

THE INFLUENCE OF WATER CONTENT ON SWELLING ABILITY  
OF THE CRUMB OF FROZEN YEAST CAKES

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**Abstract.** The object of investigation was the evaluation of the influence of water content in yeast cakes on the swelling ability of the crumb. In order to do that, the content of water was quantified with the use of drying method and the swelling ability of the crumb method proposed by Jakubczyk was implemented. The investigation determined correlations between the parameters under investigation in order to prove that the crumb swelling ability can become a parameter serving the evaluation of the quality of yeast cakes while being stored. Based on the investigations one can ascertain that there exists a strong correlation between the examined parameters, therefore monitoring in time the ability of the crumb to swell can become an important reference with regard to the quality, usability and the degree of staleness of the yeast cake.

**Key words:** crumb swelling ability, growing stale, retrogradation of starch, product water content

INTRODUCTION

Dynamic life and continuous lack of time have caused that products which can be prepared in a short time and having long usability are consumed more and more often. For this reason frozen food is in high demand. Therefore, freezing of confectionery including yeast cakes becomes more and more important.

Freezing is one of the methods which permit to lower the tempo of the process of the cake becoming stale, which is a basic problem faced by the producers of baking articles and confectionery [8].

Independently from the applied technology of fixing, frozen cakes undergo chemical and physical transformation in time; that is why it is so important to ensure optimum conditions of storage which would minimize the decrease in the product quality. The quality of frozen cakes is determined by many factors i.e.

ambient temperature, tightness of wrapping, or the mode of freezing. Non-maintenance of proper storage parameters initiates some unfavorable transformations including changes in the water content, which has been an important criterion of the quality and usability of food [1,13]. When storing frozen food, water might evaporate partially as a result of sublimation and settle inside the wrapping. Water content in yeast cakes has an important influence on their quality by affecting such parameters as e.g. porosity, elasticity or swelling ability [7,8].

The aim of the study was to prove that the evaluation of the swelling ability may become a parameter serving the definition of changes in the level of quality of yeast cakes in storage conditions.

The range of work:

1. To determine the changes in the water content during storage in diverse temperatures,
2. To determine the changes in the swelling ability of the cake during storage in diverse temperatures,
3. To define the correlation between the water content and the swelling ability of the yeast cake.

#### MATERIAL AND METHODS

The material under investigation comprised yeast cakes without additives. The cake consisted of cake-flour (type 450), eggs, yeast leaven instant, milk 2% fat, vegetable fat and sugar. The cakes were packed in polythene foil and warehoused for four months in three different storage chambers:

- In variable temperature ( $-18^{\circ}\text{C}$ ;  $-22^{\circ}\text{C}$ ), which was initiated every 72 hours,
- In constant temperature of  $-18^{\circ}\text{C}$ ,
- In constant temperature of  $-30^{\circ}\text{C}$ .

The majority of frozen cakes which are available on the market have the usability period of four months, therefore the examinations were carried out every 30 days. In the course of 120 days the content of water was determined by means of the drying method compatible with standard PN-84/A-88027 and the swelling ability of the cake according to Jakubczyk [6].

The initial content moisture was 39.4%.

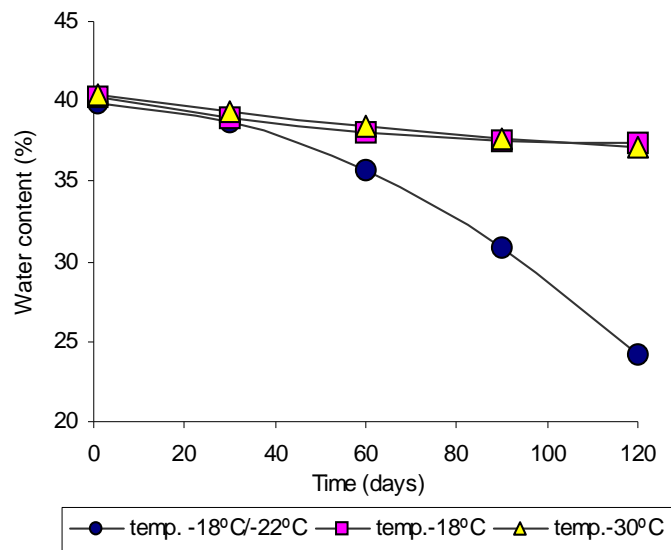
#### RESULTS AND DISCUSSION

Empirical results of measurements of such parameters as the change in time of water content and change in the swelling ability were presented as a square function of regression, which each time was characterized by the smallest square of deviation from empirical data [10].

Water content in the products under investigation systematically lowered during storage. This phenomenon was a result of the endeavor of the product to achieve the state of humidity equilibrium with the environment. According to the literature, the higher the temperature of environment the greater the air humidity capacity and the greater humidity it can take from products found in it.

The distribution of results in Figure 1 indicates that the changes of water content in time were dependent on ambient temperature. Temperatures assumed in the experiment and their variations might influence the changes in the quantity of water in the product, thus influencing the durability and quality of yeast cakes.

In constant temperatures ( $-18^{\circ}\text{C}$ ;  $-30^{\circ}\text{C}$ ) the decrease of water was insignificant and equaled 9.08% and 7.42%, respectively. In fluctuating temperature ( $-18^{\circ}\text{C}$ ;  $-22^{\circ}\text{C}$ ) the decrease of the water content was decidedly greater and equaled 34.26%.



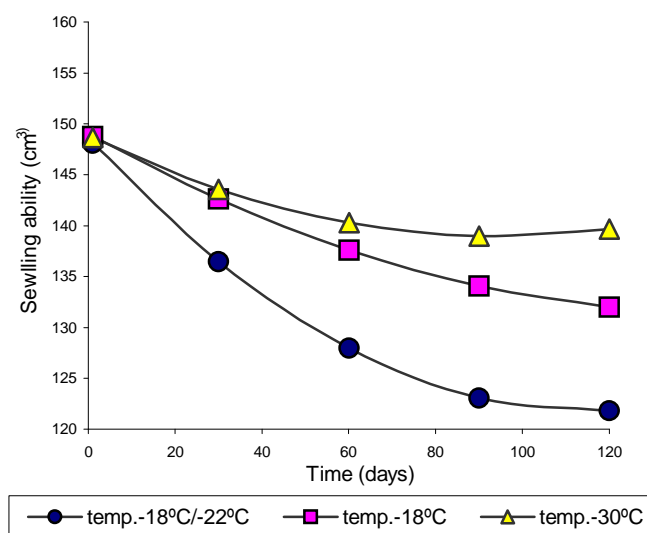
**Fig. 1.** Correlation of water content and time in frozen yeast cakes during storage in diverse temperatures

It must be stated then that the least advisable variant, as far as storing is concerned, was to store yeast cakes in fluctuating temperature. Changes of ambient temperature during storage led to considerable decrease of water in yeast cakes, which in turn led to a decrease of the quality of the product as estimated by a panel of specialists. Moreover, it was found that the changes of water content also contributed to physical and chemical changes of tested products [3,4]. While

giving up water into the environment, the structure of the prevailing component of cakes, i.e. the starch, was subject to change [5]. Systematic decrease of water led to retrogradation of starch, consisting in an increase of the degree of cross-linking of particles of starch which was characterized by a well ordered and compact structure, leading in consequence to the cake becoming stale, which was manifested by hardening and crumbling of the crumb. Thanks to that it was easier to evaporate for water bound in the structure of gel [9].

The swelling ability may be treated then as a parameter being derivative of the water content and reflecting the state of starch, which might influence the sensory assessment.

Figure 2 presents changes in time of the swelling ability of the cake crumb, stored in three variants of temperature.



**Fig. 2.** Correlation of swelling ability and time in frozen yeast cakes during storage in diverse temperatures

Swelling ability of the crumb, in this case, was understood as the ability to change the structure, mass and volume under the influence of water. Using the method proposed by Jakubczyk, the swelling ability of the crumb was qualified on the basis of the height of the column of sediment accumulated as a result of swelling of a piece of cake. The minimum volume of the column of sediment should equal 140 cm<sup>3</sup> [6]. Lowering of the swelling ability usually means that the quality of the product has deteriorated and is less acceptable to the consumer.

Diminution of the swelling ability of the crumb indicated the decrease of water in a product, which to a large extent was related to the retrogradation of starch. Transformation of starch from the amorphous form to the well arranged crystalline form caused the change of the cake structure and the water contained in it diffused into the environment and could be accessible to other components [5]. As a result of the transformation of starch and climatic conditions the cake could become stale.

While storing frozen cakes, their swelling ability dropped down, which might have been the consequence of a decrease of water content. The dynamics of the swelling ability was strictly related to the storing temperature. In those chambers where the temperature was  $-30^{\circ}\text{C}$ , after 120 days of storage it was found that the swelling ability of the crumb lowered inconsiderably. Probably there took place the least changes in the structure of the product compared to the other analyzed temperatures. In low temperatures the yeast cakes maintained the quality accepted by consumers throughout the whole period of 4 months. It was confirmed by a high value of the swelling ability which each time was higher than  $140\text{ cm}^3$  of the column of sediment. It guaranteed high quality of cakes after defrosting. Quick freezing and the maintenance of stable low temperature permitted to preserve proper structure of the cake. Processes of arrangement of starch forms and retrogradation were not advanced, thanks to which there was enough room left for water in the empty spaces. Free water which remained inside stopped further unfavorable transformations, thus preserving the cake on the acceptable level. Another stage of the research was to determine the correlation between the compactness of water and the swelling ability of the crumb.

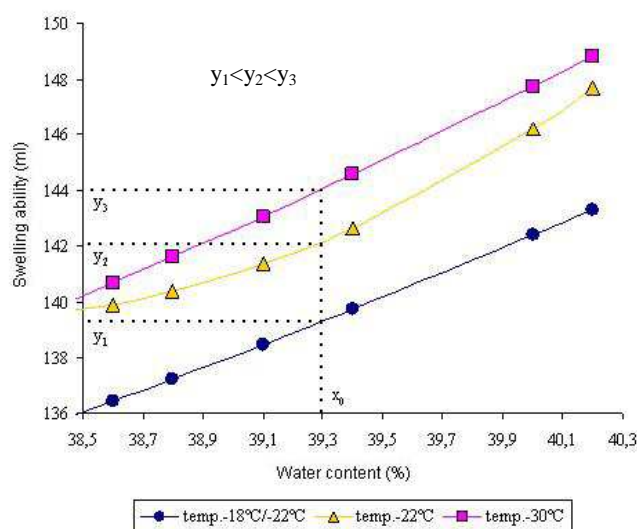
Analyzing the dependence of the water content and the swelling ability of crumb, it must be stated that the quality of the product was dependent not only on the content of water but also on the conditions in which this level of moisture was reached.

At the level of moisture marked as  $x_0$  (Fig. 3), the swelling ability was higher for cakes stored in stable, low temperature. It can be presumed, then, that the product kept in such conditions not only preserves the desirable level of quality conditioned by the content of water but also, when obtaining this level of moisture, is characterized by smaller structural changes and less advanced process of becoming stale. The lowest quality was demonstrated by those cakes which were stored in temperatures of  $-18^{\circ}\text{C}$  and  $-22^{\circ}\text{C}$ , and the dynamics of changes of both parameters (the content of water and swelling ability of the crumb) was the greatest.

The study has shown that there exists a strong correlation between the examined parameters, therefore monitoring in time the ability of the crumb to swell can become an important reference with regard to the quality, usability and the degree of staleness of the yeast cake.

Application of the swelling ability as a method defining the quality of the product has its economic dimension. Marking is cheap, quick and comparatively

precise. From the changes in the swelling ability of the crumb one can infer other undesirable transformations in the cake, mostly related to the product structure, i.e. its elasticity or porosity, which according to Waszkiewicz-Robak are distinguishing features of the sensory quality of yeast cakes.



**Fig. 3.** Correlation of swelling ability and water content in frozen yeast cakes during storage in diverse temperatures

## CONCLUSIONS

1. The greatest dynamics of changes in the content of water and swelling ability of the crumb was shown by yeast cakes stored in fluctuating temperature in the range of  $-18^{\circ}\text{C}$ ,  $-22^{\circ}\text{C}$ .
2. The diminishing of the swelling ability of the crumb was caused directly by the loss of water in the product.
3. There is a strong correlation between the changes in time of the water content and the swelling ability of the crumb.

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## WPLYW ZAWARTOŚCI WODY NA ZDOLNOŚĆ PĘCZNIENIA MIĘKISZU W MROŻONYCH CIASTACH DROŻDŻOWYCH

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**Streszczenie.** Przedmiotem podjętych badań była ocena wpływu zawartości wody w ciastach drożdżowych na zdolność pęcznienia miękiszu. W tym celu wyznaczono zawartość wody metodą suszarkową i zdolność pęcznienia miękiszu metoda zaproponowana przez Jakubczyka. W pracy określono wzajemne związki pomiędzy badanymi parametrami, w celu wykazania, iż zdolność pęcznienia miękiszu może być parametrem służącym ocenie jakości ciast drożdżowych podczas przechowywania. Na podstawie uzyskanych wyników stwierdzono, że istnieje silna korelacja pomiędzy badanymi parametrami, dlatego monitorowanie w czasie zmian zdolności miękiszu do pęcznienia może być ważnym i odwoławczym kryterium jakości, trwałości i stopnia sčerstwienia ciasta drożdżowego.

**Słowa kluczowe:** zdolność pęcznienia miękiszu, czerstwienie, retrogradacja skrobi, zawartość wody w produkcie.