# THE EFFECT OF PREPARATES BASED ON SODIUM CARBONATE AND CITRIC ACID ON THE PARAMETER FALLING NUMBER IN HYPERDIASTAZIC FLOURS

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***Abstract.*** *The objective was to assess the influence of compounds of sodium carbonate and citric acid on the amylase activity of hyperdiastazic flour. Four samples of wheat, with Falling Number values between 88 sec and 153 sec, were ground on pilot mill. Flour was treated with varying amounts of sodium carbonate/citric acid preparates and combinations. Results showed that the sodium carbonate preparate provides a significant improvement of Falling Number values at doses above 50 g per 100 kg, and citric acid increases Faling Number values of flour at doses greater than 200 g/100 kg. Combinations of the two, generally cancel this effect. Consequently, the use of sodium carbonate to improve Falling Number parameter values is limited because it is necessary to maintain acid pH at which bakery processes occur.*

**Keywords: wheat flour, sodium carbonate, citric acid, falling number**

## 1. INTRODUCTION

Environmental factors such as climatic conditions of the year, the area of culture, doses of nitrogen applied and fungicide treatments, influence the values of the Falling Number parameter of wheat, protein quantity and composition. The Falling Number parameter, known as Hagberg Falling index, reflects the amylasic activity of wheat and flour. More events were associated with low Falling Number, namely: late maturating wheat, which leads to reduced starch content, a lower quality of gluten and excessive rainfalls that cause the starch detachment of proteins [1].

Fungicide treatments and Fusarium infections have been incriminated in certain studies for an easy decrease of the value of this parameter [2]. For some varieties of wheat, the low values of the Falling Number parameter were correlated with a number of genetic disorders, characterized by continuation of $\alpha$-amylase synthesis in the late maturation stages of wheat grains. For most of these varieties, the phenomenon seems to be modulated by the thermal shocks (freezing), to which the wheat plant is exposed in late stages of development [3, 4].

Romanian wheat yields are generally characterized by relatively small values of amylasic activity, often having higher Falling parameter values, higher than 350 seconds [5]. However, periodically, there are situations when the quality of crops is influenced by adverse weather conditions, especially during harvest. This leads to premature germination of seeds and the increase of amylasic activity. A big amylasic activity of wheat is a problem, as it leads to obtaining improper flour technological properties. Improving solutions are generally based on the change of dough pH, but have a limited effect, due to the sensitivity of biochemical and rheological processes in dough to pH changes. Another line of research, which aimed to use amylasic inhibitors, has a limited applicability, due to their interference with the human digestive amylase.

## 2. MATERIAL AND METHODS

Four wheat samples taken from the 2010 harvest were analyzed in order to determine the amylasic activity through the Falling Index (ISO 3093:1997).

For each of the four samples we analyzed the Falling Number on the full meal (milled on the LM 120 laboratory mill taken from Perten Instruments AB) and the flour type 550 (obtained by grinding the samples on a Chopin CD1 pilot mill).

The obtained flour samples were treated with successive quantities of Rowelit (preparation based on 80% sodium carbonate, produced by Mühlenchemie), citric acid and combinations from them, in accordance with the experimental plan in Table 1.

**Table 1.** The quantities of Rowelit and citric acid used for treatments

| Sample number | ROWELIT (g/100 kg) | | | CITRIC ACID (g/100 kg) | | | ROWELIT + CITRIC ACID (g/100 kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **I.**<br>**II.**<br>**III.**<br>**IV.** | 50 | 100 | 200 | 50 | 100 | 200 | 25 + 25 | 50 + 50 | 100 + 100 | 25 + 100 | 100 + 25 |

The results have been interpreted using the methods of descriptive statistical analysis and t test (Student) for pairs of samples.

## 3. RESULTS AND DISCUSSION

The results obtained by Falling Number parameter determination, of the wheat samples and the flour produced from them, are presented in Table 2.

**Table 2.** Falling Number values and the estimates of their variability for the wheat and flour samples

| Sample number | Wheat (s) | Wheat flour (s) |
|---|---|---|
| **I.** | 132 | 158 |
| **II.** | 153 | 171 |
| **III.** | 113 | 125 |
| **IV.** | 88 | 120 |
| **Mean** | **121.5** | **143.5** |
| **St. dev.** | 27.671 | 24.906 |
| **C.V. (%)** | 17.356 | 18.791 |

The studied wheat samples had low values of the Falling Number parameter, well below the permissible limits of acceptability for their exploitation in specific technological processes of the milling and bakery industry (at least 180 s). However, we can see that the milling process improves significantly this parameter, the average values for flour being with with 22 seconds higher than the average values for wheat (+18.1%, t = 5.003, p = 0.015).

Table 3 shows the values of the Falling Number parameter and the estimates of their variability in the flour samples treated with the preparate based on Rowelit sodium carbonate.

**Table 3.** Falling Number values and their variability estimates for the flour samples treated with citric acid Rowelit

| **Sample number** | **Rowelit** | | | **Citric acid** | | |
|---|---|---|---|---|---|---|
| | **50g/ 100kg** | **100g/ 100 kg** | **200g/ 100kg** | **50g/ 100kg** | **100g/ 100 kg** | **200g/ 100kg** |
| **I.** | 177 | 181 | 219 | 163 | 158 | 179 |
| **II.** | 190 | 211 | 220 | 166 | 166 | 173 |
| **III.** | 136 | 149 | 183 | 118 | 115 | 141 |
| **IV.** | 130 | 148 | 182 | 119 | 121 | 139 |
| **Mean** | 158.250 | 172.250 | 201 | 141.5 | 140 | 158 |
| **St. dev.** | 29.736 | 30.037 | 21.370 | 26.589 | 25.729 | 20.944 |
| **C.V. (%)** | 18.791 | 17.438 | 10.632 | 18.791 | 18.378 | 13.256 |

The addition of Rowelit determines very significant increases of the values of Falling Number parameters, from untreated flour. The increase of the parameter value is almost linear (Figure 1), being 10% higher compared with the control when is treated with 50 g/100 kg (t = 5.990, p = 0.009), 20% higher compared with the control when is treated with 100 g / 100 kg (t = 7.367, p = 0.005) and 40% higher compared with the control when is treated with 200 g/100 kg (t = 19.438, p = 0.003). The enzymatic inhibition mechanism is probably based on the change of dough pH from the slightly acidic domain, that corresponds to the optimum pH of amylasic activity, to the neutral or slightly alkaline pH.

The addition of citric acid in doses of up to 100 g / 100 kg flour does not induce significant changes in the value of amylasic activity. In these treatments there have been noticed a slight increase in amylasic activity, showed by the decrease of the Falling Number parameter, compared to the control (-1.4% and -2.5%). The optimum pH of the amylasic activity in wheat is generally in the range 5.2 - 5.6, and a slight decrease, caused by the addition of citric acid may explain these results. However, treatments with bigger quantities of citric acid (200 g / 100 kg flour) decrease significantly the alpha-amylasic activity of flour (+ 10.1% compared to the control, t = 3.379, p = 0.040).

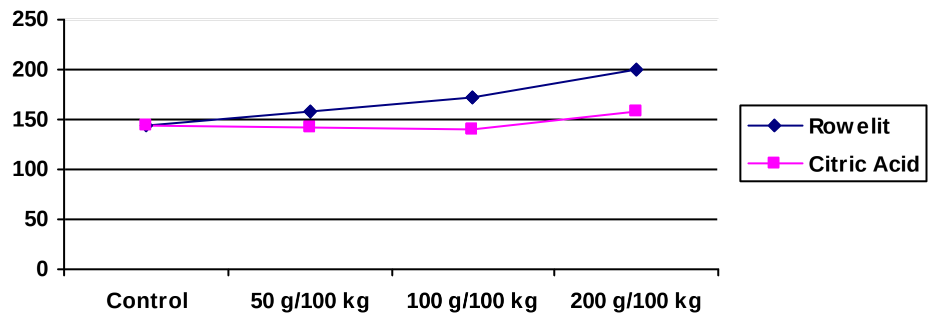


**Figure 1.** The evolution of the Falling Number parameter in case of treatments with Rowelit and citric acid

Since in bakeries using a wide range of acidifiers (acetic acid, lactic acid, citric acid etc), the use of sodium carbonate can be a problem, due to its reactivity. Table 4 contains the results obtained by the treatment of the flour samples with different combinations of the two preparates, namely Rowelit and citric acid.

**Table 4.** Falling Number values and their variability estimates for the flour samples treated with Rowelit and citric acid

| **Sample number** | **Rowelit + Citric acid** | | | | |
|---|---|---|---|---|---|
| | **25 + 25 g/100kg** | **50 + 50 g/100 kg** | **100 + 100 g/100kg** | **25 +100 g/100kg** | **100 + 25 g/100kg** |
| **I.** | 158 | 165 | 166 | 175 | 195 |
| **II.** | 173 | 185 | 189 | 175 | 189 |
| **III.** | 123 | 125 | 121 | 120 | 139 |
| **IV.** | 116 | 120 | 118 | 121 | 138 |
| **Mean** | **142.500** | **148.750** | **148.500** | **147.750** | **165.250** |
| **St. dev.** | **27.404** | **31.456** | **34.799** | **31.468** | **30.988** |
| **C.V. (%)** | **19.231** | **21.148** | **23.434** | **21.298** | **18.752** |

From Table 4 we notice that the use of equal quantities of the two preparates did not alter significantly the value of the Falling Number parameter. Also, the combination of 25 g/100 kg Rowelit and 100 g/100 kg citric acid does not significantly influence the amylasic activity of flours. Instead, the combination of 100 g/100 kg Rowelit and 25 g/100 kg citric acid causes a significant increase of the Falling Number parameter (+ 15.16% compared to the control, $t = 4.207$, $p = 0.024$). This fact suggests that the use of average doses of sodium carbonate can be considered for reducing the amylasic activity in flours with defects, while the technological processes use relatively small quantities of acidifiers. However, the degree of inhibition of amylasic activity is not big enough to allow the correction of some flours having initially large amylasic activity. In the context of this research, we consider that the potential of reducing the amylasic activity by using sodium carbonate is limited, for the flour or wheat samples having initially Falling Number greater than 140 seconds.

## 4. CONCLUSIONS

Our results show that the addition of sodium carbonate significantly decreases the amylasic activity of flours, which is valued by the Falling Number parameter. A similar effect can be achieved by using big doses of citric acid. Using combinations of equal quantities of citric acid - sodium carbonate does not significantly influence the amylasic activity of flours; this suggests that in the technological processes using acidifiers, the use of sodium carbonate has a limited applicability. However, the average doses of sodium carbonate combined with low doses of citric acid can be used for a slight decrease of amylasic activity. The effectiveness of treatment with sodium carbonate depends on the initial value of amylasic activity of flour; that is why we consider that this method can be used only for wheat flours having the value of the Falling Number parameter bigger than 140 seconds.

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