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# Effects of different doses of ascorbic acid on alveograph and bread making quality of wheat flour with average quality as starting material

**Georgiana Gabriela Codină**

*"Ştefan cel Mare" University, Faculty of Food Science and Engineering, 9th Universităţii Ave , Suceava- Romania*

## *Abstract*

This experimental study deals with experiments regarding the influence that the addition of ascorbic acid exerts over the rheological and technological properties of the dough obtained from average quality flour. The rheological determinations have been accomplished on alveograph and their technological behavior has been evaluated on the basis of the results obtained from the baking samples. In order to clearly establish what is the best dose of ascorbic acid that should be added, tests have been performed on seven different doses of ascorbic acid (10ppm, 30ppm, 50ppm, 70ppm, 100ppm, 150ppm, 200ppm). As a result, it has been concluded that the best dose of ascorbic acid that can be added for the improving average flour quality is 50-70 ppm. Above this level, the effect of improvement produced by the oxidizer acquires a negative trend due to the exhaustion of the SH-reactive groups.

***Keywords***: average quality flour, ascorbic acid, alveograph, rheology, bread-making

## 1. Introduction

The oxidizing substances are used for processing weak-gluten flours, aiming at the improvement of the rheological properties of the dough. These substances develop dough's capacity of retaining gases and maintaining shape. Therefore, the products obtained have a higher volume, superior crumb structure and color, smaller expanding degree.

The ascorbic acid (AA) represents the most important oxidizer for the dough, whose use has no sanitary restrictions. It operates as a conditioner to improve dough and bread quality only if oxidized by the dehydroascorbic acid (DHHA).

Nakamura, 1997, Lu, 1998, have determined the concentration of AA and DHHA for different moments of dough mixing. They have established that increasing kneading time leads to a decrease of AA and an increase of the DHAA in the dough.

Thus, have established that for a dose of 10 ppm added, the conversion of AA into DHAA was 70% after 3 minutes of mixing and 98.5% after 12 minutes of mixing. For a dose of 100 ppm AA added to the dough, the conversion of AA into DHAA was 35%. For doses such as 1000 ppm AA added to the dough, DHAA has not been detected even after 12 minutes kneading. Thus, the oxidation ratio of ascorbic acid in the dough depends on the dose that has been added.

Apparently, there is a mechanism through which AA is oxidized into DHAA during the process of mixing dough in the presence of oxygen; this mechanism is stereospecific for the L-ascorbic acid or the L-dehydroascorbic acid, thus the involvement of other enzymes being suggested. Studies of molecular kinetics have shown that the oxidation of ascorbic acid to dehydroascorbic acid is done under the effect of an ascorbate oxydase enzyme.

Corresponding author: *e-mail address*: codinageorgiana@yahoo.com

Nevertheless, 1996, have demonstrated, through their experiments, that there is no critical level of ascorbate oxydase (AOX) in the dough. Therefore, the bread obtained from flours with a low level of AOX and addition of ascorbic acid has the same score with the bread obtained by adding ascorbic acid and AOX. These results have shown that the ascorbic acid probably oxidizes fast enough in the dough under the effect of the oxygen integrated in the dough while kneading.

It has been concluded that, depending on the flour quality, according to the traditional way of preparing the dough, the usual doses of ascorbic acid are 10-50 ppm but they can reach 100 ppm. The weaker the flour, the bigger the dose. Intensive and rapid kneading of the dough requires an optimum dose of 75 ppm.

If in earlier studies (Codina, 2007) we have analyzed, from the rheological (alveographical and consistographical) point of view the influence of the addition of ascorbic acid on poor-quality flour, in this experiment our aim is to establish the effect of the oxidizer on medium-quality flour from the rheological point of view using the Chopin alveograph and from the technological point of view through baking tests.

## 2. Materials and methods

The experiments there have chosen average quality flour for bread-making as raw material. Control flour was analyzed by performing Romanian standard methods: STAS 6124-73, STAS 90-88, STAS 6283-83 and SR ISO 3093:1997. In experiments, flour with 14.1% moisture, and 12.1% crude protein content was used. The determined values for physical-chemical properties are mentioned as following: ash content 0.65%, wet gluten content 26.6% and gluten deformation 14 mm, and falling number 310s. Data acknowledge that the control flour has an average potential for bread-making from that the point of view.

Starting from the chosen flour for analyses, different samples of flour have been used in experiments, improved with different doses of ascorbic acid (10ppm, 30ppm, 50ppm, 70ppm, 150ppm, 200ppm). Rheological behavior of dough prepared from wheat flours was carried out on Chopin alveograph according to SR ISO 5530-4:1998.

## 3. Results and discussions

The experiments had a starting point in the determination of the deformation index for different doses of ascorbic acid. The resulting values are shown in table 1.

**Table 1.** The effect that the ascorbic acid has upon the deformation index of the gluten for average quality flour.

| | 0ppm (M) | 10ppm | 30ppm | 50ppm | 70ppm | 100ppm | 150ppm | 200ppm |
|---|---|---|---|---|---|---|---|---|
| Deformation index, mm | 14 | 12 | 10 | 8 | 7 | 6 | 5 | 5 |

**Table 2.** The parameters obtained by the alveograph for the dough resulted from weak flour supplemented with different doses of ascorbic acid.

| Characteristics | M | 10 ppm | 30 ppm | 50 ppm | 70 ppm | 100 ppm | 150 ppm | 200 ppm |
|---|---|---|---|---|---|---|---|---|
| Maximum pressure (P), mm | 76 | 83 | 96 | 103 | 110 | 108 | 100 | 94 |
| Extensibility (L), mm | 82 | 75 | 73 | 72 | 69 | 68 | 68 | 71 |
| Swelling index (G), mm | 20.2 | 19.3 | 19.0 | 18.9 | 18.5 | 18.4 | 18.4 | 18.8 |
| Energy $W \cdot 10^4 J$ | 205 | 219 | 228 | 242 | 278 | 275 | 242 | 213 |
| Ratio P/L | 0.93 | 1.11 | 1.32 | 1.43 | 1.59 | 1.59 | 1.47 | 1.32 |
| Elasticity index (Ie), % | 52.1 | 55.0 | 48.5 | 48.1 | 55.7 | 56.6 | 52.6 | 46.0 |

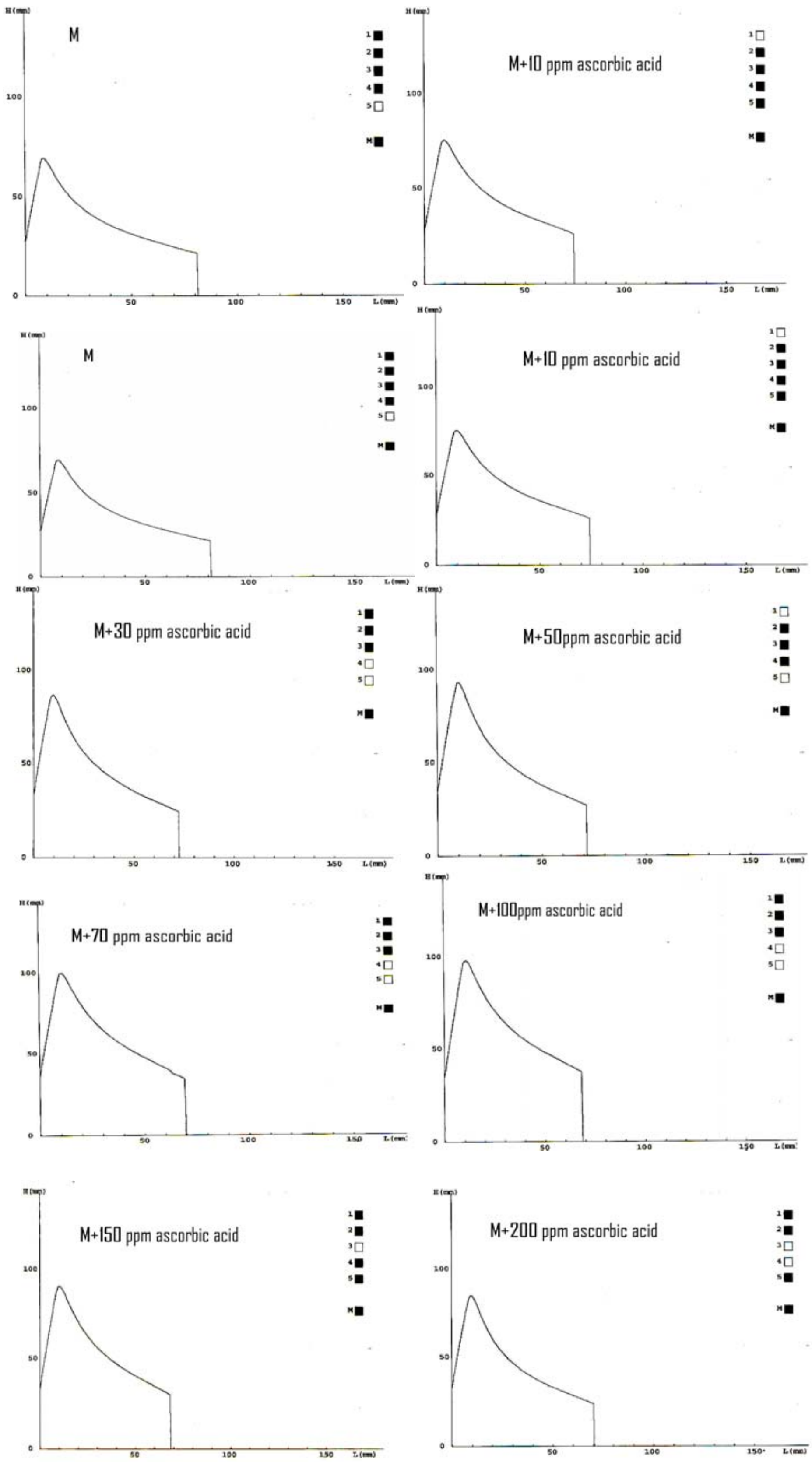


**Figure 1.** The alveograms for average quality flours (supplemented with different doses of ascorbic acid)

The results shown in table 1 indicate an improvement of flour quality due to addition of different doses of ascorbic acid through a significant decrease of the deformation index, which indicates a progressive increase of dough's strength. The results reach their peak around the value 50-70 ppm for average quality flour. Adding too much ascorbic acid leads to a strong glutenic matrix with a low deformation index.

The rheological behavior of the dough has been appreciated on the basis of the determinations carried out by the Chopin alveograph. The results are shown in table 2 that matches figure 1.

If one is to analyze the rheological behavior of the samples treated with ascorbic acid, from the alveographical point of view, an effect of dough strengthening is to be noticed (44.7% – see figure 2) and a reduction of dough flexibility (20.5% - see figure 3). The increase of dough strength due to the action of the ascorbic acid, is somehow predictable, confirming the hypothesis that the ascorbic acid produces an effect of strengthening of the glutenic network that can successfully oppose to forces applied to it. Also, the addition of ascorbic acid on the dough resulted from the two types of flour leads to an increase of the P/L ratio.

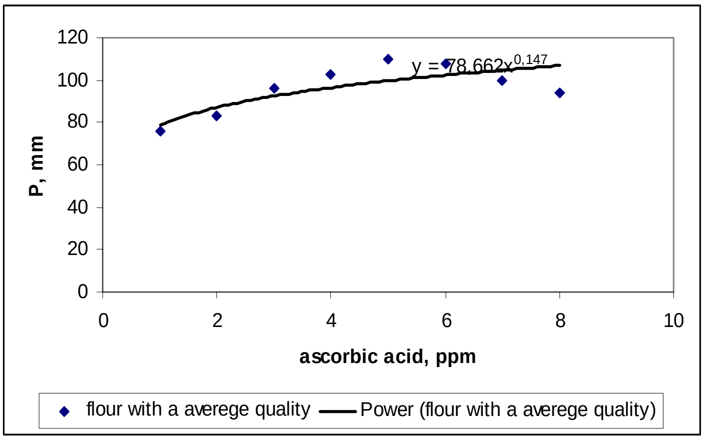


**Figure 2.** The variation of parameter P as determined on the alveograph according to the quantity of the added ascorbic acid.

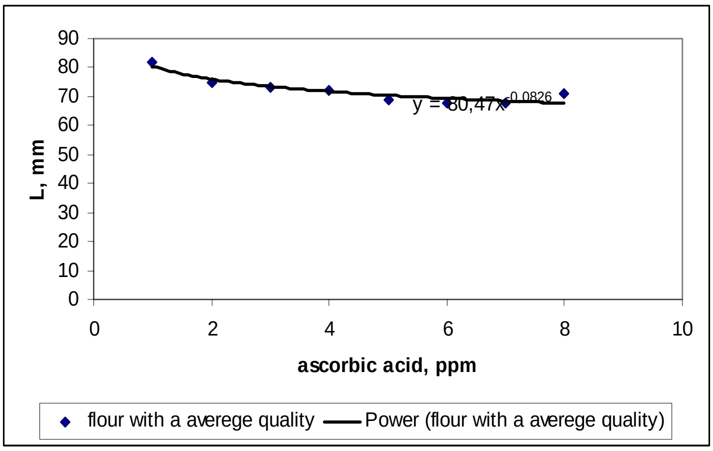


**Figure 3.** The variation of parameter L as determined on the alveograph according to the quantity of added ascorbic acid.

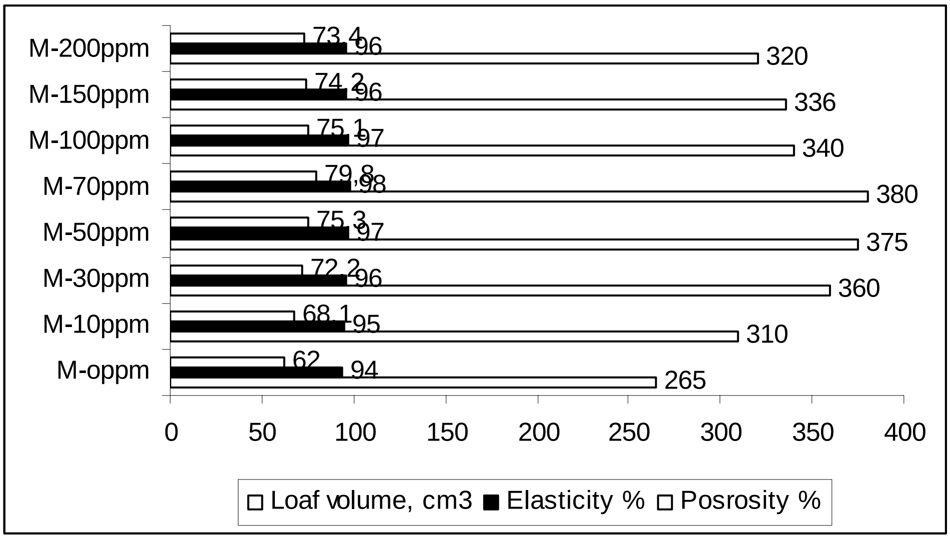


**Figure 4.** Bread volume, porosity and elasticity variation, supplemented according to the added dose of ascorbic acid

What is remarkable is that, after exceeding the optimum levels of additives, a decrease of dough strength is to be noticed together with an almost linear increase of its extensibility, probably due to the exhaustion of the reactive SH-groups but up to values that haven't lead to a deterioration of the dough's properties (see ratio P/L). The optimum doses of ascorbic acid stay around 70 ppm.

The qualitative evaluation of the flours taken into consideration has been completed with baking tests. The variation registered for the characteristics of the bread obtained at the previously mentioned doses is shown in figure 4.

The effect of the supplementation of ascorbic acid on the volume of bread obtained through the baking samples can be defined by a linear increase of the volume, together with the increase of oxidizer dose up to the optimum degree. The result is more evident for the poor-quality flours. This means an increase of the dough's capacity of retaining fermentation gases due to the action of ascorbic acid of strengthening the glutenic network.

It has also been noticed that the sensorial properties of the crumb have been improved (the crumb is more light-colored), along with its elasticity and porosity. The baking tests certainly indicate an optimum dose of 50-70 ppm for the medium-quality flour.

## 4. Conclusions

Experiments have been carried out regarding the influence that the addition of ascorbic acid exerts on the rheological and technological properties of the dough obtained from average quality flour. The rheological determinations have been carried out with the help of the alveograph and its technological behavior has been evaluated according to the results obtained from the baking tests. The conclusions can be resumed as following: the ascorbic acid is involved in the amplification of the oxidizing processes that take place in the dough and has as purpose the strengthening of the glutenic network reflected in a higher resistance of the dough in case of pressure and in the reduction of its extensibility; the action of the ascorbic acid determines an increase of the capacity of gas retention by the dough resulted from these types of flours.

This is concretized through volume, porosity and elasticity increase for bread that is supplemented with ascorbic acid. In the case of medium-quality flours, the addition of a dose of ascorbic acid of 50-70 ppm is enough.

Above this level, the effect of improvement produced by the ascorbic acid acquires a negative trend, probably due to the exhaustion of reactive SH-groups.

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