Analecta
REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964
Vol. 10, No. 1 2016

THE ROLE OF SALT FORM AND CONCENTRATION ON THE RHEOLOGICAL PROPERTIES OF BAKERY PRODUCTS

[1]Z. Győri, [2]P. Sipos
[1]University of Debrecen, Institute of Nutrition, Egyetem square 1., H-4032 Debrecen, Hungary,
e-mail: gyori.zoltan@unideb.hu
[2]University of Debrecen, Institute of Food Technology, Böszörményi street 138. , H-4032 Debrecen, Hungary,
e-mail: siposp@agr.unideb.hu

ABSTRACT

The effect of different salt forms and concentrations were evaluated on the rheological properties of dough made from wheat and rye flours. Our aim was to investigate that how does the sodium chloride change the properties of gluten network and therefore the structure of bakery products and what effects can be experienced when it is substituted by other organic and inorganic salts. Different rheological tests were used to monitor the effects on dough (Farinograph, Alveograph and Extensigraph tests) and on the end-product (texture analysis, sensory analysis). It was found that all the salt forms significantly influenced the rheological parameters of dough and not the sodium chloride addition had the most favourable effect in every case.

Keywords: flours, rheological properties, firmness of bread, salts

1. INTRODUCTION

Salt (sodium chloride) is maybe the oldest raw material and additive of our foodstuffs. It gives taste or influences the taste for the product, can easily store and due its non-specific (good solubility, decreases the water activity) and specific (specific inhibition) effects on microbes it has been used as preservative for a long time. It can be found in several foodstuffs but its highest concentrations are consumed by cereal and meat products: the former one gives about 35% of total consumption and the latter one about 25% while the contribution of other food kinds are under 10% each [1].
The salt is accused of causing serious health risks: a strong connection was found between the high sodium intake and the risk of high blood pressure and cardiovascular diseases [2-4] and it was also reported that decrease in sodium intake results proportional decrease in blood pressure immediately [5]. On the other hand, sodium is essential element, it plays role in maintaining the balance of osmotic potential and acid-basin system, and in the impulse transport in the nervous system. The optimal daily intake for adults is about 5 g sodium chloride (2,4 g sodium), but the real intake is higher than this value worldwide and Hungary is one of the leaders with 17 g/day sodium chloride intake, but the consumption in Bulgaria is also outstanding with a 12 g/day value [6]. Salt intake reduction programs started worldwide to decrease the people's sodium consumption. These programs are hard to progress because of the fact that the sodium chloride also has significant role in the dough formation. Its addition influences the water absorption capacity, increases the development time and stability while making the dough more strength by the slight rise of pH, which decreases the number of positive ions and helps the formation of cross-bindings [7, 8]. On the other hand, the saltless bakery products are rejected by the consumers, therefore its decrease may make the market position of these products worse. The ionic concentrations in the dough influences the technological value of flours and the salt has important role in the formation and stability of gluten network [9-11] and these changes can be determined by different rheological methods [12-13]. Our aim was to evaluate the effect of different salt forms on the rheological properties of dough and bread made from wheat and rye flours.

2. MATERIALS AND METHODS

The evaluated flour samples were BL55 (wheat flour with 0,55% ash content) and RL60 (rye flour with 0,60% ash content). Farinograph (Brabender GmbH & Co. KG, Duisburg, Germany) and alveograph (Tripette & Renaud, Villeneuve La Garevne, France) tests were performed according to AACC approved

methods 54-21 and 54-30, respectively [14]. A Brabender extensograph was used to perform uniaxial extension on the doughs according to the AACC Standard method [15, 16].
The evaluated salt forms were sodium chloride, potassium chloride, sodium acetate, potassium acetate and calcium acetate (VWR, Belgium). Baking tests were performed by the MSZ 6369-8:1988 [17]. Hungarian Standard using Metefém 2001LMS laboratory baking oven (Metefém, Budapest, Hungary) by direct dough making method (300 g flours, 9 g fresh yeast, 6 g salt, 4.5 g sugar). Bread crumb firmness was analysed by TA.XT Plus texture analyser (Stable Micro Systems, Surrey, UK). Firmness was defined the force (expressed in kg by the software of the equipment) required to compress a 30 mm thick bread slice to 1.9 mm distance using a 36 mm cylinder probe with 36 mm diameter. The pre-test speed was 1 mm/s, the test speed was 1.7 mm/s. The firmness tests were performed 12 hours after the test baking in six repeats. All the other measurements were performed in two repeats.

3. RESULT AND DISCUSSION

3.1. Results on Farinograph water absorption and baking value

All the examined salt forms increased the baking value of wheat flour, the increasing concentrations resulted more improvement and the highest concentrations gave the highest readings. The effects of sodium salts were the lowest, the average increase was 13-14% in the average while the Ca acetate resulted 16% and the potassium salts 21-24% increase. In the case of rye the sodium chloride addition resulted a small decrease in the originally low value and the same tendencies can be observed as the effect of increasing potassium chloride and sodium acetate concentrations. The highest baking value was found by the addition of potassium acetate and the lowest by the calcium acetate (Figure 1 and 2).

3.2. Results on the alveograph and extensigraph energy values

The responses of doughs made with different salt forms were different in the resistance against tensile. On average the the alveograph energy readings required to deform the dough were much higher for wheat than for rye, but the extensigraph energy readings were higher for rye dough in several treatments. In the case of wheat flour the alveograph W value were increased by the increasing concentrations of sodium chloride (until the 4th concentration), sodium acetate and potassium acetate and also increases were experienced in the case of rye dough using potassium chloride and sodium acetate, but the use of sodium chloride resulted weaker rye dough (Figure 3).
The extensigraph energy values were similar for wheat and rye dough, only in some cases were experienced projecting values for wheat dough (the use of 6g sodium chloride, potassium chloride and potassium acetate) while the readings for rye flour seem to be unmodified by salt forms and concentrations (Figure 4).

3.3. Results on test baking

In the case of the evaluation of test breads significant differences were found for rye and wheat breads. The crumb firmness values were much higher for rye breads; the average value was 2,0 kg in the case of wheat breads and 9,3 kg for rye breads one day after baking. In the case of fresh wheat bread harder crumb was experienced when sodium and potassium chlorides were used, but no clear tendencies can be found in the readings of rye bread. Repeating the measurement 3 days after baking 50 and 100% higher values were experienced. Addition of sodium acetate and the first concentration of potassium acetate resulted lower aging for the wheat bread, but in the case of rye bread 2% sodium chloride, 1% sodium acetate and 2% calcium acetate resulted moderate crumb hardening during storage (Figure 5 and 6).
The taste of breads were significantly influenced by the salt forms. The bread made without salt was tasteless and its crumb was slightly coloured. The addition of sodium chloride resulted the usual taste but it

Analecta
REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

was not typical in the case of 1% addition. The taste of potassium chloride is found to be metallic by references; it was experienced in the 2% addition but the lower concentration resulted slightly salty taste. The acetates resulted dense crumb. The sodium acetate gave insipid taste, but the aftertaste was pleasant and these breads have typical crunchy crust. The taste of breads made with potassium acetate were characterless but their crusts were crispy. The calcium acetate gave sweet taste to the crumbs of breads, especially in 1% concentration but their crusts were tasteless again.

4. CONCLUSIONS

It was found that all the salt forms significantly influenced the rheological parameters of dough and not the sodium chloride addition had the most favourable effect in every case. On the other hand, the taste of sodium chloride seems hard to be substitued by other salt forms.

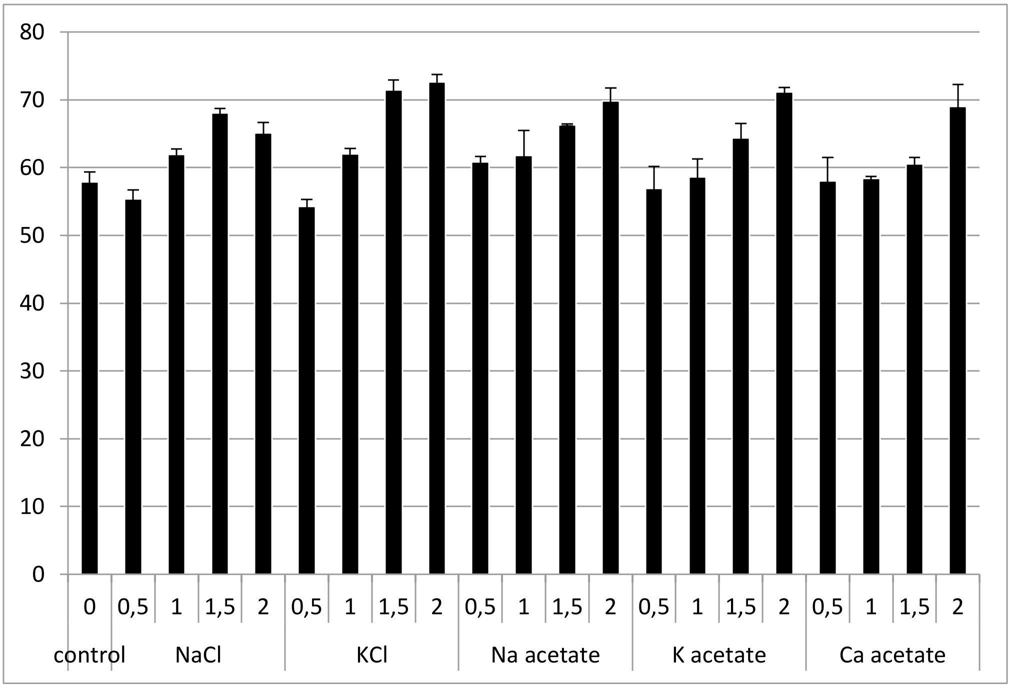

Figure 1. Effects of salt forms and concentrations on the baking value of BL55 flour

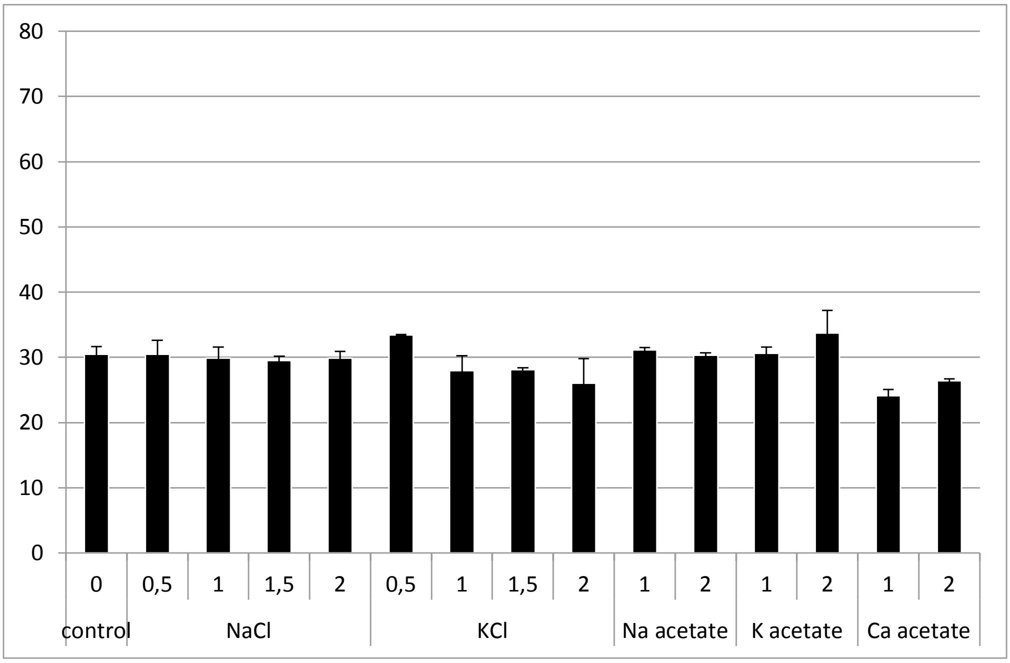

Figure 2. Effects of salt forms and concentrations on the baking value of RL60 flour

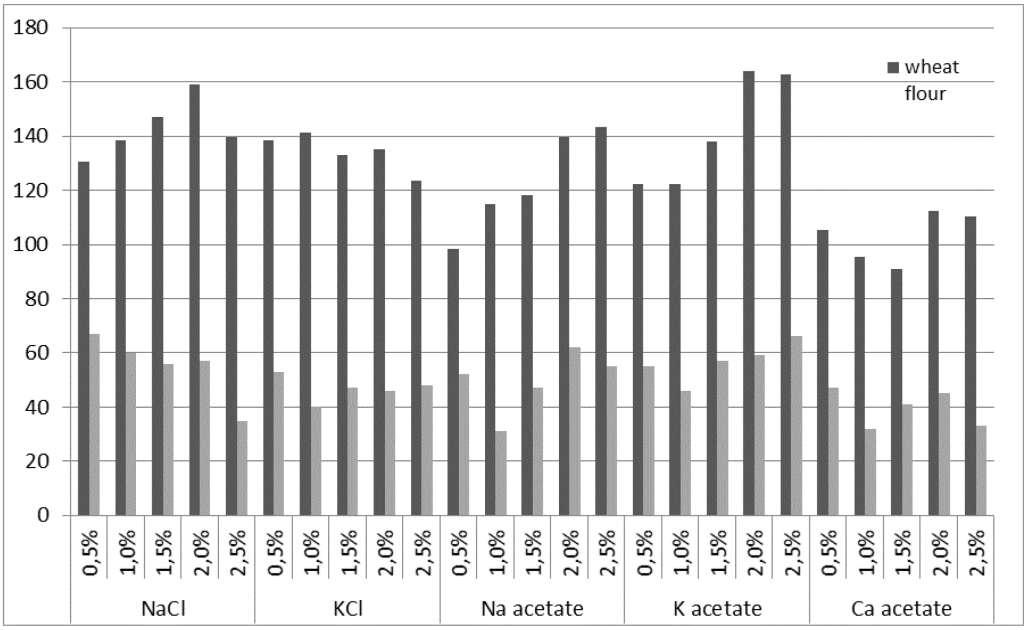

Figure 3. Effects of salt forms and concentrations on the alveograph energy of BL55 and RL60 flours (10^{-4} J)

Analecta
REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

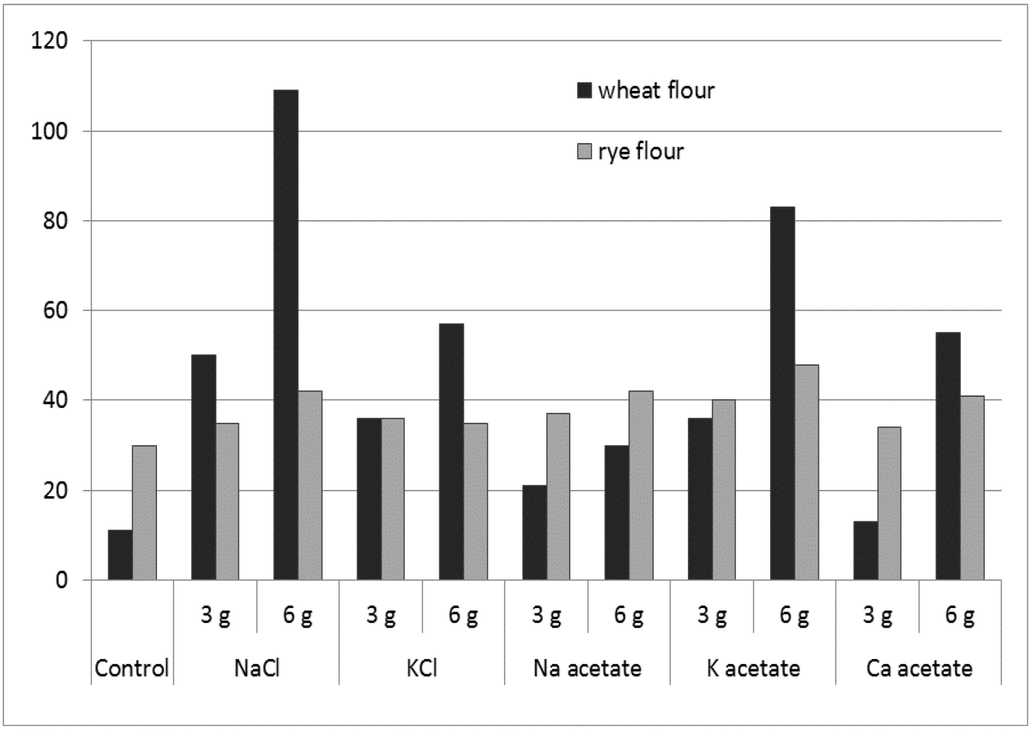

Figure 4. Effects of salt forms and concentrations on the extensigraph energy of flours (cm^2)

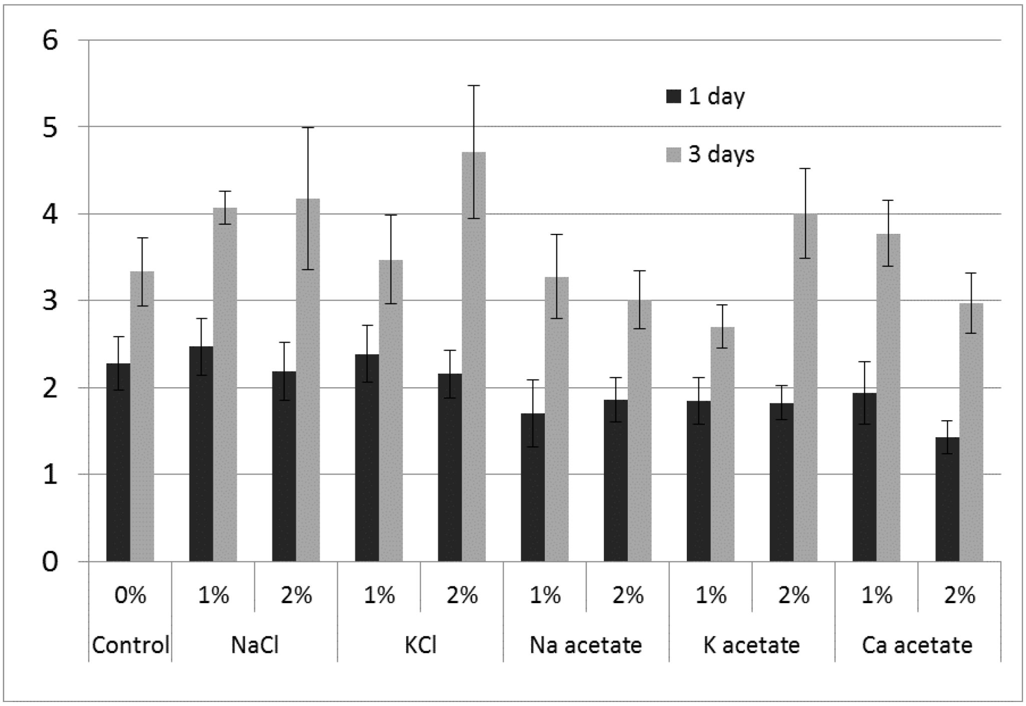

Figure 5. Effects of salt forms and concentrations on the firmness of wheat bread crumb (kg)

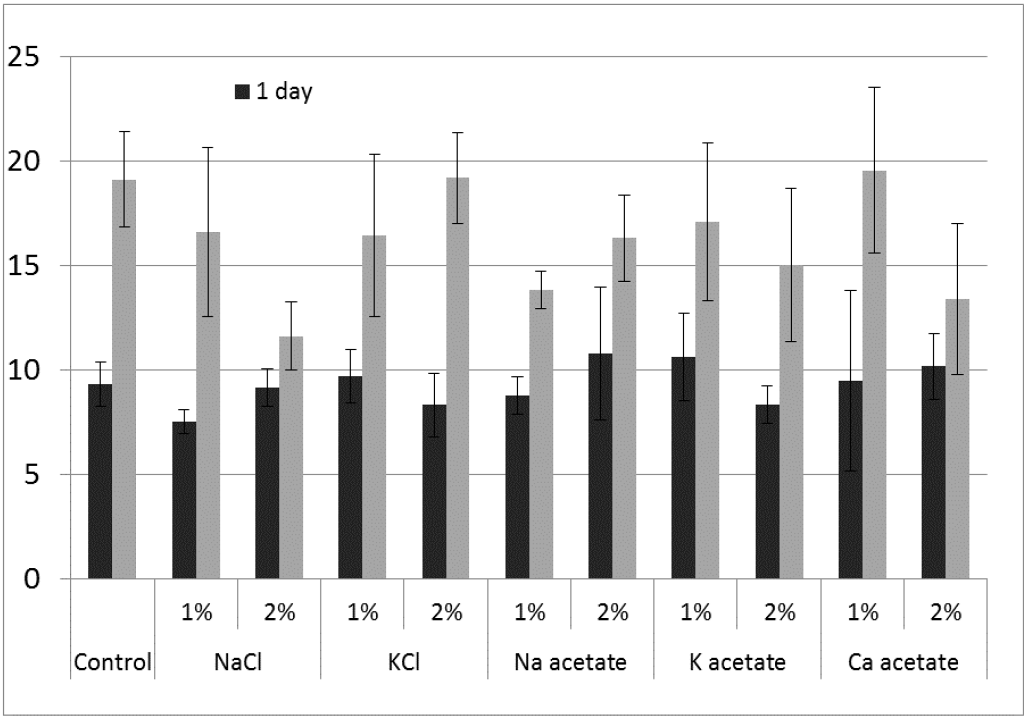

Figure 6. Effects of salt forms and concentrations on the firmness of rye bread crumb (kg)

ACKNOWLEDGEMENT

This research was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.4.A/ 2-11/1-2012-0001 'National Excellence Program'. This study was funded in part by COST Action 1001 project.

REFERENCES

[1] F. Angus, Dietary salt intake: sources and targets for reduction. In D. Kilcast, & F. Angus (Eds.), Reducing salt in foods: Practical strategies. (pp. 3-17). Abington: Woodhead Publishing Limited, 2007

[2] F. J He, G. A.MacGregor, Reducing salt in foods. In D. Kilcast, & F. Angus (Eds.), Reducing salt in foods: Practical strategies. Abington: Woodhead Publishing Limited 18–46. 2007, pp. 18-46

[3] J. M. Jones, Salt and blood pressure – A need to reduce levels at any age. Cereal Foods World, 53, (2008), pp. 43-45

[4] N. A. Kurtzman, Should man live by low-salt bread alone? American Journal of Kidney Diseases, 37. (2001), pp. 636-637

[5] M. Satin, The great salt debate. Cereal Foods World, 53, (2008), pp. 9-16.

[6] É. Martos, Európai összefogás a lakosság sóbevitelének csökkentése érdekében – nemzeti sócsökkentőprogram. Metabolizmus, 8, (2010), pp. 23-24

[7] K. R. Preston, Effect of neutral salts upon wheat gluten protein properties. I. Relationship between the hydrophobic properties of gluten proteins and their extractability and turbidity in neutral salts. Cereal Chemistry, 58, (1981), pp. 317-324

[8] G. Danno, R. Hoseney, Effect of sodium chloride and sodium dodecyl sulfate on mixograph properties. Cereal Chemistry, 59 (1982) 202-204.

[9] S. A. Matz, Bakery technology and engineering. Third edition, Van Nostrand Reinhold/AVI, NY.

[10] K. Tanaka, K. Furukawa, H. Matrumoto, The effect of acid and salt on the farinogram and extensogram of dough. Cereal Chemistry, 44. (1967), pp. 675-680
[11] I. Hlynka, Influence of temperature, speed of mixing, and salt on some rheological properties of dough in the farinograph. Cereal Chemistry, 39. (1962), pp. 286-303
[12] P. Sipos, Á. Tóth, Á Pongráczné Barancsi, Z. Győri, A búzaliszt reológiai vizsgálata különböző módszerekkel Élelmiszervizsgálati Közlemények. 53 (3), (2007), pp. 145-155
[13] P. Sipos, Á. Elek, Z. Győri, Application of texture analyzer in the quality analysis of bakery products. Journal of Food Physics, 21, (2008), pp. 99-102
[14] AACC International, Approved methods of Analysis. 11th Edition. Method No. 54–21.02. Rheological Behavior of Flour by Farinograph: Constant Flour Weight Procedure St. Paul, Minnesota, USA, 2000
[15] AACC Approved methods of Analysis. 11th Edition. Method 54-30.02. Alveograph method. Alveograph Method for Soft and Hard Wheat Flour St. Paul, Minnesota, USA, 2000
[16] AACC Approved methods of Analysis. 11th Edition. Method 54–10.Extensograph method. AACC International St. Paul, Minnesota, USA, 2000
[17] MSZ 6369-8:1988. Lisztvizsgálati módszerek. Sütéspróba