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Research for identifying the optimum technological profile of rice flour for obtaining agglutene biscuits

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Abstract

During the last decades, due to world globalization, rice flour has got assimilated by the European dishes especially to its benefits for the people suffering from gluten intolerance.

Without gluten-generating proteins, rice flour is a real challenge in applying the processing technologies, especially the adapting of the existing ones.

However, there have already made scientific approaches on the processing of this type of flour, with different applications for pasta, bread and even diverse doughs for making fancies, cookies and biscuits on classical technological lines, thus being a topic of scientific debate and a challenge.

The aim of this paper is to establish a mixolab profile for rice flour so that it can be applied to the production of agglutenic biscuits in order to support local producers Ascorbic acid and glucose oxidase were used as additives to strengthen the flour network.

Keywords: rice flour, biscuit, additive, profile, ascorbic acid.

1. Introduction

Gluten-free products are a challenge for both scientific world and producers. This fact is due to the higher and higher demand of gluten-free products by people suffering from allergy to gluten. The challenge resides in the fact that gluten contributes to the forming of a strong network which provides the dough with viscous-elastic properties that are not present in other cereals. [7, 19]. In order to make gluten-free products, different new methods based on fermentation, enzyme action, microwaves, baking, extrusion [8]. Gluten-free products contain mainly rice flour, but also other flours obtained from different cereals, as well as mixes of these ones [18].

Diverse studies have highlighted the products that can be made from gluten-free flours and also the modalities in which their organoleptic properties can be improved. One of the most used flours in such experiences is the rice flour. Regarding this type of flour, special attention was given to the way in which the products' quality is being influenced, if the size of particles at milling is getting modified and then being treated with organic acids.

The size of particles and the treatment with citric acid influence viscosity and heat stability of rice flour-based products based on rice [13]. Also, the citric acid was taken into consideration when the rheological properties of dough based on maize starch of different percentages of ascorbic acid were studied [14].

The treatment of rice flour with 4α glucan transferase shows that the molecular weight of starch decreases rapidly in 1 hour of reaction, then the decrease is slow. This treatment has a positive influence on the sensory properties of sponge cakes. A flour treated for 48 hours has as benefit the shelf life prolongation of the finished product [1, 14, 15].

The studies were carried out on diverse products, for example: muffins with addition of rice and vegetable flour whose behavior was similar to those made from wheat flour.

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Viscosity was lower in the muffins made from flour mixes, and the volume of the finished product was significantly small than that in the wheat flour [6].

The choice of the products studied was made concomitantly with the choice of different ingredients added, having in view either their stability or the sensory characteristics of the products obtained as compared to the control sample. There have been made such studies which show that gums were added in order to improve the manufacture of the products based on rice flour and to extend the shelf life and volume of the bread [4, 12, 16, 20]. The addition of glucose oxidase in bread improves its volume and texture [9]. In this sense, preservation methods of products have been tested. For example, it is well known that frozen products and then defrosted change their organoleptic properties. In the case of studies on sponge cakes made from rice flour as compared with those from wheat flour, good results were obtained by the sponge cakes made from rice flour [10, 11].

Many research studies were carried out on biscuits made from rice flour, taking into consideration that they stand for a market of interesting products. In this view, the studies were focused both on the making process itself and on the possibility of using different ingredients in order to improve the dough's rheological properties and its final organoleptic properties.

Biscuits contain important percentages of fat and therefore, the kneading and baking effect on the biscuits' quality was studied through degradation of lipid fractions [2, 3]. Other studies show the influence of ingredients on the rheological characteristics of biscuits: hardness, density, consistency [17]. Also the use of new ingredients, of nonconventional ones, such as sericin [5], was studied in order to check their influence on the rheological properties of buckwheat flour [21].

The present study aims at demonstrating the influence of ascorbic acid and glucose oxidase addition on the rheological and organoleptic properties of the biscuits made from rice flour. Due to its chemical composition, rice flour is free from gluten proteins specific to wheat flour. Having in view this aspect, mixolab was used in order to study the rheological properties. By means of profiler mixolab results, an adjustment of rice flour's parameters was tried in order to apply it to sugar biscuits. This was carried out, by analyzing the influence of ascorbic acid addition (P1) 30 ppm and of glucose oxidase (P2) 30 ppm, respectively. For both samples the biscuits were kneaded according to a standard recipe and the biscuit form was compared organoleptically before baking. This fact led to results regarding the dough acceptability from the point of view of stability before baking. The influence of other ingredients was taken into consideration as well: fat, sugar, eggs, which have a major impact on dough and on its stability. The making of gluten-free products is a pretty difficult process because of the rheological behavior of rice flour, from the point of view of mixolab, which is atypical when interpreting.

The research was focused to the possibility of improving the rheological properties of rice flour with application in obtaining gluten-free biscuits. Rice flour is a challenge for Romanian technologies because the basis of scientific research focuses on the applications of wheat flour.

In this context, the technological process of making rice flour biscuits starts from the establishment of a target profile for rice flour in order to ensure a constant quality in the processing of doughs. Rice flour, in part, gluten-free, can be added with various ingredients to ensure stability and processing.

Since making biscuits is an area which raises the issue of decreasing waste by keeping shape and size constancy biscuits using of ascorbic acid vs glucose oxidase has the effect of improving the rheological properties of flour destination for these products.

So far there are no studies that highlight the role of ascorbic acid vs glucose oxidase on the rheological parameters of rice flour. This is an original study that brings a significant contribution to research and is relevant for the biscuit factories.

2.Materials and methods

2.1.Raw materials

The aim of this study is to show that rice flour, even if it does not form the usual gluten network, can be analyzed from the rheological point of view, and the products obtained can be taken into consideration from the organoleptic point of view – the dough form immediately after shaping.

Moreover, as a challenge as regards the previously mentioned, the present paperwork aims at demonstrating that it is possible to make rice flour biscuits, even if from the rheological point of view, this type of flour is more difficult to work with.

This paperwork also emphasizes the fact that the addition of an ingredient with oxidant role can improve the rheological and sensory characteristics. Form was chosen as a sensory characteristic; more precisely the form's keeping after shaping, as it is known this characteristic is important, especially for the packaging process.

In order to get available results, rice flour was used in our experiment, purchased from PIRIFAN, batch 28039, shelf life 15.03.2020, humidity 10,8% and CH 65%. The characteristics were determined by means of Chopin mixolab.

30 ppm ascorbic acid (P1) and 30 ppm glucose oxidase (P2) were added in the rice flour blank sample (M) in order to obtain the samples. The flours were analyzed from the rheological point of view on the basis of the protocol Mixolab Chopin Profiler.

To make the dough, rice flours were used in which fat of animal origin was added, President butter, shelf life 31.10.2020, Margaritar crystal sugar, big whole eggs, A category, Albert Distribution, shelf life 17.03.2020, Vanilia Burbon aromas, supplier Dr Oetker, shelf life 05.2020, iodized salt (according to the Romanian legislation – Government Decision 568/2009), supplied by Nutriprod, valid date 2020, acid ascorbic import China, shelf life 05.2021, glucose oxidase, Danisco, shelf life 03.2021. After kneading, the shaping was done by spreading the dough and cutting it in different forms.

The dough's stability immediately after cutting was compared. The observation was made organoleptically by measuring the size of the biscuits made.

All the experiments are made in the research laboratory of Stefan cel Mare University of Suceava and the Economic College Viilor, Bucharest.

2.2.Analysis techniques

Evaluation of rice flour samples: In order to be evaluated, the flour samples were marked as follows: M-control flour, P1 –control flour with 30 ppm ascorbic acid, P2–control flour with 30 ppm glucose oxidase.

The samples were analyzed on Mixolab Chopin, according to the Profile protocol. The curves obtained are shown in fig. 1, 2 and 3.

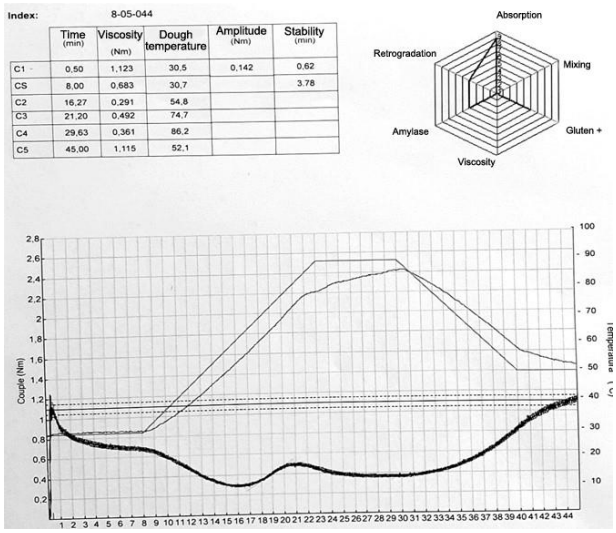

Figure 1. Evaluation curves of control flour M

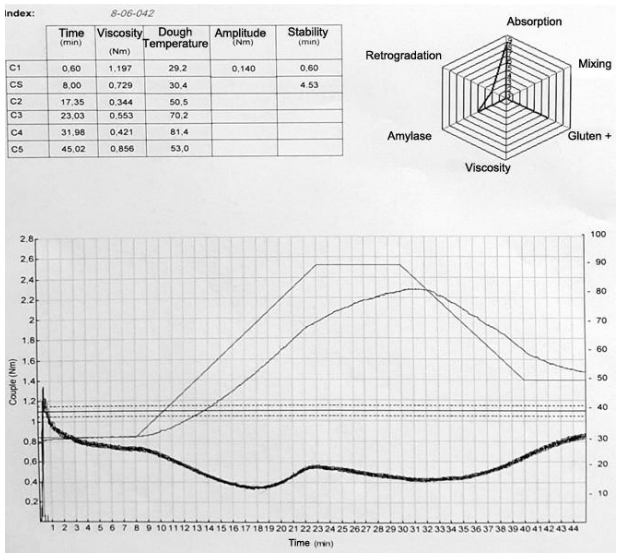

Figure 2. Evaluation curves of P1 (control flour with 30 ppm ascorbic acid)

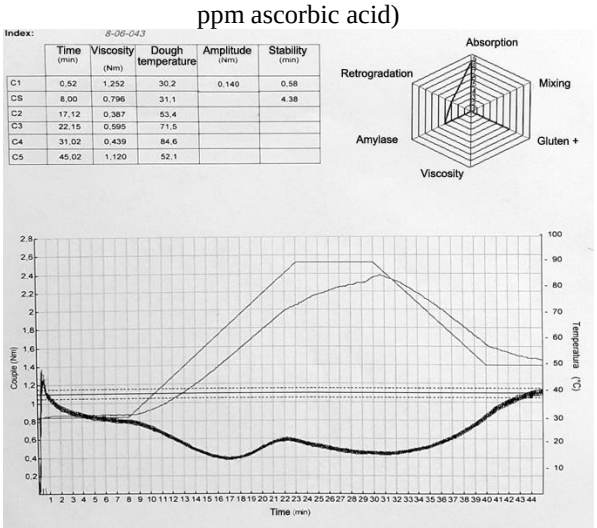

Figure 3. Evaluation curves of P2 (control flour with 30 ppm glucose oxidase)

According to the results obtained by means of Mixolab Profile, for the same percentage of additives used, one can notice that the index of absorption is not influenced, remaining at the maximum value of 8. As the rice flour does not form gluten, this aspect is also checked by the index of mixing which is 0 in all the samples and by the index of viscosity which is 0 in all the samples. The gluten index is high, 5 and 6 respectively, fact which stands for dough's high resistance.

As regards the amylase activity, the index is a medium one: 4, and regarding the retro gradation, low values of this index show that long shelf life is provided.

Stabilities at mixing are low, but there is an increase of stability in the system. The best stability is observed at the addition of glucose oxidase, 4, 53 minutes as against the control sample 3, 78 minutes.

From the analysis of α parameter, the slope which represents the soaking rate of proteins due to heat, one can notice that the highest breakdown rate of proteins when heated is registered by P2 with addition of 30 ppm glucose oxidase

$$\alpha_M < \alpha_{P1} < \alpha_{P2}$$

$$-0,0076 < -0,062 < -0,054, \text{ Nm/min}$$

From the analysis of β parameter, the slope which represents the jellifying rate of starch, it is obvious that the highest rate is registered by the control sample:

$$\beta_M > \beta_{P1} > \beta_{P2}$$

$$0,076>0,070>0,060, \text{ Nm/ min}$$

The last parameter completing the rheological analysis of samples is γ, the slope which represents the rate of enzymatic breakdown.

As it was foreseen, the highest rate of enzymatic breakdown is registered by P2 with addition of 30 ppm glucose oxidase:

$$\gamma_{P2}>\gamma_M>\gamma_{P1}$$

$$-0,008>-0,016>-0,022, \text{ Nm/ min}$$

3.Results and discussion

When biscuits are being brought into discussion, the keeping of their form is an essential parameter, as all along the technological flow it influences the losses in the packaging process. It is acknowledged the fact that biscuits' packaging is strict: the sizes of individual and collective packages are well known. Therefore, keeping constantly the form and size, for each batch of dough is extremely important.

The dough for biscuits was made on the basis of a recipe calculated for 100 kg of rice flour, called control M and shown in the table 1. Sugary dough (short dough) was shaped and its form after being shaped was analyzed. Similarly the things were done for the samples P1 and P2.

Table 1. Standard Recipes for 100 kg flour

Ingredients	**UM**	**Control sample biscuits, M**	**Ascorbic acid addition**	**Glucose oxidase addition**
			P_1, 30 ppm	**P_2, 30 ppm**
M (rice flour)	kg	100	100	100
Ascorbic acid	kg	-	0.03	-
Glucose oxidase	kg	-	-	0.03
Butter (80% fat)	kg	30	30	30
Sugar	kg	20	20	20
Whole fresh eggs	kg	30	30	30
Iodized salt	kg	2,0	2,0	2,0

The shaped dough was analyzed from the point of form on the basis of the standard SR EN ISO 13299:2016.

Preparation consisted in the mixing of fat with sugar until a cream was obtained, to which eggs and salt were added. Then the flour was mixed in gradually till homogeneous sufficiently plastic dough was obtained.

Biscuits were shaped by laminating the dough and cutting them out the dough sheet.

The shape of P2 is the closest to the control M in terms of size after shaping. This fact shows that the glucose oxidase addition is not as aggressive against the dough as the ascorbic acid is. The results were analyzed from the organoleptic point of view by the method of shape scoring and the average values obtained are shown in the table 2. The maximum grade is considered 5.

Table 2. Mean scores for sensory analysis

Shape		
Well shaped (target 5 points)		
M	P1	P2
4.85	3,6	4,15

Table 3 presents the ANOVA statistical analysis for the results obtained by mixolab. For the hydration capacity (CH), the F ratio was relatively high in the dataset, the differences between the sample means being minimal, which indicates very small variance within the samples. The P value is almost 0, confirming the statistical significance.

Table 3. ANOVA analysis for mixographic results

Mixolab analysis	**Sum of squares**	**Df**	**Squares mean**	**Fischer ratio**	**P**
Hydration capacity (HC)					
Set	68.778	2	34.3888	50.2	$3.183*10^{-15}$
Error	59.594	87	0.685		
Total	128.371	89			
Stability (S)					
Set	43.556	2	21.7781	25.48	$1.9441*10^{-9}$
Error	74.348	87	0.8546		
Total	117.905	89			

For stability (S) the F ratio has a relatively high value for the dataset, while the rather large variance between the samples means indicates a small variance within the groups. The P value is almost 0, confirming the statistical significance.

4.Conclusions

When making biscuits, the most important aspect from the technological point of view is the maintaining of shape as constant as possible.

From the study hereby dealt with, it is obvious that the addition of glucose oxidase in the rice flour which does not form gluten network is more adequate than the ascorbic acid one to improve and maintain constant the biscuits' shape.

From the analysis of samples, based on the protocol Mixolab Profiler, mention should be made that there is no target profile for the rice flour to be applied for biscuits. Therefore, we can state that this research comes to the support of producers of rice flour biscuits, by proposing a flour profile. Definitely the target can be reached also by other types of enzymes used, depending on the basis of rice flour which is available. Six indices of quality shown by Mixolab Profiler.

- According to the results obtained by means of Mixolab Profile, for the same percentage of additives used, one can notice that the index of absorption is not influenced, being at the maximum value of 8.
- As the rice flour does not form gluten, this aspect is also checked by the index of mixing which is 0 in all the samples and by the index of viscosity which is 0 in all the samples.
- The gluten index is high, 5 and 6 respectively, fact which stands for dough's high resistance.
- As regards the amylase activity, the index is a medium one: 4, and regarding the retro gradation, low values of this index show that long shelf life is provided.
- Stabilities at mixing are low, but there is an increase of stability in the system. The best stability is observed at the addition of glucose oxidase, 4, 53 minutes as against the control sample 3, 78 minutes.
- α parameter, the soaking rate of proteins due to heat, one can notice that the highest breakdown rate of proteins when heated is registered by P2 with addition of 30 ppm glucose oxidase
- β parameter, the jellifying rate of starch, has got the highest value in the control, showing that additives do not influence the starch's jellifying
- γ parameter, the rate of enzymatic breakdown, has got the highest value when enzymes are added, P2 of 30 ppm glucose oxidase

Of the two types of samples made, it is clear that P2 has a better stability with the addition of glucose oxidase for the making process of rice flour-biscuits. Hence, by extrapolation, a pilot profile can be made to be put to more tests until it gets rough-wrought.The profile proposed index for carrying further the research is: 8-06-042.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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