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DYNAMICS OF FREEZING AND DEFROSTING OF DOUGH

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ABSTRACT

The aim of this work was to investigate the dynamics of dough freezing and defrosting. The freezing rate of smaller pieces is faster than of bigger ones.
The freezing rate depends on the mass of dough sample both at -20°C and -35°C. The time of freezing of 100 and 150 g pieces is half of the time needed for the freezing of 450 and 600 g pieces.
Freezing temperature affects also the time of freezing. The samples frozen at -35°C reach the freezing temperature in halt of the time needed for samples frozen at -20°C. The defrosting time depends both on temperature and mass of dough samples.

1. INTRODUCTION

Temperature and rate of freezing are important for the interruption of dough fermentation. The first trials with shock freezing with CO_2 showed clearly that freezing at very low temperatures affect negatively the dough. However, »shock« with CO_2 has some advantages for small bakery goods to somedegree. The diameter of dough is an important parameter for fast cooling, so the stopping of fermentation is still not in use for most forms of whole breads [1].

In order to perform continuous, and moderate temperature decrease at the same time, dough pieces are placed in one layer on perforated tins in the freezing device and cooled til -12°C to -15°C in the middle of the dough, applying lower air circulation rate. The conventional freezing devices should be cooled previously to about -30°C, and the storage chamber should be kept at -15°C to –20°C [2].

The frequent opening of freezing chambers has a negative effect on the frozen dough quality. The »still« atmosphere is a very important aspect in the storage chamber. It is very important not to cool the dough below the temperature at which the enzymes are completely inactivated [1]. When the temperature of the thermal center in the dough is about -12°C, the dough cannot be mechanically processed, and has to be packed

in bags for better storage in order to prevent the drying of the surface due to freezing. The pieces that are kept for only a short time should also be packed, especially when the keeping chambers are frequently opened and the temperature is varying. Packaging which is not permeable to water, should be used.

The temperature of the surface should not be higher than -10°C [2]. The temperature increase from -12°C to -5°C should be slow. The water in dough for dough is melting at –5 to +5°C. This increase of temperatures should be rather fast, in 30 – 45 min, depending on the capacity of the freezer, [1]. The subsequent fermentation phase should be performed in such a way that the average temperatures are reached gradually, and not too forced. It is very important that the difference of temperatures at the surface and of the inner part is as small as possible.

The temperature increase in the fermentation chamber should be regulated on the basis of the temperature of the inner part of dough [3]. It is rather difficult to give some recommendations regarding the moisture content during the fermentation phase.

The moisture content of the surface layer is always higher, as the temperature in the fermentation chamber is always higher than the dough temperature. If these relations are under control, there will be no negative influence [1]. Brok and Hanneforth cite four defrosting regimes: defrosting at room temperature (20 – 22°C and about 40% of relative air humidity), fast defrosting in the fermentation chamber, at 32°C and 80 to 100% of relative air humidity, and defrosting of dough in the fermentation chamber with regulated conditions [4].

2. MATERIALS AND METHODS

The amount of yeast for mixing is 2%, calculated on flour, using fresh baker's yeast with 30% of dry matter. The amount of salt was 1,8% (calculated on flour). The amount of added water depends on the water content of used yeast, and is calculated in such a way that the water content of dough is constant.

The necessary amount of dough was prepared by intensive mixing processes for 30 min. At the end of the mixing, the temperature of the prepared dough was 35°C. The weighed dough samples (100, 150, 450 and 600 g) were frozen in the freezing chamber at -35°C (K.O.M.A, the Netherlands, temperature range 0 to -40°C), and the temperature was followed in the middle of the samples.

Dough samples were frozen in the freezer also, at -20°C, and the temperature was followed by digital thermometer Testo 925 (temperature range –50 to +1000°C). Three temperatures were chosen, in accordance with the technical-technological conditions in bakery for the defrosting of samples. The defrosting time of dough samples was chosen on the basis of the investigated defrosting dynamics. All measurements (trials) were performed in triplicate.

3. RESULTS AND DISCUSSION

The influence of mass of dough samples on the freezing rate is presented in Figure 1. The temperature was measured in the middle of the sample, in function of time f(t), from 0 to 280 min.

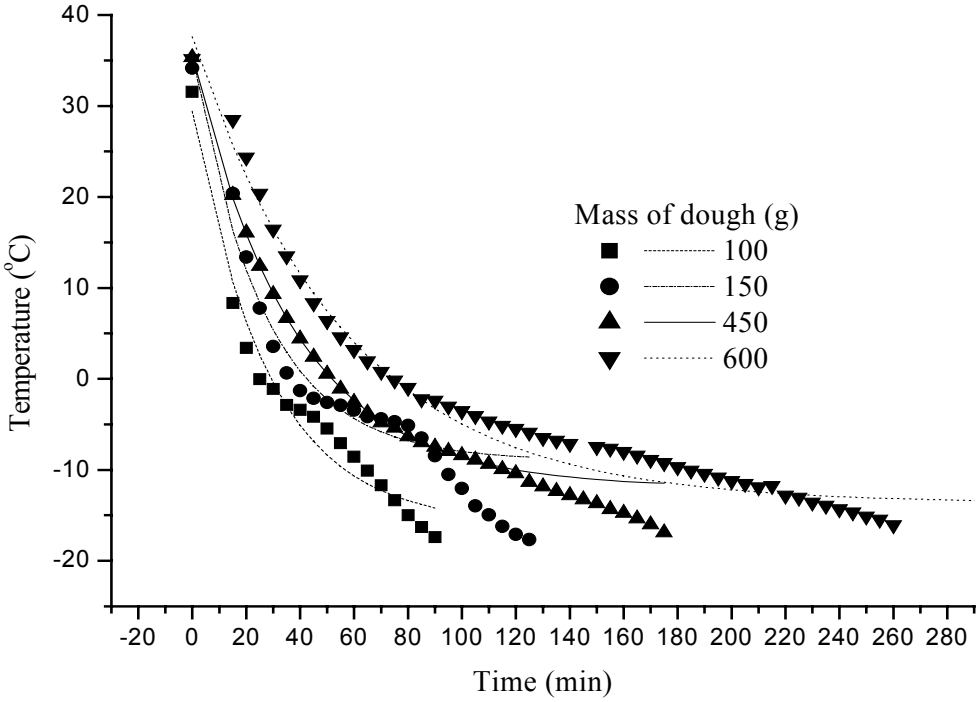

FIGURE 1. FREEZING DYNAMICS OF DOUGH SAMPLES
OF DIFFERENT MASS (in freezer at –18 to -20°C)

The analysis of the obtained results leads to the conclusion that the mass of dough samples affects significantly the temperature in the mass of dough and the freezing time. So, in the 100 g sample, -18°C was reached after 85 min, while in the 150 g one, the same temperature was achieved after 124 min. In sample weighing 450 g, -16°C was registered after 180 min, and in sample weighing 600 g, -15°C was registered after 260 min.

The influence of mass of dough samples on the freezing rate in the freezing chamber is presented in Figure 2.

The 100 g dough sample reaches -22°C in 46 min, this value is significantly lower, 1,85 times, compared to time when the freezing temperature was -20°C. The 150 g dough sample reaches -22°C in 50 min in the freezing chamber; this time is 2,48 times shorter compared to freezing at -20°C. The 450 g dough reaches the freezing temperature of -18°C in 105 min. This value is 1,71 times lower than the time necessary for the freezing in the frezer. The 600 g sample reaches -18°C in 125 min. The obtained value is 2,08 times lower than the one obtained when the sample was frozen in the freezer.

The results presented in Figures 1 and 2 lead to the conclusion that the freezing time of samples, is two times shorter at -35°C compared to -20°C, independently on the mass of dough.

The influence of defrosting temperature on defrosting time and mass of dough samples on the temperature measured in the middle of the samples is presented in Figures 3, 4 and 5. The defrosting temperature of the frozen samples was +4°C (Figure 3), +20°C (figure 4) and +35°C (Figure 5). The higher the defrosting temperature, the shorter the defrosting time and the higher the temperature measured in the middle of the sample.

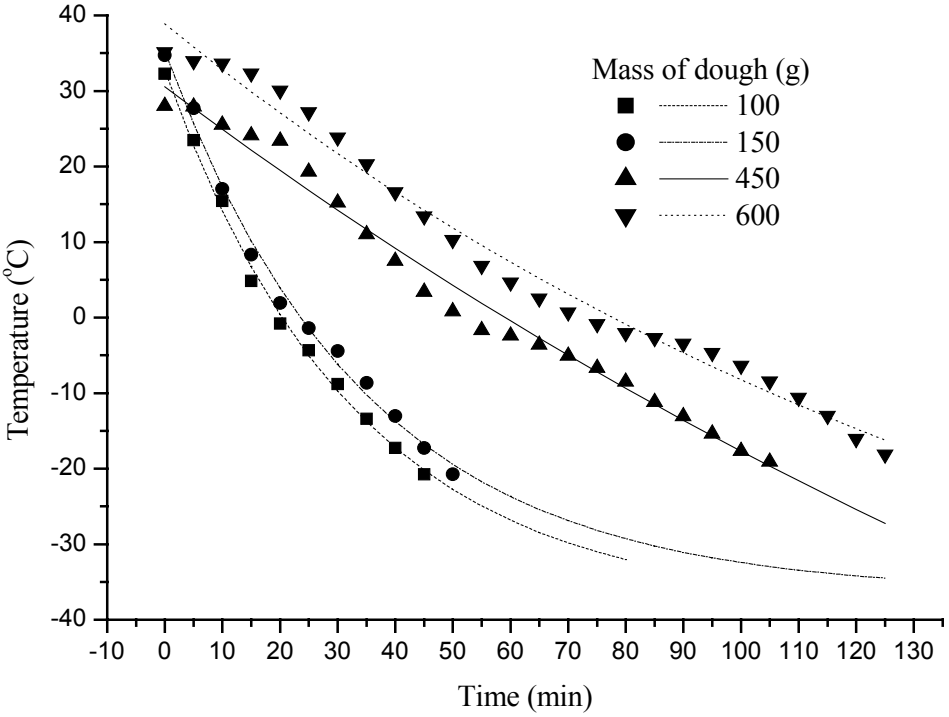

FIGURE 2. FREEZING DYNAMICS OF DOUGH SAMPLES OF DIFFERENT MASS (IN FREEZING CHAMBER,–-35±1°C)

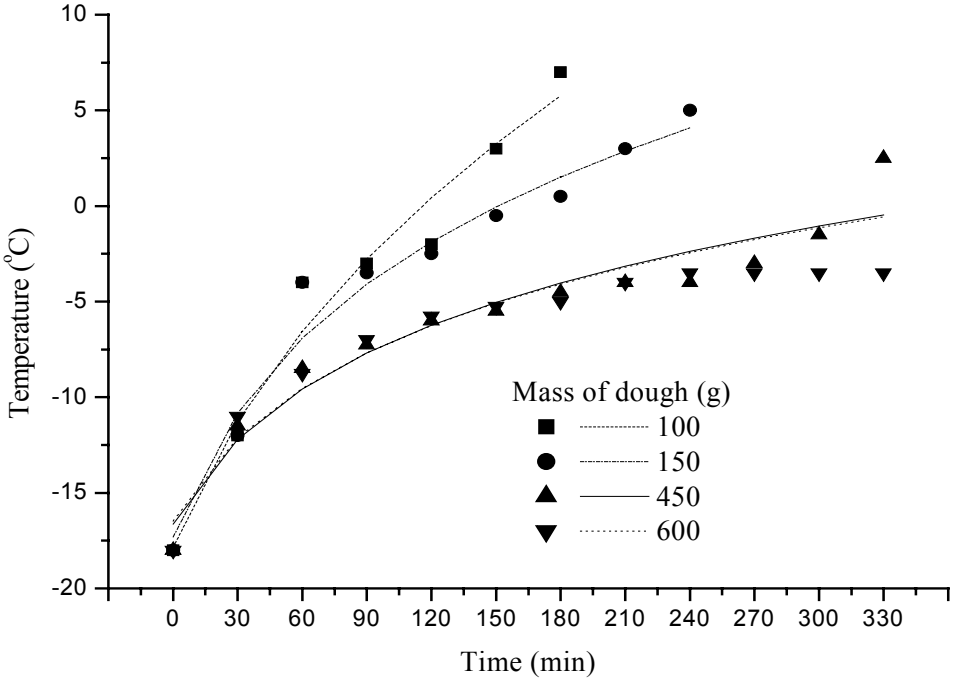

FIGURE 3. DYNAMICS OF FROZEN DOUGH DEFROSTING (SAMPLES OF DIFFERENT MASS, IN THE REFRIGERATOR (-4±2°C)

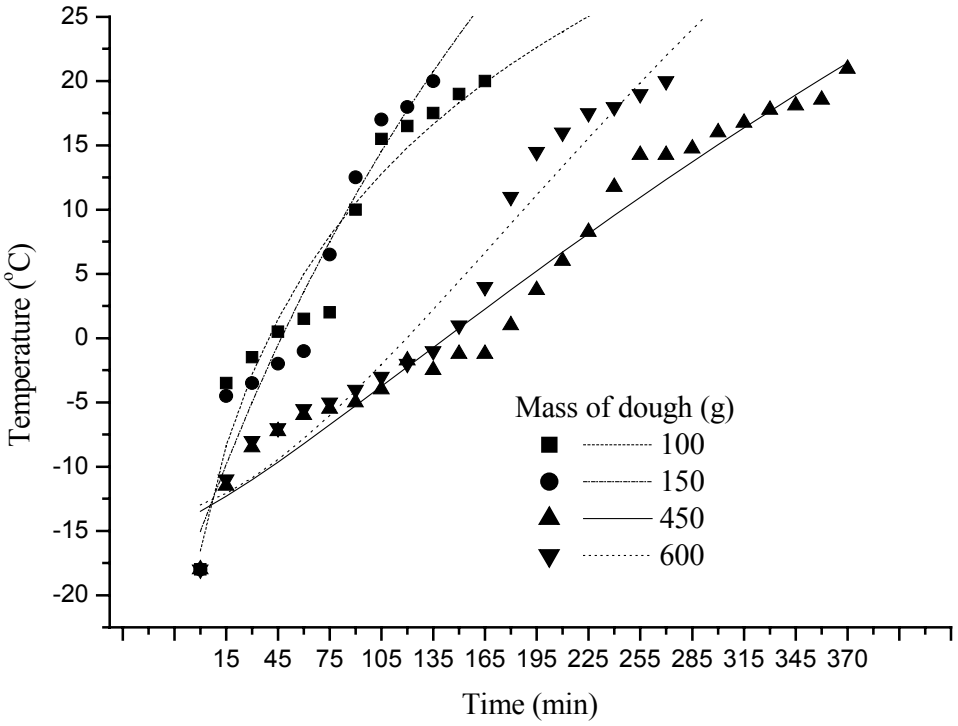

FIGURE 4. DYNAMICS OF FROZEN DOUGH DEFROSTING
(SAMPLES OF DIFFERENT MASS, AT ROOM TEMPERATURE 20±1°C)

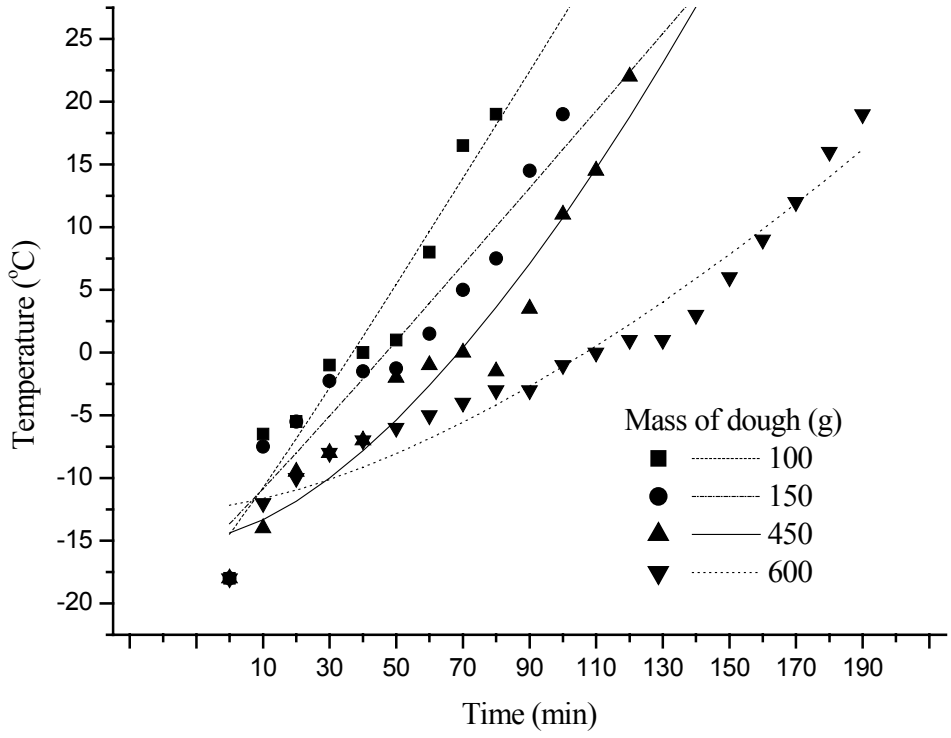

FIGURE 4. DYNAMICS OF FROZEN DOUGH DEFROSTING
(SAMPLES OF DIFFERENT MASS, IN THE THERMOSTATE 35±1°C)

4. CONCLUSIONS

The freezing rate depends on the mass of dough both at -20°C and -35°C. Dough samples of smaller mass are frozen faster than of bigger

mass. Dough samples weighing 100 and 150 g are frozen two times faster then the 450 g and 600 g samples.

The freezing time depends on the freezing temperature also. The samples frozen at -20°C reach the freezing temperature two times slower compared to samples frozen at -35°C. The defrosting time depends on the temperature and mass of dough sample.

5. REFERENCES

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