The monitoring of enzyme activity of amylase on the bread dough

David I., Berbentea F., Danci M., Bujancă G., Georgescu L.

U.S.A.M.V.B., Banat University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technologies, Calea Aradului 199, Timisoara, Romania

*Corresponding author. Email: *neda_university@yahoo.com

Abstract This study presents the action of an exogenous enzyme: amylase in different dosages, in the bread dough. The determination of the rheological characteristics of the dough is obtained by alveographic method. Addition of amylase enzymes in bakery products results in larger loaf volume, also the effect of amylase on the bread volume improvement results from redistribution of water from the gluten phase that gives the gluten more extensibility. In the presence of amylase the fermentable sugars from the dough increase, due to the hydrolysis of starch and thus ensure the formation of enough gas in the final dough fermentation and in the first part of the baking phase, which is necessary for obtaining a loose product, well-developed. The remaining unfermented sugars contribute to taste and flavor of the product and the crust color. The amylase enzyme are specially used for obtaining bread with low fat content, low sintetic aditiv content and high fiber content. Also they are used for improving bakery products texture and flavore. The influence of amylase enzyme in the dough for bread can help evaluate and improve the insufficiently developed technology and the nutritive value of the products.

Bread is the most comun traditional food product in the entire world. It has a high nutritive value due to the content of easily retainable sugars, lipids and proteins.

Enzymes applications have grown to be a common practice in the baking industry with advantage of being considered as natural additives. The exogenous enzymes are being used in the baking industry to improve dough-handling properties. The synthetically additives can be replaced with natural additives, as enzymes.

Addition of amylase in dough leads to: extension of freshness; the increase of the quantity of fermentation sugars, capable of forming gases during the entire period of the technical process inside the chains of amylpectine (Bor dei, 2005); the obtaining of finite products with a more pronounce color of crust, by increasing the quantity of fermentation sugar; the increase of carbon dioxide quantity. Amylase hydrolysis the α-1,4-glycosidic connections from the amylese and amylpectine structures and helps forming dextrine and maltose, witch in normal quantity have a favorable effect on dough, by increasing the capacity of water retention and improving the aspect of the middle part (soft, fluffy) (Mencin copski and David, 2008). The reduction of dough’s consistency through the addition of alpha amylases leads to the increasing of extensive character and decreasing of the resistance of dough. This behaviour is due to the fact that the maltose obtained by starch hydrolysis realizes a dehydrating action on gluten. The quantity of free water in dough will increase, reducing consistency. Amylase is deactivated in the oven, before the amidon’s gelatinization. Therefore, this excludes the risk of excessive dextrinization that could live to a sticky content.

The enzyme addition of flours presents the advantage of constant quality flour, which does not modify the technological process, does not affect the health of consumers. The enzymes are used in small quantities and do not influence to a great extent the price of bread. They can be successfully used in the place of chemical additives for synthesis.

Materials and Method

Samples preparation

Materials used for the preparation of the dough samples are wheat flour 650 with normal bread making properties (moisture 13.30%, protein content 12.75%), salt, water, yeast and amylase.

The amylase used is: Fungamyl SG – enzyme preparation witch contains amylase with 2500 FAU/g (FAU- fungal amylase unit) enzyme activity

A sample of 250g of flour is mixed with a solution of salt, yeast and amylase in a laboratory mixer 15 min to form dough. The amount of water was adjusted according to the water absorption capacity of flour.
The first dough sample MARTOR contained 95% flour, 1.7% salt, 1.7% yeast and does not any amylase.

The second dough sample F1 contained 95% flour, 1.7% salt, 1.7% yeast and 1g/100kg amylase.

The third dough sample F2 contained 95% flour, 1.7% salt, 1.7% yeast and 2g/100kg amylase.

The fourth dough sample F3 contained 95% flour, 1.7% salt, 1.7% yeast and 3g/100kg amylase.

Each dough sample is divided in five circular consecutive dough patties which are rested 20 min in the alveograph in a temperature-regulated compartment at 25 °C. Each dough patty is tested individually and the result is the average of the five dough patties.

**Methods of analysis**

The determination of the rheological characteristics of the dough was obtained by alveographic method. The alveographic method relies on measuring the resistance to biaxial stretch under air pressure of a dough sample prepared in standard conditions.

The dough patty is placed on the alveograph, which blows air into it. The dough patty expands into a bubble that eventually breaks. The pressure inside the bubble is recorded as a curve on graph paper. The alveograph determines the gluten strength of dough by measuring the force required to blow and break a bubble of dough. The results include P Value, L Value, and W Value. Stronger dough requires more force to blow and break the bubble (higher P value). A bigger bubble means the dough can stretch to a very thin membrane before breaking. A bigger bubble indicates the dough has higher extensibility; that is, its ability to stretch before breaking (L value). A bigger bubble requires more force and will have a greater area under the curve (W value).

From the alveogram the following indicators were obtained:

- **P Value** is the force required to blow the bubble of dough. It is indicated by the maximum height of the curve and is expressed in millimeters (mm). It is also known as the viscosity or the value of maximum pressure that is in relationship to the resistance of the deforming dough (mm H2O).
- **L Value** is the extensibility of the dough before the bubble breaks. It is indicated by the length of the curve that begins from the origin until the perpendicular point that corresponds to decreasing pressure due to rupture of air bubble and is expressed in millimeters (mm).
- **W Value** is the area under the curve. It is a combination of dough strength (P value) and extensibility (L value) and is expressed in joules. It represents the action of deformation of the dough, based on a gram of dough, evaluated at 10 E – 4 joule, calculated as follows: W= 1.32 x (V/L) x S, where V-air volume in mm³; L- the average abscise at breaking point in mm; S- surface of the curve, cm².
- **P/L Ratio** is the balance between dough strength and extensibility. It is the rapport of configuration of the curve.

**Results and Discussions**

The dough samples alveograms are represented in Fig. 1, Fig. 2, Fig. 3 and Fig. 4. Each dough sample alveogram show the five dough patties tested (marked with different colors) and the parameters registered at the testing moment. The results of the samples are represented by the average value obtained from the values of the dough patties tests for each dough sample.

In Fig. 1 the dough sample MARTOR alveogram represents the dough sample that does not contain any amylase. This sample is considered the standard blank sample. The alveogram’s characteristics for flour used for bread have the following values: P = [65 – 75mm], L = [130 – 150mm], G = [20 – 30], P/L = [0,5 – 0,6] and W > 180 10⁻⁹J. The values for dough sample MARTOR, regarding the resistance of the deforming dough (P) and the balance between dough strength and extensibility (P/L ratio) are higher than the normal values. The values regarding the dough extensibility (L), expansion index (G) and the total quantity of absorbed energy during the dough deformation (W) are very low, therefore the dough is sensitive to stretch and can easily brake. It cannot be used for bread making.
Sample MARTOR (no enzyme)

Parameters
Lab. temp: 25 ºC
Moisture: 13.30%
Falling number (FN): 332 s

Results
P = 59 mmH₂O
L = 64 mm
G = 17.1
W = 161 10⁻⁴J
P/L = 1.02
Ie = 29.8 %

Fig 1. MARTOR (no amylase) sample alveogram
Sample F 1 (amylase 1g/100kg)

Parameters
Lab. temp: 25 ºC
Moisture: 13.30%
Falling number (FN): 280 s

Results
P = 63 mmH₂O
L = 93 mm
G = 18.8
W = 176 \times 10^{-4} J
P/L = 0.65
Ie = 46.2%

Fig. 2. F 1 (enzymes preparation which contains amylase) sample alveogram

Sample F 2 (amylase 2g/100kg)

Parameters
Lab. temp: 25 ºC
Moisture: 13.30%
Falling number (FN): 253 s

Results
P = 72 mmH₂O
L = 136 mm
G = 22.4
W = 232 \times 10^{-4} J
P/L = 0.53
Ie = 77.2%

Fig. 3. F 2 (amylase 2g/100kg) sample alveogram

Sample F 3 (amylase 3g/100kg)

Parameters
Lab. temp: 25 ºC
Moisture: 13.30%
Falling number (FN): 175 s

Results
P = 50 mmH₂O
L = 61 mm
G = 17.1
W = 118 \times 10^{-4} J
P/L = 0.85
Ie = 24.04%

Fig. 4. F 3 (amylase 3g/100kg) sample alveogram
In Fig. 3 the alveogram of dough sample F 2 (amylase 2g/100kg) represents the dough sample that contains 2g/100kg amylase. There is a noticeable increase in all the indicators that suggests the improvement of the dough. The dough resistant to deformation (P) has increased, also the dough extensibility characteristics (L and G) are higher than the value of dough sample MARTOR. Moreover, the elasticity index (Ie) has increased with 40% and the total quantity of absorbed energy during the dough deformation (W) is with 71 \(10^{-4}\) J higher then the value of dough sample MARTOR. This result expresses advantages of using amylase in the preparation of the dough for bakery. The reduction of dough’s consistency through the addition of amylase leads to the increasing of extensive character and decreasing of the resistance of dough.

In Fig. 2 is represented the alveogram of dough sample F 1 (amylase 1g/100kg) that has in composition 1g/100kg amylase. Compared with the blank sample MARTOR there are small different regarding the dough strength (P) that increases only with 4 mmH2O, but looking at the extensibility characteristics and the absorbed energy during the dough deformation we can see, obviously, the dough quality improvements. Only the P/L ratio has decrease because of the dough strength and the dough extensibility. Using 1g/100kg amylase improves the stability of dough and its tolerance for fermentation and decreases of dough viscosity.

In Fig. 4 is the alveogram for the dough sample F3 (amylase 3g/100kg) that contains 3g/100kg amylase. Addition of this dosage of amylase, decreased the dough strength (P) with 9 mmH2O. The absorbed energy during the dough deformation (W) is reduced and the P/L ratio has increased. The extensibility characteristics and the elasticity index (Ie) have decreased. Dough with amylase 3g/100kg cannot be used for bread making. The overdose of amylase in bakery products lead to negative effects especially on the physical attributes of the breadcrumb that can become wet and sticky. The cause for these effects are the large amount of dextrins produced and the unbound free water form the jellification process of the starch.

### Table 1

Alveograph results of the dough samples: MARTOR (no amylase), F 1 (amylase 1g/100kg), F 2 (amylase 2g/100kg), F 3 (amylase 3g/100kg)

<table>
<thead>
<tr>
<th>Sample</th>
<th>MARTOR (no amylase)</th>
<th>F 1 (amylase 1g/100kg)</th>
<th>F 2 (amylase 2g/100kg)</th>
<th>F 3 (amylase 3g/100kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(mmH2O)</td>
<td>59</td>
<td>63</td>
<td>72</td>
<td>50</td>
</tr>
<tr>
<td>L(mm)</td>
<td>64</td>
<td>93</td>
<td>136</td>
<td>61</td>
</tr>
<tr>
<td>G</td>
<td>17.1</td>
<td>18.8</td>
<td>22.4</td>
<td>17.2</td>
</tr>
<tr>
<td>W(10^-4J)</td>
<td>161</td>
<td>186</td>
<td>232</td>
<td>158</td>
</tr>
<tr>
<td>P/L</td>
<td>1.02</td>
<td>0.67</td>
<td>0.53</td>
<td>0.85</td>
</tr>
<tr>
<td>Ie(%)</td>
<td>29.8</td>
<td>46.2</td>
<td>77.2</td>
<td>24.04</td>
</tr>
</tbody>
</table>

In Table 1, there are presented the characteristics of dough samples obtained by alveographic method. The dough sample F 2 (2g/100kg amylase) has the highest value for the following indicators, the dough extensibility characteristics (L and G), the total quantity of absorbed energy during the dough deformation (W) compared to the dough samples F 1 (1g/100kg amylase) and F 3 (3g/100kg amylase).

The dough sample F 1 (1g/100kg amylase) presents improvements of the dough extensibility characteristics compared to the MARTOR sample. The dosage of 1g/100kg amylase dough viscosity and improves the processing quality but it does not achieve the standard parameters for bread.

The dough sample F 3 (3g/100kg amylase) has the worst values for all the indicator compared to the dough sample F 1 (1g/100kg amylase) and dough sample F 2 (2g/100kg amylase). This dosage shows that the dough extensibility characteristics (L and G) and the total quantity of absorbed energy during the dough deformation (W) have decrease significantly.

### Conclusions

The additive actions of complex enzymes as ameliorator on flour have positive effects on the rheological characteristics of dough. The technological characteristics of the flour and the nutritive value of the bread are characterized by the following variables: initial volume, fermentation time, flexibility, the dough condition to fermentation, water retention, maximum resistance, extensibility, final rise to baking, final volume of the bread, nutritive value, and energy value. In order to improve these variables, different additives and substances are used in the bread manufacture, some of these being native components of the flour. The alveograph test provides results that are common specifications used by flour millers and processors to
ensure a more consistent process and product. The alveograph is well suited for measuring the dough characteristics of weak gluten wheat. Weak gluten flour with low P value (strength of gluten) and long L value (extensibility), is preferred for cakes and other confectionery products. Strong gluten flour will have high P values amylase and is preferred for breads.

Addition of the correct dosage of amylase in dough can improve the extension of freshness, increases of the quantity of fermentation sugars that can make finite products with a more pronounce color of crust.

A lower dosage of amylase does not have a big improvement effect on the quality of the dough and it is not relevant for the technological process.

The overdose of amylase leads to a wet and sticky content of the dough which affects the dough handling during the technological process and an abnormal volume and porosity.

Selecting a correct dosage of amylase will be made in conformity with the rheological characteristics of dough and the proportions from the dough will be added so that they would be maximal. The enzyme preparations are used to obtain bakery products with “clean label”, more natural, this products being the product that enjoys the greatest interest from consumers.

References