EFFECT OF SUCROSE ON THE MIXOLAB, ALVEOGRAPH CHARACTERSITICS AND BREADMAKING PROPERTIES OF STRONG WHEAT FLOUR

Georgiana Gabriela CODINĂ[1], V. PÂSLARU[2]

[1]"Stefan cel Mare" University, Faculty of Food Science and Engineering, Suceava, ROMANIA; *e-mail: codinageorgiana@yahoo.com*

Enzymes & Derivates" Co., "Cantacuzino Pascanu" Hall, Costisa Neamt, ROMANIA*;*
e-mail: vasile.paslaru@enzymes.ro

The effects of the addition of sucrose (1%, 3%, 6%, 15%, 20%), on various rheological characteristics of wheat dough from a strong flour has been studied. Rheological investigation (alveograph, mixolab-the latest equipment in this line launched on the market in 2005) and laboratory baking test were used for the characterization of flour and dough. In addition to mixolab experiments, dough consistency decreases and the gelling and diastatic activity of a sweetened dough remain the same apart from the gelling and retrogradation temperature, which are lower, which means better product conservation. In addition to alveograph experiments, sucrose decreases elasticity and increases extensibility leading to a more fragil dough. Although these rheological methods are different, they have both elaborated a rheological optimum for an addition of sucrose of 3-6%. As a result of the baking tests, the optimum dose of 3% of the added sucrose has been set.

Key words: *strong flour, sucrose, mixolab, alveograph, bread volume*

The sucrose is one of the main auxiliary products used in the baking industry. When added to the dough it influences its rheological properties, yest activity and the quality of the product [8]. The proportion of sucrose that is the crystalline state and the size of the sucrose crystals would affect its rate of dissolution in water and, therefore, would affect dough consistency [1].

Dough consistency is recorded during mixing by measuring the resistance of the dough to mixing. The recording dough mixers usually measure the rheological characteristics. Rheological characteristics, such as elasticity, viscosity and extensibility, are important for the milling and baking industry in view of the prediction of the processing parameters of dough and the quality of end products [5]. These rheological characteristics change during the breadmaking process and are difficult to measure in definitive terms [3].

Investigation on flour and dough characteristics have been conducted using traditional instruments as farinograph, alveograph [2] and extensograph [7]. which provided practical information for the bakery industry. The mixolab technique (Chopin, Tripette et Renaud) launched on the market during the annual reunion of AACC 2006 carries out a complete analysis of the flour.. He allows to record the mechanical changes due to mixing and heating simultating the mechanical work as well as the heat conditions that might be expected during the baking process [6]. The tests that have been carried out on this new device by Chopin (France) have shown a very good correlation between the farinographic, consistographic (in the kneading phase) data and the falling index (in the warming phase) with the parameters obtained in the mixolab. From the alveographic point of view, the correlation of the parameters has been unsatisfactionary, probably due to the fact that in the alveographic method the dough must face a biaxial compression, in contrast with the previously mentioned metrhods where the dough must face an uniaxial compression.

Therefore, we have regarded as useful the development of an experimental study on the rheological behavior of the dough with different types of sucrose addition on the devices of 2006-the mixolab and the alveograph.

MATERIAL AND METHOD

Commercial wheat flour (harvest 2006) were milled on an experimental Buhler mill from Mopan S.A. (Suceava, Romania) and granulated sucrose was provided by Enzymes@Derivates (Pascani, Romania). Deionised water was used in all experiments. The effect of sucrose was evalueted by the addition of 1%, 3%, 6%, 15%, 20% related to the flour weight.

Rheological properties of wheat flour were determined by a Chopin alveograph (according ICC Standard 5530-3) and Mixolab (Chopin, Tripette et Renaud). Each alveograph chart was analysed for five factors: P-the maximum over pressure needed to blow the dough bubble-expresses dough elasticity: L- the average abscisa at bubble rupture-expresses dough elasticity, P/L-alveograph ratio, W- the deformation energy, I_e-elasticity index.

The mixolab, developed by Chopin, is an apparatus used to characterise the rheological behaviour of dough subjected to a dual mixing and temperature constraint. It measures in real time the torque (expresses in Nm) produced by passage of the dough between the two kneading arms, thus allowing study of rheological and enzymatic parameters: dough rheologic characteristics (hydration capacity, develpoment time, etc.), protein reduction, enzymatic activity, gelatinistaion and gelling of strach.

The procedure followed for the analysis of the mixing and pasting behaviour to the mixolab is the following: mixing speed 80rpm, tank temeprature 30˚C, heating rate 2˚C/min, total analysis time 45 minute.

The baking test was performed according to the Romanian method and the protocol used was: flour 2100g, yeast 63g, 31.5g salt, sugar in different doses (0%-blank sample, 1%, 3%, 6%, 15%, 20%) and water 1176ml to 29-30˚C. Bread volume was determined after two hours of coolig by means of rape seeds.

RESULTS AND DISCUSSION

Analytical characteristics. The chemical composition of the flour were determined according to Romanian, or international standard methods, indicated the following values (±values given are standard deviations): 0.64±0.05% for ash content, 14.2±0.02 % for water content, 13.2%±0.03 for crude protein, 5mm±0.01 for deformation index, 2.2±0.01% for acidity and 290s for falling number.

Rheological characteristics for mixolab. The results obtained from mixolab measurement of dough are presented in table 1. According to these characteristics in the first phase of the mixolabic curve, the flour supplemented with different doses of sucrose leads to a decrease of the moment opposed by the dough during kneading and to an increase of dough stability up to 3-6% of added sucrose. The explanation is that, once introduced in the dough, the sucrose leads to a dehydration of the proteic micells and to a decrease of its consistency. The sucrose addition leads to an increase of the concentration of solluble substances in free water and therefore, the osmotic pressure increases. Water's ability to mix the components of the flour is modified, the quantity of free water increases, the necessary water in proteins is not to be found anymore thus the dough dissolves, becomes less flexible. Small doses of added sucrose have a positive effect on dough's rheology with a value of approximately 6%. Smaller supplements of sucrose lead to an overwhelming weakening of the glutenic network and therefore to a negative change of the rheological properties of the dough.

The sucrose addition, which competes for water, postpones the bloating of starch grains during gelling (the temperature of zone 2 of the mixolabic curve increases) and impedes the development of the viscosity and gelatine formation.

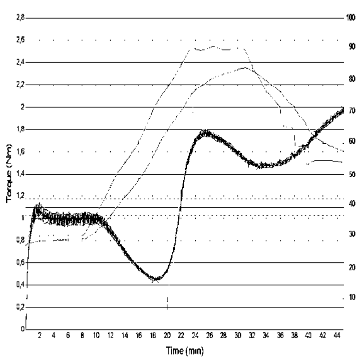
For zones 3, 4 and 5 of the mixolabic curve, the data obtained for the gelling and retrogrdation temperature are lower, which will probably mean better product conservation.

Rheological characteristics for alveograph. The results obtained from alveograph measurement of dough are presented in *table 2*. According to these characteristics a decrease of dough resistance occurs (given by parameter P) along with an increase of its extensibility in relation with the quantity of added sucrose. Parameter W decreases by supplementing dough with sucrose, its value being brought in the domain in which superior-volume bread is obtained. The rheological properties of the dough have achieved optimum values for a dose of 3-6% sucrose added.

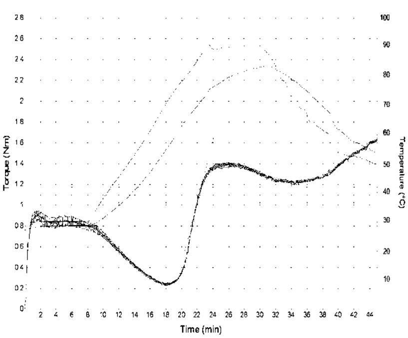
Tabel 1

The parameters resulted on the alveograph for the doughs obtained from wheat flour dough supplemented with different sucrose doses

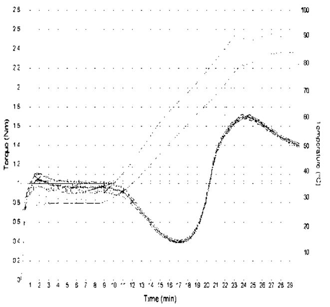
Characteristics / Samples		0%	1%	3%	6%	10%	15%	20%
WA (%)		56%						
Dough development (C1)	Formation time C1 (min:s)	01.51	02.05	01.51	01.33	01.49	01.39	01.29
	C1 (Nm)	1.08	1.07	1.05	1.04	1.00	0.91	0.9
	Dough temperature (°C)	28.2	28.4	28.7	28.1	28.5	28.5	28.7
	Stability (min:s)	10.30	10.40	10.34	10.40	08.15	08.07	07.37
Protein breakdown (C2)	Formation time C2 (min:s)	18.19	18.08	17.06	18.55	18.17	17.56	18.29
	C2 (Nm)	0.45	0.45	0.40	0.37	0.28	0.26	0.25
	Dough temperature (°C)	56.6	56.8	57.1	57.3	57.5	57.7	57.9
Starch gelatinization (C3)	Formation time C3 (min:s)	25.18	25.24	24.30	25.02	25.06	26.25	26.37
	C3 (Nm)	1.77	1.77	1.70	1.66	1.52	1.43	1.42
	Dough temperature (°C)	78.8	78.2	80.1	76.9	79.1	80.1	79.9
Amylase activity (C4)	Formation time C4 (min:s)	33.01	34.57	30.3	35.45	34.37	34.25	34.51
	C4 (Nm)	1.47	1.42	1.41	1.18	1.00	0.96	0.92
	Dough temperature (°C)	81.6	78.0	84.9	76.2	76.7	78.2	77.4
Starch gelling (C5)	Formation time C5 (min:s)	45.03	45.03	45.03	45.03	45.03	45.03	45.03
	C5 (Nm)	1.98	1.79	1.65	1.49	1.31	1.28	1.15
	Dough temperature (°C)	57.4	56.9	56.1	55.9	53.4	53.6	53.7



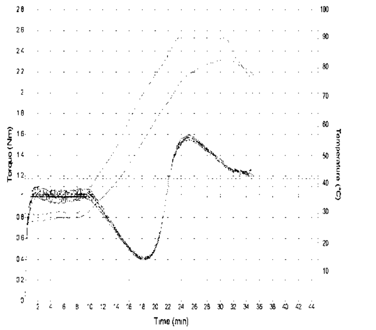
0% sucrose



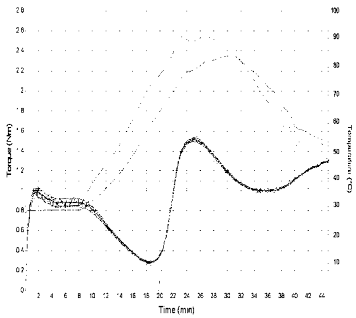
6 % sucrose



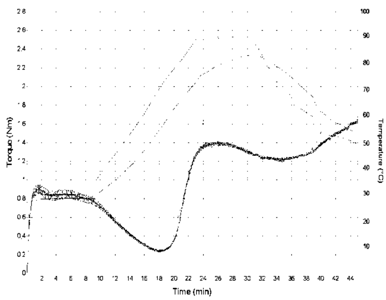
1% sucrose



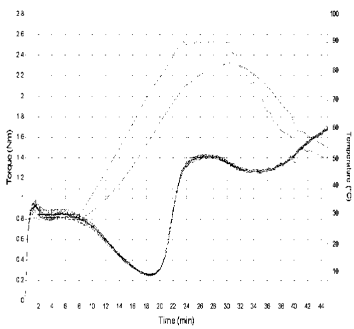
3% sucrose



10% sucrose



15% sucrose



20% sucrose

Figure 1 **The mixolab curves of analyzed samples**

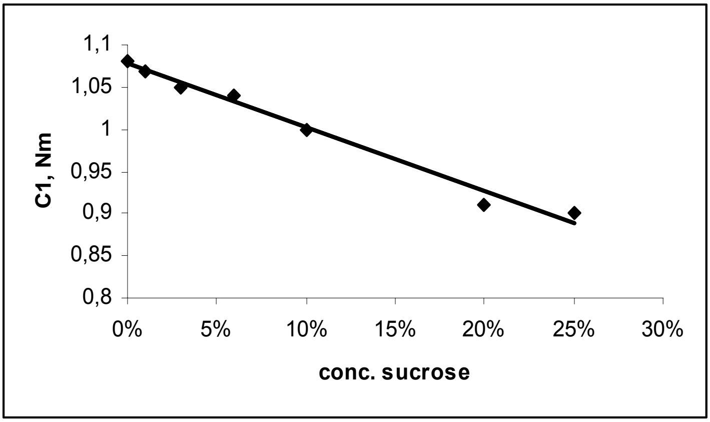


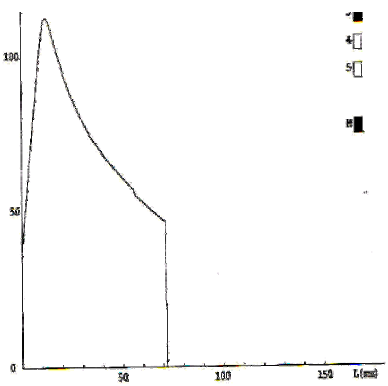
Figure 2 **Regression analysis between C1 and sucrose concentration. Points on the figures represent the mean of duplicate values. Relationship between C1 and sucrose concentration y=-07586+1.0776, r^2=0.98**

Table 2

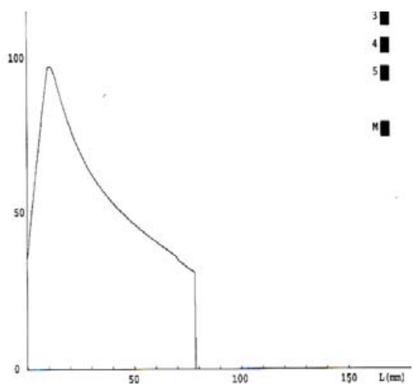
The parameters resulted on the alveograph for the doughs obtained from wheat flour dough supplemented with different sucrose doses

Characteristics	0%	1%	3%	6%	10%	15%	20%
P mm	124	107	88	75	77	64	55
L, mm	72	79	88	89	94	96	114
G, mm	18.9	19.8	20.9	21.0	22.6	21.8	23.8
$W \cdot 10^{-4}$J	339	291	259	248	220	194	171
P/L	1.72	1.35	1.00	0.84	0.82	0.67	0.48
Ie, %	61.3	55.3	55.0	63.2	51.1	53.5	48.2

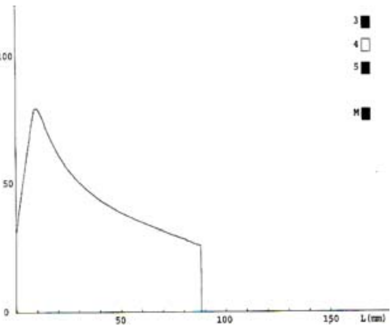
[1]P: tenacity (maximum pressure reached blowing the dough piece to rupture); L: extensibility (length to the curve); P/L is the ratio of elastic to viscous properties of dough



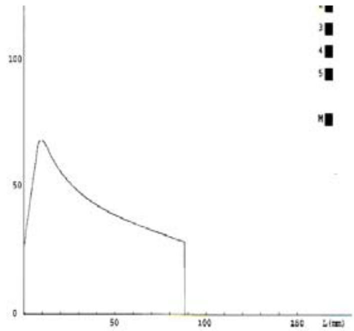
0% sucrose



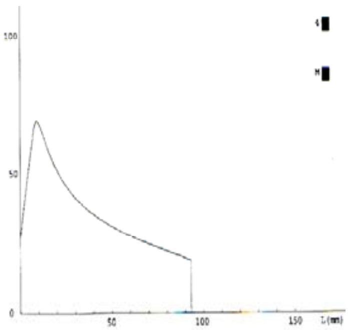
1% sucrose



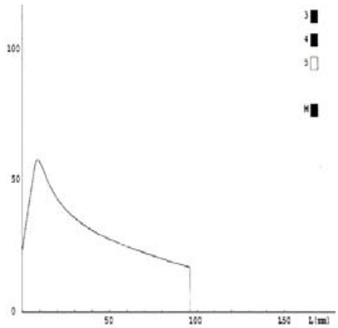
3% sucrose



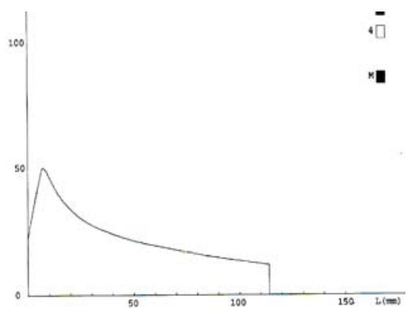
6 % sucrose



10% sucrose



15% sucrose



20% sucrose

Figure 3 **Alveograms of analyzed samples**

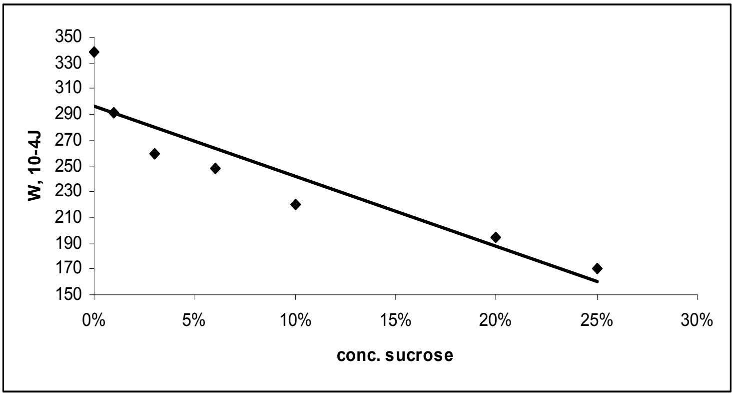


Figure 4 **Regression analysis between W and sucrose concentration. Points on the figures represent the mean of duplicate values. Relationship between W and sucrose concentration y=-542.62x+296.39, r^2=0.84**

The results from the mixolab tests are similar to those from the alveograph test. Still, the parameter correlation is low. The correlation between stability and W is r^2=0.71, and between W and elasticity index the correlation is r^2=0.65. This fact is explained by the differences in the analysis techniques (bubble swelling versus torque measurements during the kneading process, resting time for the alveograph not applicable to the mixolab and test temperature for the mixolab).

Baking tests. *Figure 5*, which describes the variation of bread volume obtained from witness flour according to the sucrose dose added, shows that along with the increase of the sucrose dose up to a certain value, an increase of the bread volume due to a weakening of the glutenic network because of the osmotic intemicellar pressure and of the progressive installment of an equilibrium between elasticity and extensibility. Moreover, the addition to the dough of a supplimentary quantity of sugar stimulates fermentation and postones maltose metabolising which allows its adaption to the environment. Therefore, the quantity of gases in the dough is increased and the products will have improved their physical properties.

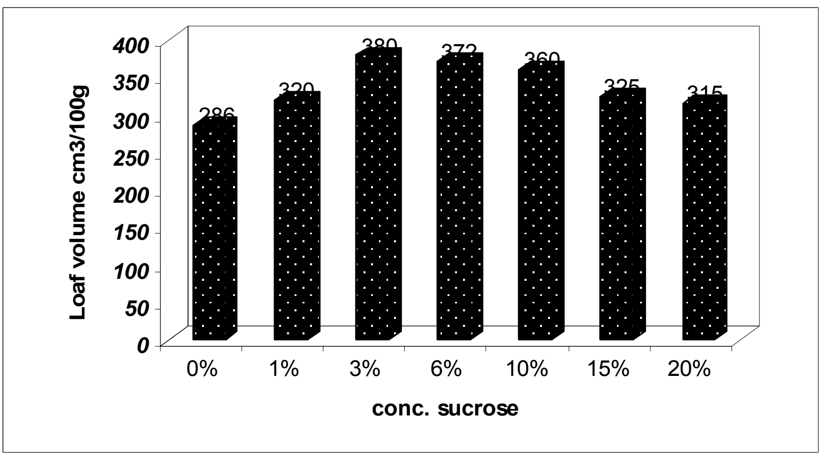


Figure 5 **The variation of the bread volume according to the sugar dose added. All values shown are the means of dulpicate analysis, error±2% of the mean**

By increasing the sucrose addition above the optimum dose, bread volume decreases as a result of the diminution of dough capacity to retain fermentation gases. Concentrations that are higher than 6% impede the fermentation process by increasing the osmotic pressure in the liquid phase of the dough.. The maltase break superposes on the fiinal fermentation or the first baking phase, which leads to a reduced volume of the products. The dough becomes sticky, difficult to manage and bread volume decreases.

The initially decreased value of the volume of the witness sample (and accordingly of the porosity and elasticity) is caused by a very high resistance and elasticity of the glutenic network which makes the dough oppose a resistance suitable to the increasing pressure of the gases resulted from fermentation.

CONCLUSIONS

Experiments have been carried out in terms of the influence that the addition of sucrose exercits on the rheological and technological properties of the dough obtained from high-quality flour. The rheological tests have been carried out with the mixolab and the alveograph and the technological behavior has been evalueted with on the basis of the baking samples. The influence of sucrose on the strong flour was significant leading to a weakening of the glutenic network of the dough with good effects on its rheological properties and bread quality. From the mixolabic point of view, sucrose addition leads to a decrease of dough consistency, of the gelling temperature and sarch gell viscosity during baking. From the alveographic point of view, sucrose diminishes the strength and tenacity of the dough. Both from the alveographic and the mixolabic perspective, the optimum dose of sucrose added was 3-6% and as a result of the baking tests, an optimum volume of 3% was obtained

BIBLIOGRAPHY

1. Baltsavias A., Jurgens A., Vliet T., 1999 - *Large deformation properties of short doughs: effect of sucrose in relation to mixing time,* Journal of Cereal Science, 29, p. 43-48.
2. Faradi H., Rasper V.F., 1987 - *The Alveograph Handbook.AACC*, Inc., St. Paul, Minnesota, US, p. 17-22.
3. Haros M., Ferrer A., Rosell M.C., 2006 - *Rheological behaviour of whole wheat flour,* 1139-1148, http://iufost.edpsciences.org/.
4. Hruskova M., Smejda P., 2003 - *Wheat flour dough alveograph characteristics predicted by NIRSystems 6500*. Czech Journal of Food Sciences, 21, p. 28–33.
5. Jusra O., Hruskova M., Svec I., 2007 - *Bread features evaluation by NIR analysis*. Czech Journal of Food Sciences, 25, p. 243–2487.
6. Gurjal H.S., Singh N., 1999 - Effect *on additives on dough development, gaseous release and breadmaking properties,* Food research international, 32, p. 691-697.
7. Raper V.F., Preston K.R., 1991 - *The Extensigraph Handbook.* AACC, Inc., St. Paul, Minnesota, US, p. 13-18.
8. Salvador A., Sanz T., Fiszman S.M., 2006 - *Dynamic rheological characteristics of wheat flour–water doughs.* Effect of adding NaCl, sucrose and yeast ,Food Hydrocolloids, 20, p.780-786.