Influence of added inulin on the Alveograph rheological characteristics of dough from 800 wheat flour type and bread quality

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Abstract: -The aim of this study is to analyze the effect of inulin addition of the level of 0, 5, 10, 15 and 20% on the rheological properties of the dough and bread making quality. The rheological properties of the dough, added with inulin were recorded in the Alveograph device. From this point of view the addition has the effect of decreasing the dough extensibility simultaneously with the increase dose of the inulin addition level. Baking samples test obtained were analyzed from the point of view of loaf volume, porosity and elasticity. General data on basis of both rheological and bread making characteristics indicated better results for a dose of 5% inulin addition.

Key words: wheat flour, rheological properties, Alveograph, inulin, bread

1 Introduction
Inulin is a fructan and it is to be found in over 36,000 species of plants. Plants with the highest level of inulin content are: banana, onion, artichoke, asparagus, leek, chicory root, garlic, e.g. [1]. The main industrial source of inulin and oligofructose is chicory fresh root (Cichorium intybus) [2] commercialized in Romania by the company Enzymes@Derivates, Costişa Neamţ Romania which provide it from Consucra Group Warcoing, Belgium.

From a structural point of view, inulin is a fructan formed of a mixture of fructo-oligosaccharides and of fructo-polysaccharides [3]. It is a soluble fibre [4] not degraded until it reaches the colon, where the action of different bacteria finally deteriorates it to hydrogen, methane, carbon dioxide and short-chained fat acids: acetic, propionic, butyric. Even though it is only digested in the colon, inulin’s transition from foods through different organs of the digestive apparatus has certain positive effects on the human body. In the stomach, it increases satiety and ensures a better digestion of foods. In the small intestine, it provides a better digestion and decreases sugar absorption in the human body, which has a highly positive effect for diabetics. In the large intestine, it reduces constipation, thus leading to a better intestinal health. Research has shown that each short-chained fat acid produced from the degradation of inulin in the colon has a certain positive effect on the human body [5]. Therefore, the propionic has an important role in lowering cholesterol, the butiric acid helps preventing colon cancer, while the acetic acid stimulates glycogenesis (known to be a forerunner of the cholesterol). Another important role that inulin has in the human body is that of functioning as a prebiotic [2], an indigestible food ingredient which influences the body in a positive way through the selective stimulation of the growth and/or the activity of some species or of a limited number of bacteria in the colon like Bifidobacteria, Lactobacillus e.g. [5]. Research has also shown that inulin contributes in a positive way to calcium and magnesium absorption in the human body [1]. The absorption of these elements in the body is according to a process that hasn’t yet been clarified.

The inclusion of inulin in bread is made both for it nutritional and it functional and technological effect [6]. The main advantage of inulin fiber addition versus alternative sources of fibers such as cereal type is due to the fact that this kind of fiber is a soluble one. This is particularly important from the nutritional point of view because we should daily consume between 30 and 50% of the soluble fibers in water. Therefore we used in this manuscript like row material flour with a high insoluble fiber content (800 type) which was added with different doses of inulin in order to obtain products with insoluble and soluble fiber content.
The aim of this study is to analyze the effect of inulin on wheat flour dough rheological properties using the Alveograph device and bread making quality.

2 Problem Formulation
Commercial wheat flour (harvest 2012) was milled on S.C. Oltina Impex Prod Com S.R.L. (Prahova, Romania) and inulin (Fibruline DS2 – commercial name) was provided by Consucra Group Warcoing, Belgium. Deionised water was used in all experiments.

The effect of inulin was evaluated by the addition of 0, 5%, 10%, 15% and 20% related to the flour weight. Single wheat flour was used as control sample. The chemical composition of the flour was determined according to Romanian or international standard methods: moisture (SR EN ISO 712:2010), wet gluten content (SR EN ISO 21415-1:2007), protein content (ICC Standard No. 202), gluten deformation index (SR 90:2007), ash content (SR EN ISO 2171:2010), falling number (SR EN ISO 3093:2010). Rheological properties of wheat flour were determined by a Chopin Alveograph (according to SR EN ISO 27971:2008). The parameters determined by Alveograph device were: P - the maximum over pressure needed to blow the dough bubble, expresses dough resistance, L - length of the curve, expresses dough extensibility, P/L – configuration ratio of the Alveograph curve, G – index of swelling, W – baking strength (surface area of the curve). The baking test was performed according to the Romanian method (STAS 91-83). Bread volume was determined after two hours of cooling by means of rape seeds. The elasticity and porosity parameters of bread have also been determined according to the methods described by STAS 91-83.

All the measurements were performed at least in triplicate. The values of different parameters are expressed as the mean ± standard deviation to a confidence interval of 95%. Data were analyzed using Microsoft Excel 2003. Also, STATISTICA 6.0 software was used for graphical representation.

3 Problem Solution
The analytical characteristics of the wheat flour used in the experiment are shown in Table 1. According to it analytical characteristics, the wheat flour used in the experiment is very good flour for bread making.

### Table 1. Flour analytical characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average value</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>14.00</td>
<td>0.20</td>
</tr>
<tr>
<td>Wet gluten content (%)</td>
<td>28.80</td>
<td>0.60</td>
</tr>
<tr>
<td>Protein content (%)</td>
<td>11.80</td>
<td>0.20</td>
</tr>
<tr>
<td>Gluten deformation index (mm)</td>
<td>6.00</td>
<td>0.40</td>
</tr>
<tr>
<td>Falling Number index (s)</td>
<td>280.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Ash content (%)</td>
<td>0.80</td>
<td>-</td>
</tr>
</tbody>
</table>

The Alveograph was used for the tests carried out on flour with 0, 5%, 10%, 15% and 20% inulin addition. The results are displayed in Table 2.

### Table 2. The Alveograph parameters for dough added with different quantities of inulin

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control sample</th>
<th>Inulin dose addition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenacity, P (mm)</td>
<td>76.00±</td>
<td>78± 78± 77± 73± 18± 18±</td>
</tr>
<tr>
<td></td>
<td>0.40</td>
<td>0.50 0.40 0.20 0.20 0.20</td>
</tr>
<tr>
<td>Extensibility, L (mm)</td>
<td>103.00±</td>
<td>89± 38± 33± 26± 26±</td>
</tr>
<tr>
<td></td>
<td>0.40</td>
<td>0.20 0.20 0.10 0.10 0.20</td>
</tr>
<tr>
<td>Index of swelling, G (mm)</td>
<td>22.60±</td>
<td>21.00± 13.70± 12.80± 11.40±</td>
</tr>
<tr>
<td></td>
<td>0.10</td>
<td>0.20 0.20 0.10 0.10 0.20</td>
</tr>
<tr>
<td>Baking strength, W (10^-4 J)</td>
<td>1850±</td>
<td>204± 38± 24± 18±</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>2.00 1.00 1.00 2.00</td>
</tr>
<tr>
<td>Configuration ratio (P/L)</td>
<td>0.65</td>
<td>0.88 0.81 0.70 0.69</td>
</tr>
</tbody>
</table>

Addition of a high doses of inulin (more than 5%) conduct to a weakening effect of the gluten network fact reified by the decrease of the Alveograph parameters dough tenacity (P) and baking strength (W). This fact is explainable, because inulin present a slightly dehydration action on wheat flour protein micelle which induces a decrease in dough strength and tenacity.

The graphical representation of dough tenacity in relation with the level of addition with inulin and the baking strength parameter is shown in Fig. 1. From the representation, it can be seen that the dough’s tenacity and baking strength decreases simultaneously with the increase of the addition dosage of more of 5% inulin. Tenacity reaches a maximum value of addition of the base flour with 5% inulin for the baking strength parameter value of 204.
Effect of inulin addition on dough extensibility, measured by the Alveograph device, is shown in Fig. 2. From the representation it can be seen that the dough’s extensibility (L) and index of swelling decreases simultaneously with the increase dose of the inulin addition as a result of the interference of the inulin fibres with the gluten network in the wheat flour dough.

Dough strengthened in terms of the configuration ratio of the Alveograph device was changed by an increase of these parameter value until 10% inulin addition allowed then by a slightly decrease.

General data on basis of Alveograph determination indicated better results on rheological behaviour of wheat flour dough for a dose of 5% inulin addition. Results obtained by baking test assessment are shown in Fig. 3.

Fig. 1 Variation of tenacity (P) with inulin addition and baking strength (W): a) spatial representation; b) representation by contours curves.

Fig. 2 Variation of index of swelling (G) with inulin addition and extensibility (L): a) spatial representation; b) representation by contours curves.

Fig. 3 Loaf volume, porosity, elasticity of analyzed samples.
The increase doses of inulin addition up to 5% conduct to an increase value of loaf volume, porosity and elasticity. This fact may be a consequence to a gluten network weakening effect caused by an increase of osmotic intemicellar pressure that will led to a good equilibrium between elasticity and extensibility fact relived by the Alveograph P/L ratio value. Moreover, the inulin addition in wheat flour dough will conduct to a higher quantity of oligofructose that will stimulate the fermentation process and therefore to the increase of the gas volume release in the wheat flour dough.

By increasing the inulin addition above the optimum dose of 5%, loaf volume, porosity and elasticity decreases as a result of the reduction of dough capacity to retain the fermentation gases released. The results obtained are in agreement with those obtained by [6]. To the inulin doses higher than 6% the fermentation process by the wheat flour dough becomes weakening, difficult to manipulate fact that will conduct to a decrease in the values of bread characteristics.

4 Conclusions
Inulin is a functional ingredient because it provides a series of benefits for human health like an increase of fiber content, present a bifidogenic effect, improve the calcium absorption, e.g. The addition of it in wheat flour dough from the rheological point of view will lead to a decrease of dough strength and an increase of dough extensibility. The optimum dose of inulin addition from the values obtained regarding the baked products characteristics is of 5% inulin addition.

References: