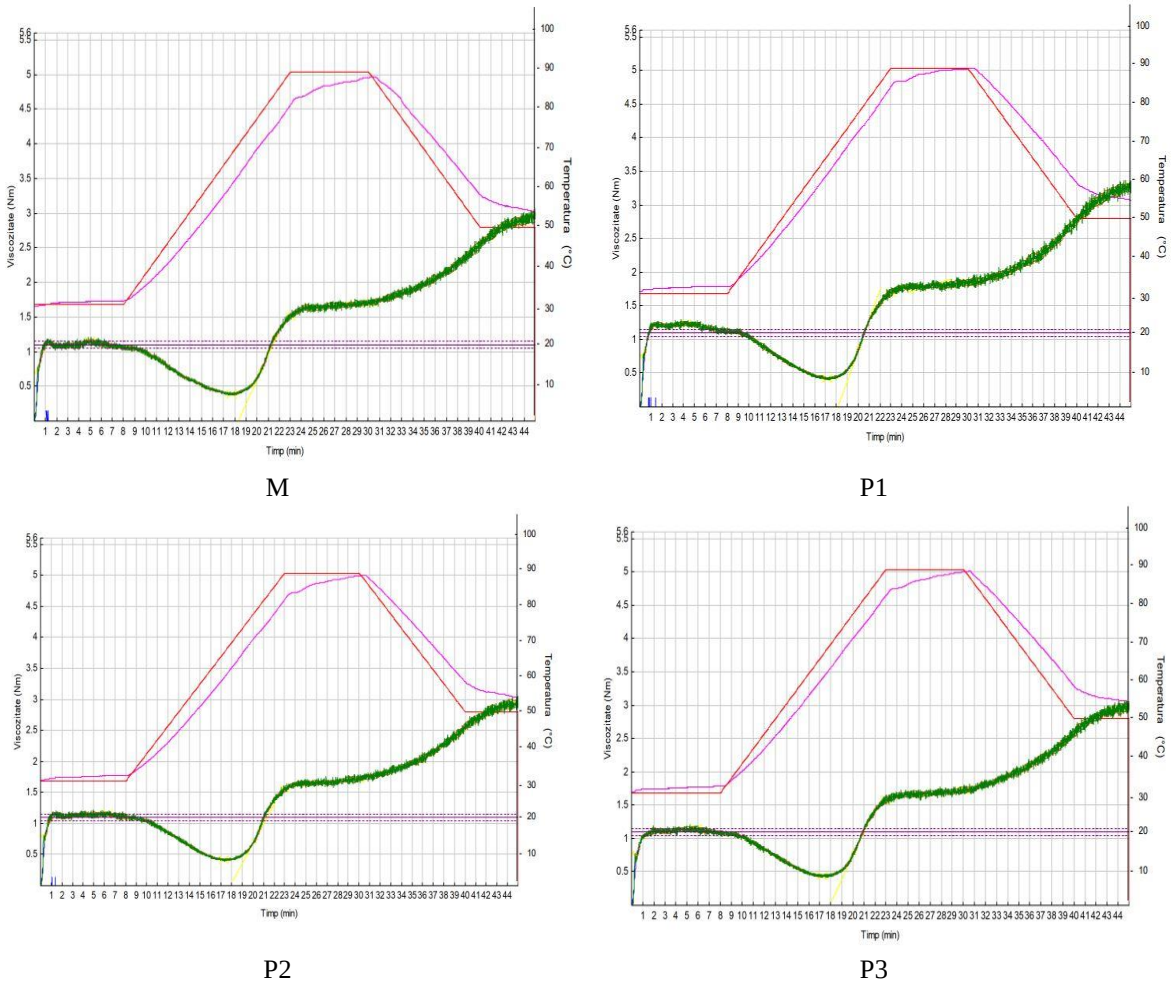
constant. The obtained hays were subjected to tests to determine the Falling Number, the rheological parameters, with the help of Mixolab Chopin, then the bread was prepared.
For the preparation of the bread, modern devices of the latest generation, UNOX production, were used. The ingredients were mixed until a homogeneous dough was obtained, of normal consistency, specific to bread dough. The divided and shaped dough was left to rise at 30^0C, relative humidity 60%, for 60 minutes. After baking and cooling, the bread was scanned for 20 minutes using the Volscan Profiler device. At the end of the scan, the device generates a complex report in which parameters such as weight, volume, specific volume, density, height, width, number of slices, maximum and average H/D ratio are entered. These parameters were correlated with the results obtained for flour.

All data were done in triplicate and were expressed as the mean ± standard deviation of the measurements.

3. Results and discussion

3.1. The effect of enzymes on the quality of flour

The aim of this research was to establish an optimal profile of the enzyme flour in order to obtain bread with the best organoleptic properties, for a falling index of 350 s. Reference is made to volume, but also to other parameters such as the ratio H/ D, density, maximum circumference.
We start from a flour with certain rheological parameters, from which we obtained bread with a specific volume of 5.071 ml/g through the baking probe, as seen in table 1.



M P1

P2 P3

Figure 1. Mixolab profiler for each sample

By adding the xylanase and lipase enzymes, a flour is obtained, with good stability, the high C2 couple, which characterizes the protein quality and as seen in table 2, is correlated with the bread volume, 5.574 ml/g, for P1.

If we keep constant the addition of xylanase and lipase and vary the percentage of alpha-amylase, it is observed that for samples P2 and P3, the C2 couple decreases, which translates into an increased rate of protein degradation, and a decrease in specific volume.

The torque C3, which refers to the maximum consistency of the starch gel, is maximum in sample P1, without the addition of alpha-amylase. The starch gel has maximum viscosity at P2 and the rate of gelatinization, β, is the lowest.

The volume is good and the H/D ratio of 0.67, the highest of all samples, shows that the bread does not tend to flatten.

ϒ, which has the capacity of enzymatic degradation, is the largest sample P3, with the addition of 1 ppm of alpha amylase. The maximum consistency of the gel is obtained in sample P1, without the addition of alpha amylase. The C5 torque, which indicates the maximum gel consistency, is maximum at P1, indicating that the bread will age faster than the other samples.

Table 1. Mixolab results for tests

Nr crt	Sample	CURBA MIXOLAB C+											
		Stability (min)	Ampl (Nm)	CH %	C1 (Nm)	C2 (Nm)	C3 (Nm)	C4 (Nm)	C5 (Nm)	α (Nm/min)	β (Nm/min)	γ (Nm/min)	Index
1	M	9.6	0.086	57.5	1.029	0.34	1.544	1.69	2.88	-0.114	0.362	-0.02	4 41 478
2	P1	9.9	0.059	55.0	1.129	0.363	1.472	1.755	3.031	-0.114	0.314	0.002	2 51 288
3	P2	9.7	0.043	57.2	1.121	0.417	1.547	1.684	2.950	-0.112	0.290	0.022	3 51 378
4	P3	10.4	0.063	56	1.061	0.299	1.418	1.645	2.832	-0.118	0.338	0.024	2 51 278

From Table 1, it is observed that C2 torque which correlates with specific volume is best at P1. When we add alpha-amylase, there is a decrease in the C2 couple, which is correlated with a decrease in the volume of the bread.

An addition of 5 ppm of alpha-amylase as an effect of increasing the C1 couple, but also the C5 couple, responsible for the image of starch degradation, which translates into a decrease in the aging speed of the bread, but also with a good specific volume, close to sample P1. At an addition of 10 ppm alpha-amylase, a minimum of the C2 and C5 couple is obtained.

The couple C1 indicates the maximum consistency of the dough and provides an image of the behavior of the dough during kneading. This couple, correlated with the temperature and the time in which Cmax is reached, provides an image of the protein's characteristics. The **α** slope, the softening speed of the proteins is higher in the case of the addition of 10 ppm alpha-amylase.

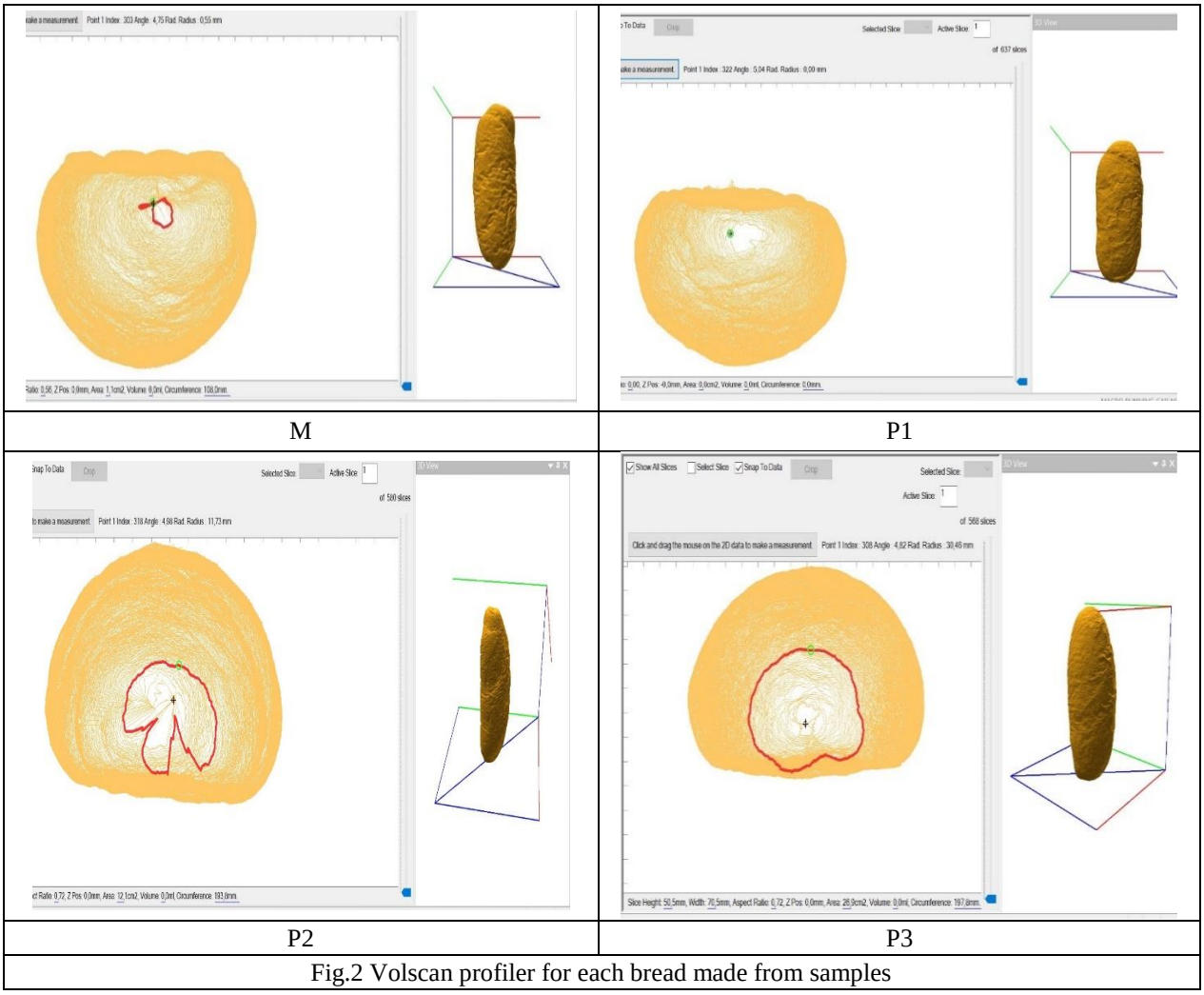
3.2. The effect of enzymes on the quality of bread

If we analyze the values in table 2, we notice that as more alpha amylase is added to the corrected flour, the volume decreases (including the specific volume). The flour yield is better at P2, P3 being close to P2. Looking at the results in table 1, samples P1 and P2 are close in terms of results and better than the control sample and sample P3 with 10 ppm alpha amylase. The density is significantly higher at P3 and is correlated with a small H/D max ratio, 0.59, which indicates that the product has a tendency to flatten. The lower density correlates with a higher ratio (close to 1), which indicates that the product is not very flattened, the slice has a loose core, lower density.

Table 2. Volscan results for backing tests

Sample ID	Volume (ml)	Specific Volume (ml/g)	Volume-Yield η (ml/100 g flour)	Density (kg/m^3)	Aspect Ratio at Max Height	Max Circumference (mm)
M	1872	5.071	748.9	197.2	0.56	372.4
P1	1948	5.574	779.2	179.4	0.66	372.7
P2	1918	5.362	767.2	186.5	0.67	349.3
P3	1793	4.955	717.1	201.8	0.59	353.5

Figure 2 shows the profile of the bread scanned with Volscan Profiler, both 2D and 3D. From the infrared analysis, it can be seen that the slices of bread are well contoured, the 3D images show that the bread has a slight tendency to flatten.



M | P1

P2 | P3

Fig.2 Volscan profiler for each bread made from samples

4. Conclusions

The influence of the addition of these enzyme combinations on the rheological parameters was monitored and it was observed that as the amount of alpha amylase increased, there was a decrease in FN with little change in the other parameters. Since the basic flour (the control) was one with above-average baking properties,

the baking samples were not negatively influenced by the increase in the percentage of alpha-amylase, characteristics also supported by the addition of xylanase and lipase. As a result of experimental research and taking into account the correlation between the falling index and dough workability, the most affordable mixture could be 10 ppm alpha amylase and 5 ppm xylanase and lipase, but it depends on the quality of the wheat flour. for each batch of raw material.

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Stefan cel Mare University of Suceava, Faculty of Food Engineering, Romania

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