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EFFECT OF DRY SOURDOUGH ADDITION IN WHEAT FLOUR ON DOUGH RHEOLOGICAL PROPERTIES

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Abstract

The aim of this work was to characterise the rheological changes of wheat doughs with dry sourdough addition on mixing and pasting characteristics. Nowadays, it is well known that there is an increased demand for bakery products, obtained from natural ingredients, with good sensory characteristics. The use of sourdough in wheat flour improves bread sensory characteristics of bakery products which may present a better taste and flavour and longer shelf-life. Our study meets the demands of bakery consumers which desire products close, if it is possible to the traditional ones, by using the sourdough in the bread recipe. The advantage of this process is that the sourdough is directly introduced in the bread recipe fact that now in the "century of speed" facilities the bakery process. In order to know the way in which sourdough may change the bakery technological behaviour it is important to study dough rheological characteristics. For this purpose our study analyzes by using modern devices such as Farinograph, Extensograph and Amylograph the way in which sourdough addition changes dough rheological characteristics.

Key words*: Amylograph, bread, dry sourdough, Extensograph, Falling Number, Farinograph, wheat flour.*

INTRODUCTION

Sourdough has been used in the preparation of bread as a leavening agent for over 500 years and represents one of the oldest traditional and biotechnological products of all fermented foods (Arendt et al., 2007; Yu et al., 2018).

Sourdough is characterized as a dough composed of flour and water fermented by yeast and lactic acid bacteria and is used in the bakery industry as a leavening agent (Siepmann et al., 2018).

Poutanen et al. (2009), Manini et al. (2016) and Neysens & De Vuyst (2005) reported that sourdough due to its higher acidity, antifungal and antimicrobial activity may improve the shelf-life of the final product. Moreover, a considerable consensus has been reached on the positive effects of using sourdough in bread making, such as increased bread volume in the finished products an improved crumb structure (Clarke et al., 2004) and better sensory and aroma profile(Corsetti, 2012). Sourdough fermentation influences the rheological and functional properties of bakery products, affecting the rheology of the dough in two stages; at the first stage, that of sourdough itself and at the second stage, that of bread dough prepared with sourdough. In sourdough, fermentation decreases elasticity and viscosity of the wheat flour dough; therefore, addition of sourdough to bread dough results in less elastic and softer dough (Chavanet al., 2011; Clarke et al., 2002; Wehrle et al., 1997).

By adding sourdough in bread recipe all parameters change significantly such as dough's characteristics, nutritional value of bread, taste and flavour (Chavan et al., 2011; Katina et al., 2006; Tafti et al., 2013).

Sourdough has a major effect on dough properties and bread quality and in wheat breads, sourdough may be used to reduce phytic acid content which is a natural anti-nutrient compound found in the flour (Hansen et al.,1994; Clarke et al., 2002; Crowley et al., 2002; Lavermicocca et al., 2003; Dal Bello et al., 2007)

In recent years, the tendency of consumers towards traditional products has resulted in a huge success of traditional bread prepared with sourdough which produce a more natural taste and is healthier for the human body (Brummeret al., 1991).

Despite its long tradition and the well-documented positive effects on bread products, the use of sourdough in a dry form is not very

common in Romania however there is an increased tendency of using it The producers do not fully understand the influence of it's use on dough and finished products, which is significant (Armero et al., 1996; Gobbetti, 1998; Hammes et al., 1998; Brandt, 2001).

However, in addition to the positive aspects of adding the sourdough in the bread receipt, there are some disadvantages due the fact that it addition during mixing modify the technological process of bread making. Therefore, it is necessary that all the technological parameters of bread making to be adapted due to the dry sourdough addition in order to obtain bakery products of a good quality. Successful development of equipment for mechanized sourdough production is a positive step toward safe, competitive application of sourdough in wheat bread production. Initially, most used sourdoughs were liquid sourdoughs obtained through fermentation of wheat flour dough, that could be pumped on the fabrication process (Brümmer, 1991). The fermentation process changes the flow behaviour, viscosity and density of dough and also the chemical composition and microbial status of sourdough (Meuser et al., 1993). Many factors influence the rheological characteristics of the fermented dough. At the beginning of the mixing process, physical actions such as hydration take place, the gluten network is formed by proteins, and starch granules absorb water. Enzyme activity of amylases, proteases, and hemicelluloses causes the breakdown of several flour components (Wehrle et al., 1997). Recent researchers have led to systems that work with dry sourdough in a powder form (Meuser, 1995).

The aim of this work was to investigate the effect of the addition of dry sourdough (DS) on dough rheological properties by addition up to 5% sourdough.

MATERIALS AND METHODS

Wheat flour (harvest 2019) of a refined type was provided by S.C. MOPAN S.A. (Suceava, Romania) and dry sourdough from wheat flour by Enzymes & Derivates S.A. Company (Romania, Neamt).

The wheat flour was analyzed through the international and Romanian standard methods: falling number (ICC 107/1), wet gluten (SR90:2007) and gluten deformation index (SR 90:2007).

Dough rheological properties during mixing were analyzed by farinographic and extensographic assays.

The Farinograph device (Brabender, Duigsburg, Germany, 300 g capacity) and Extensograph device (Brabender OGH, Duisburg, Germany) was used according to ICC method 115/1.

The pasting properties of dough samples were analyzed by using the Falling Number (Perten Instruments, Sweden) device according to ICC method 107/1 and the Amylograph (Brabender OGH, Duisburg, Germany) device according to ICC method 126/1.

Statistical analysis was performed with XLSTAT (Version 2019.14.1, free trial; Addinsfot's Corporation, USA). A Tukey and ANOVA tests were performed with a 95% confidence interval.

RESULTS AND DISCUSSIONS

The wheat flour used in this study is one of a very good quality for bread making, with a low α amylase activity according to the obtained data: 0.66 g/100 g ash content, 14.0 g/100 g moisture content, 12.7 g/100 g protein content, 30 g/100 g wet gluten content, 6 mm gluten deformation index, and 442 s Falling Number value.

Effect of dry sourdough on Farinograph characteristics

The Farinograph is the standard device used for measuring water absorption capacity, and it is a very useful tool for measuring the mixing characteristics of wheat flour giving good indication of flour performance in bread making (Catterall, 1998).

According to the standard procedure (ICC 115/1) the following Farinograph indices were determined: water absorption (WA), development time of dough (DT), stability of dough (ST), and the degree of softening of dough (DS).

Table 1 shows the values obtained from the Farinograph for dough samples with different levels of dry sourdough addition. It may be seen that the addition of dry sourdough significantly increases the water absorption (WA) up to 3.2% compared to the PM3 sample and 2.8% compared to the PM4 sample.

Table 1. Farinograph parameters of wheat flour with dry different level of dry sourdough

Sample	Parameters			
	WA (%)	DT (min)	ST (min)	DS (BU)
PM1	60.0±0.01	1.7±0.01	2.5±0.01	66±2.00
PM2	60.6±0.01	1.9±0.01	2.3±0.02	77±1.00
PM3	61.8±0.01	1.5±0.01	1.3±0.02	93±1.00
PM4	63.2±0.01	1.7±0.02	1.2±0.01	127±1.00
PM5	62.8±0.02	1.5±0.01	1.1±0.01	142±1.00

Farinograph parameters: WA, water absorption (%), DT, dough development time (min), ST, dough stability (min), DS, degree of softening at 10 min (BU)

It may be seen that DT (Figure 1) do not change in a significant way and it may be noticed a slight decrease of this value to PM 5 sample. This may be due (Hoseney, 1994) to the decrease of dough pH values by the dry sourdough addition. Hoseney (1994) reported that the pH value of the dough has major influences on the mixing time so that the doughs with lower pH require shorter mixing times.

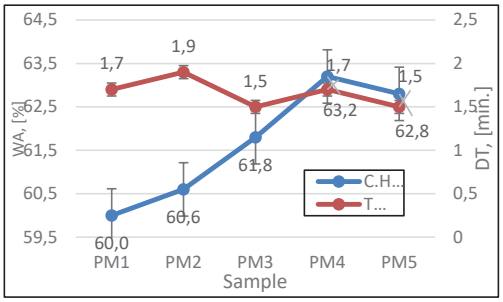

Figure 1. Representation of the correlation between water absorption and dough development time

Along DT decrease it may be seen also a decrease of ST values. Also, as it may be seen from the Figure 2 the degree of softening at 10 min (DS) increases, the maximum value being obtained for the PM5 sample which is the dough sample with the highest content of dry sourdough addition in wheat flour.

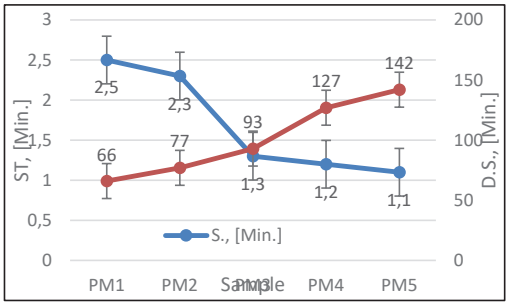

Figure 2. Representation of the correlation between dough stability and degree of softening

Effect of dry sourdough on Extensograph characteristics

The Extensograph gives information about dough extensibility and resistance to extension (Walker et al., 1996). A very desirable trait for the dough is a good combination of resistance and good extensibility.

With the increase level of dry sourdough addition from 1% to 5% the extensibility of dough gradually increased (Table 2).

Table 2. Extensograph parameters of wheat flour with different level of dry sourdough

Parameter	Sample	Time		
		45 min	90 min	135 min
Energy,E (cm^2)	PM1	52±1.00	54±1.00	58±1.00
	PM2	48±1.00	46±1.00	49±1.00
	PM3	41±1.00	40±1.00	35±1.00
	PM4	27±2.00	28±2.00	29±2.00
	PM5	39±1.00	39±1.00	39±1.00
Resistance to extension, R_{50} (BU)	PM1	230±2.00	236±1.00	235±2.00
	PM2	229±1.00	235±1.00	234±1.00
	PM3	228±1.00	237±1.00	236±1.00
	PM4	208±1.00	210±2.00	211±1.00
	PM5	207±1.00	209±1.00	210±1.00
Extensibility, E (mm)	PM1	136±1.00	137±1.00	148±2.00
	PM2	137±1.00	135±1.00	147±1.00
	PM3	135±1.00	136±1.00	149±1.00
	PM4	138±1.00	140±1.00	141±1.00
	PM5	137±1.00	139±1.00	142±1.00
Ratio number	PM1	1.7±1.00	1.7±1.00	1.6±1.00
	PM2	1.6±1.00	1.8±1.00	1.5±1.00
	PM3	1.8±1.00	1.6±1.00	1.7±1.00
	PM4	1.5±1.00	1.6±1.00	1.5±1.00
	PM5	1.4±1.00	1.7±1.00	1.4±1.00

The increase in proofing time also caused a higher value of dough extensibility. The energy or work input necessary to promote the deformation was increased with the addition of 1% to 5% dry sourdough, for all resting times. A slight decrease in deformation energy of the dough containing dry sourdough was also reported by Kulp et al. (2003), Esteve et al. (1994), Gocmen et al. (2007). They concluded that as the sourdough level increased, the resistance to extension decreased.

Effect of dry sourdough on Falling Number and Amylograph characteristics

The effects of the addition of dry sourdough on the amylograph parameters can be noted in Table 3. A significant decrease in gelatinization temperature (Tg) and peak viscosity (PV) has been noticed with the increase level of dry sourdough addition. Also a significantly decreased of the falling number values was noticed by dry sourdough addition. As it may be seen the FN value decreased up to 18.4% for the

sample with 5% dry sourdough addition in wheat flour. This fact indicates that α amylase activity in dough system increased. This may be due to the α amylase content from dry sourdough or due to the pH change from the dough up to levels to optimum α amylase activity. Also it may be noticed a decreased in PV_{max} up to 8.43% for PM5 sample. This value may be correlated with FN value. This fact is explainable since it is well known that FN is proportional to the viscosity and inversely proportional to α amylase activity (Codină et al., 2012).

Table 3.Amylograph and Falling Number parameters of wheat flour with different level of dry sourdough

Sample	Parameters		
	Tg (^{0}C)	PV_{max}(BU)	FN (s)
PM1	88.8±0.01	1195±1.00	358±2.00
PM2	88.7±0.01	1184±1.00	345±1.00
PM3	88.5±0.01	1055±2.00	330±2.00
PM4	88.4±0.01	1105±2.00	319±1.00
PM5	88.1±0.15	1102±1.00	302±1.00

Pasting parameters: Tg, gelatinization temperature, PV_{max}, peak viscosity time (min), FN, falling number.

CONCLUSIONS

By adding dry sourdough a significant impact on the dough rheological characteristics was observed. The data obtained showed that the addition of dry sourdough in the flour led to the increase of water absorption (WA) and the dough softening degree (DS) and a significantly decrease of the dough stability (ST). Also it was noticed a decrease of the resistance to extension falling number values and peak viscosity.

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