

MIXOLAB PROFILES OF GLUTEN FREE PRODUCTS INGREDIENTS

Aleksandra Torbica^{1*}, Miroslav Hadnađev¹, Petar Dokić¹,
Marijana Sakač¹



UDC 664.664: 664.236

¹Institute for Food Technology, Novi Sad, Serbia

Abstract: *Properties of gluten free components, especially hidrocoloids, are thoroughly investigated and there are published a lot of results. Experiments were usually based on characterisation system of hidrocoloids and water, as well as hidrocoloids and wheat flour. Also, there are data from a number of investigations about the influence of hidrocoloids to gluten free components in terms of viscous properties and impact on the quality of the final product. In this paper will be illustrated behavior usually used gluten free components measured by Mixolab device, which characterizes the treatment of components in terms of their behavior during mixing and heating.*

Key words: *mixolab, gluten free food, rheology*

INTRODUCTION

Rheological properties of gluten free raw materials are examined in a mixture with wheat flour or in a mixtures of gluten free raw materials. Individual investigations are not feasible by methods of applied rheology. Therefore, in this paper are presented Mixolab profiles of gluten free ingredients: different types of flour, starch and the most co-

mmonly used hidrocoloid gums - xantan and guar gum.

Wheat proteins have the unique properties of developing a viscoelastic matrix when wheat flour is mechanically mixed with water. This viscoelastic network enables the dough to hold the gas produced during the fermentation process, leading to an aerated crumb bread structure. Unfortunately, gluten

*Corresponding author:

e-mail: aleksandra.torbica@fins.uns.ac.rs

Tel: +381 21 485 3779; Fax: +381 21 450725

must be kept apart from the diet of celiac patients, who suffer very important intestinal damage when they ingest gluten-containing products. This technological obstacle has been overcome by using complex bread recipes with different starches and cereal flours like corn starch, brown rice, soy and buckwheat flour (Brites et al., 2008).

Celiac disease is a gluten-sensitive enteropathy with genetic, immunologic and environmental basis. People suffering gluten intolerance (celiac disease) are diagnosed everywhere in the world (Gujral et al., 2004).

Gluten is the main structure-forming protein in flour, and is responsible for the elastic and extensible characteristics of the dough, thus the replacement of gluten by starch results in a major challenge to the cereal technologist mainly from the rheological point of view. Gluten-free starches and flours have been utilized to formulate breads, however they fail to form a continuous phase and thus lack the necessary dough structure for the production of a good quality dough. Thus, gluten-free bakery products require polymeric substances that mimic the viscoelastic properties of gluten in doughs (Garcia et al., 2005).

Gluten may be to some extent replaced by natural or synthetic raw materials, which can significantly swell in water and form structural equivalent of gluten network in wheat dough. The most commonly used are such hydrocolloids as pectin, guar gum, arabic gum, egg albumin, galactomannans and methylcellulose. Hydrocolloids and their mixtures impact rheology of the dough as well as its baking properties and the final bread texture. Technical difficulties during gluten-free bread production (as well as gluten-free pasta) were described by many authors. Gluten free bread, based on starch, is less tasty than traditional bread and has a high staling tendency.

The crumb which after baking is wet and sticking together, on the next day becomes dry, rough and crumbly. Because home-made gluten-free bread is prepared for several

days, it is very important to preserve sufficient organoleptic quality during the storage.

Many parameters of gluten-free bread depend on the amount and type of non-starch hydrocolloids used as gluten replacers, as this determines interactions between them and starch, which is the main component of dough. There are reports on the interactions between starch and other polysaccharide hydrocolloids, such as pectin, guar gum and xanthan gum. In the earlier studies on the quality of gluten-free bread the synergistic action of guar gum and pectin in the mixture with corn starch was reported (Gambus et al., 2007).

Other compounds usually added to starch containing products are gums or hydrocolloids due to their desirable effect on the acceptability of foodstuffs. Hydrocolloids or gums have been widely used in food technology as additives in order to: (i) improve food texture, (ii) slow down the retrogradation of the starch, (iii) increase moisture retention, (iv) extend the overall quality of the product during time, and also (v) as gluten-substitutes in the formulation of gluten-free breads since gums could act as polymeric substances that mimic the viscoelastic properties of gluten in bread doughs. Among the hydrocolloids tested are guar gum, locust bean gum or xanthan gum but the majority of those studies were focused on clarify the exact mechanism of interactions between the hydroxyl groups from the hydrocolloid and the starch components, and those analysis have been performed by using high concentrations of hydrocolloids. (Rojas et al., 1999).

The development of good-quality gluten-free bread is a serious task; therefore, many researchers have investigated the substitution of gluten by ingredients able to mimic its functional properties. Several hydrocolloids are used for obtaining high-volume and soft crumb texture breads. Different nongluten proteins as soybean, pea, egg, and dairy proteins have been included in gluten-free formulations to provide structure and gas-retaining properties to the dough

and to improve simultaneously the nutritional quality of these breads. Other gluten-free flour as sorghum, buckwheat, and amaranth have been used in bread formulation. (Sciarini et al., 2008)

Mixing is an important step of dough formation. This work was also meant to study the effect of mixing on the thermal properties of starch.

Since most wheat flour is used for products that require the presence of water and mixing, it is relevant to investigate the effect mixing on wheat flour. Starch is a component of wheat flour affected by the amount of available water and the mixing process. Starch has a clear and measurable thermal transition that can be altered by mixing and water availability (Mohamed&Rayas-Duarte, 2003).

During the baking process, flour compounds are subjected to mechanical work and heat treatment that promote changes in their physicochemical properties. Usually, independent devices have been used to characterize the rheological changes of the dough. The mixing process, where the protein network is formed, and the viscoelastic behaviour, when wheat dough is exposed to large uni- and biaxial deformations, have been successfully characterized through different devices. On the other hand, the modifications undergone during heating have been extensively followed through the changes of the viscosity in wheat flour slurries. However, wheat flour slurries show different behaviour than wheat dough systems, where the amount of water is a limiting factor during starch swelling, even more noticeable when hydrocolloids are present due to their ability for holding water.

The macroscopic effect of hydrocolloids on wheat dough has been explained by structural changes induced in the main components of wheat flour. However, there is not a general consensus about the mechanism of action of the hydrocolloids (Collar et al., 2003).

The Mixolab technique can be considered as an imitative/descriptive empirical method as the classical instruments Farinograph, Mixograph, Extensograph or Alveograph, which predict, in variable extent, final product quality by simulating the steps of the breadmaking process (Collar et al., 2003).

MATERIAL AND METHODS

Material

Investigated samples are the most commonly used components included in the composition of gluten free products: soya flour, amaranth flour, rice flour, buckwheat flour, wholegrain buckwheat flour, maize starch, potato starch, xantan and guar gums.

Method

Whole Meal and Flor from *T. aestivum* – Determination of Rheological Behavior as a Function of Mixing and Temperature Increase

Dough behavior during the mixing process is related to many parameters. Some are more related to protein content and quality such as water uptake, dough development time, and dough stability during mixing. Others are related to starch content and quality such as gelatinization, setback, gelling, etc.

By measuring the torque of the dough during mixing with an increase in temperature, the Mixolab makes it possible to have complete information on the sample allowing the user to better understand the wheat or flour characteristics.

This method is applicable to flour obtained from *T. aestivum* coming from a laboratory or an industrial mill. It can also be applied to whole meal of wheat ground under standardized conditions.

Determination of dough behaviors subjected to mixing stresses and temperature stresses during constant phase, followed by a heating phase, a holding phase at high temperatures, and a cooling phase. Flour is hydra-

ted to reach a maximum consistency (1.1 Nm) during a first phase at 30 °C. The dough is mixed between two mixer arms with a rotating speed of 80 rpm. The torque created by the dough between the two arms is registered. Mixing continues as the mixer temperature is raised to 90 °C with a temperature increase of 4 °C/minute. Temperature is maintained at 90 °C for 15 minutes. The mixer bowl is then cooled down to 50 °C with a temperature decrease of 4 °C/minute. Dough consistency during the entire process is measured as well as dough temperature. The results give indication on the protein strength, starch gelatinisation and retrogradation, enzymatic systems as well as interactions (ICC 173).

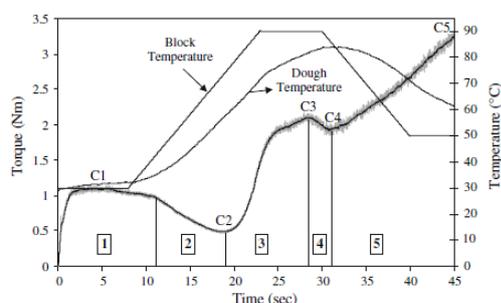


Fig. 1 Description of a typical curve obtained in the Mixolab. The numbers indicate the different areas detected in the curve according to the wheat bread dough changes. (1) Dough development. (2) Protein reduction during heating. (3) Starch gelatinization. (4) Amylase activity. (5) Starch gelling due to cooling. (Kahraman et al., 2008)

The Mixolab system, recently launched by Chopin Technologies (France), measures and plots in real time the torque (expressed in Nm) produced by passage of the dough between the two kneading arms (Figure 1), thus allowing the study of mixing and pasting behaviour of the wheat flour dough. For the assays, 50 g of wheat flour were placed into the Mixolab bowl and mixed with the rest of the ingredients following the factorial

design. The amount of water (water absorption) to be added was previously determined in the Brabender farinograph. The protocol consisted of a heating/cooling cycle after a certain mixing time at constant mixing speed. Main derived parameters from the Mixolab curves are the following: development (C1) or maximum torque reached during mixing at 30 °C, stability (min) or elapsed time at 30 °C at which the torque is kept at 1.1Nm, stability during heating (min) or elapsed time during heating at which the torque is kept at 1.1Nm, beginning of protein weakening, is the temperature at which dough consistency starts to decrease, protein reduction (Nm, C2) or the minimum torque produced by dough passage subjected to mechanical and thermal constraints, protein weakening or torque difference between the maximum torque at 30 °C and minimum torque, starch gelatinization (Nm, C3) or peak torque produced during the heating stage, temperatures associated to the starch gelatinization comprises initial and final pasting and pasting temperature range, starch gelatinization range or the torque difference between the starch gelatinization and the protein reduction, amylase activity (Nm, C4) or the minimum torque reached during cooling to 50 °C, cooking stability range (Nm) calculated as the difference between the amylase activity and the starch gelatinization, starch gelling (Nm, C5) or the torque after cooling at 50 °C, cooling setback (Nm) the difference between the torque produced after cooling at 50 °C and that defines the amylase activity. In addition, the angles between ascending and descending curves α , β and γ were calculated and defined as protein breakdown, gelatinization and cooking stability rate, respectively.

RESULTS AND DISCUSSION

In Table 1 parameters values of Mixolab determinations for all measured samples are presented.

Table 1.
Parameters values of Mixolab curves of all samples

	C1			C2			C3			C4			C5		
	Time (min:s)	Torque (Nm)	Temperature (°C)	Time (min:s)	Torque (Nm)	Temperature (°C)	Time (min:s)	Torque (Nm)	Temperature (°C)	Time (min:s)	Torque (Nm)	Temperature (°C)	Time (min:s)	Torque (Nm)	Temperature (°C)
Wheat flour	01:21	1,05	29,5	17:49	0,53	53,7	24:20	2,31	76,5	35:45	1,88	81,4	45:02	2,57	62,6
Soya flour	00:30	1,44	29,5	23:30	0,62	72,4	36:18	0,91	79,0	36:32	0,87	78,6	45:03	1,07	62,0
Amaranth flour	00:30	1,09	29,6	19:45	0,15	60,2	45:02	0,39	59,4	-	-	-	-	-	-
Rice flour	08:46	1,07	32,3	16:48	0,81	50,4	24:50	2,77	77,9	33:08	2,52	85,9	45:03	3,16	65,0
Buckwheat flour	06:38	1,10	31,7	18:11	0,49	59,2	29:00	1,86	85,7	32:41	1,82	85,7	45:03	2,59	62,8
Buckwheat wholegrain flour	05:56	1,09	30,7	18:58	0,37	56,6	24:53	1,30	76,3	32:36	1,13	83,9	45:03	1,62	61,9
Maize starch	00:36	0,28	30,2	19:41	-	59,5	26:18	2,64	80,6	33:36	2,13	84,4	45:02	2,84	62,4
Potato starch	10:14	0,98	33,8	18:32	0,53	54,2	25:11	3,76	76,8	31:51	3,04	86,2	45:03	4,77	65,9
Xantan gum	00:30	2,01	28,6	00:46	0,81	28,9	09:12	2,67	33,9	20:42	2,02	63,7	45:02	3,69	62,8
Guar gum	00:53	2,79	29,3	20:34	1,14	62,4	34:14	1,90	82,8	37:23	1,78	78,0	45:03	1,67	62,2

If we treated the sample of wheat flour as standard sample, we could notice that the most similar Mixolab characteristics to wheat flour have samples of rice, buckwheat and buckwheat wholegrain flours. Behaviour of non-wheat flours are the most different from the wheat flour in the first part of the curves, which means that their proteins have smaller water absorption (Figs. 2, 5, 6 and 7), and from that reason those flours in comparing with wheat flour need

more time to achieve maximum torque during mixing at 30 °C (C1).

Two samples of starches have very different Mixolab profiles between themselves in the whole measurement range (Figs. 8 and 9).

Different trends of time-tempering regime between each other also show the Mixolab curves of hydrocolloids-xantan and guar gums (Figs. 10 and 11).

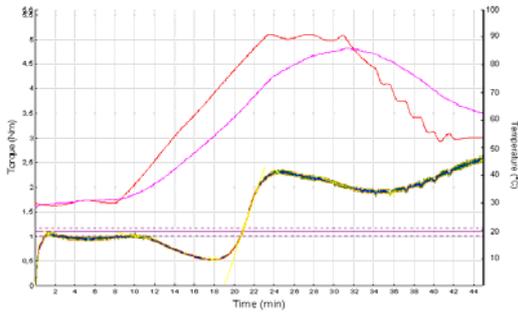


Fig. 2. Mixolab profile of wheat flour

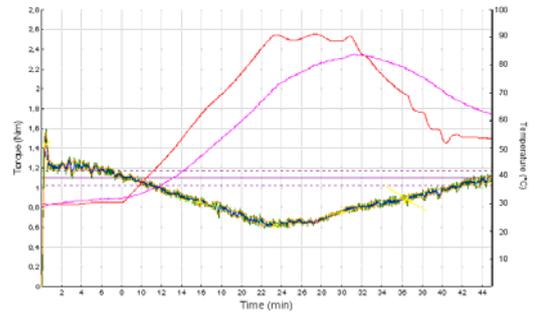


Fig. 3. Mixolab profile of soya flour

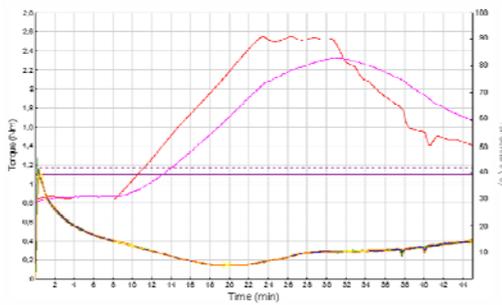


Fig. 4. Mixolab profile of amaranth flour

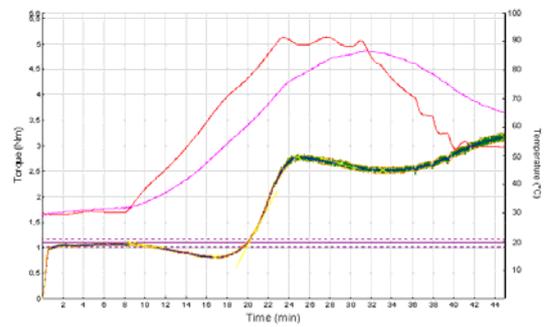


Fig. 5. Mixolab profile of rice flour

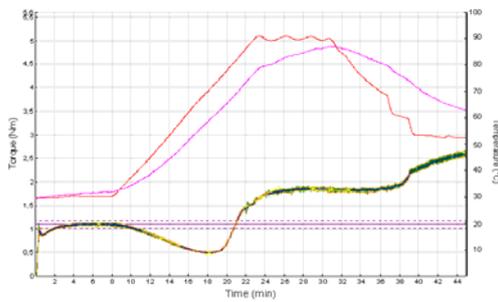


Fig. 6. Mixolab profile of buckwheat flour

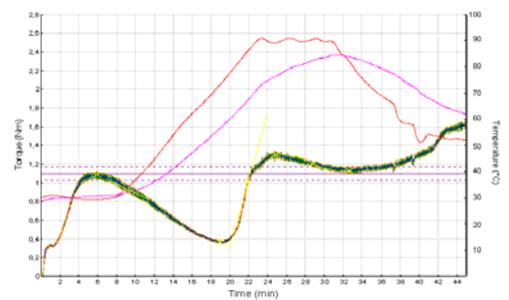


Fig. 7. Mixolab profile of buckwheat wholegrain flour

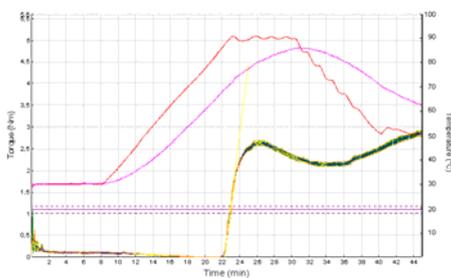


Fig. 8. Mixolab profile of maize starch

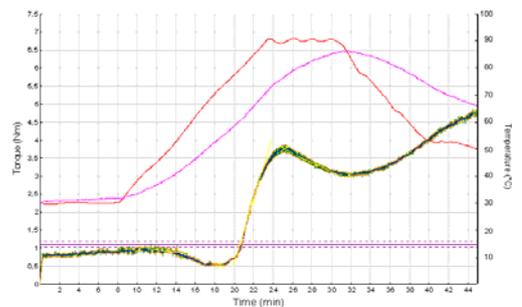


Fig. 9. Mixolab profile of potato starch

Mixolab characteristics of the flour samples were determined and are presented in Figures 2-7. Mixolab characteristics of the starch samples were determined and are presented in Figures 8 and 9. Maize is a gluten-free cereal, thus suitable to produce foods addressed to celiac patients. The acquired knowledge on broa (made from compositemaize-rye-wheat flour) is important for facing the challenges in producing gluten-free bread that usually exhibits compact crumb texture and low specific volume. Therefore, a better understanding of this breadmaking process would provide the basis for developing glutenfree bread based on maize flour. (Brites *et al.*, 2008). Mixolab characteristics of the gum samples were determined and are presented in Figures 10 and 11.

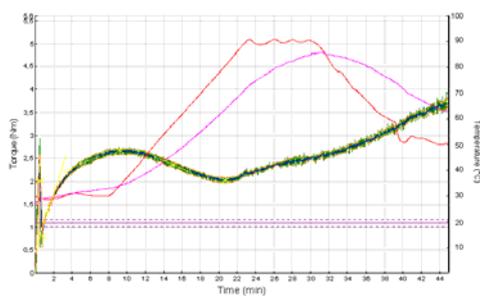


Fig.10. Mixolab profile of xantan gum

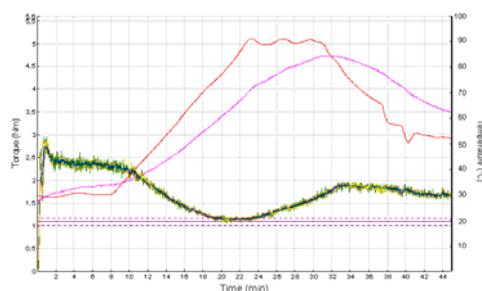


Fig.11. Mixolab profile of guar gum

Xanthan gum and guar gum are some of the hydrocolloids that may be added to gluten-free doughs. The specific polysaccharide component of guar gum is guaran, a galactomannan where about one-half of the beta-D-mannopyranosyl main-chain units, joined by (1→4) bonds, contain an α-D-galactopyranosyl side chain attached at O-6. Xanthan gum is an exocellular polysaccha-

ride produced by the bacterium *Xanthomonas campestris* and it may be considered an anionic polyelectrolyte. Its primary structure is based on a β-1,4 linked glucan backbone, as in cellulose, but every second glucose residue is attached to a charged trisaccharide side chain (β-D-mannopyranosyl-(1→4)-β-D*-glucuronopyranosyl-(1→2)-o-acetyl-β-D-manno-pyranosyl units, about half of them have pyruvic acid attached to a 4,6-cyclic acetal). Pseudoplastic behavior of xanthan gum is important in bakery products during dough preparation, i.e. pumping, kneading and rolling. Interactions between xanthan gum and guar gum have synergistic effects, such as enhanced viscosity that can improve dough handling (Garcia *et al.*, 2005).

CONCLUSION

The illustrated Mixolab profiles of gluten free ingredients give a information of their rheological behaviour. This is very important in creating of new products, because we could predict some properties of them. Also, this method is not time consuming, so on this way producer obtain useful and fast data.

ACKNOWLEDGMENTS

This work was supported by the Project No 20068, Ministry of Science and Technological Development, Republic of Serbia.

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