

THE DEPENDENCE OF FROZEN YEAST CAKE QUALITY PARAMETERS ON THE THERMAL CONDITIONS OF STORAGE

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Abstract. The subject of this study was to determine the impact the storage temperature exerts on selected quality parameters of frozen yeast cake by X and Y producers. The water content, size of the shrinkage formed inside, and the ability to absorb and keep water by the cake crumb were determined. The conducted study revealed that temperature and its stability in time significantly define the properties of the studied product. The most favourable temperature variant for storage was -22°C . Yeast cake stored in such conditions was characterised by the smallest size of the inside shrinkage and the highest level of water absorbing and maintaining ability, regardless of the producer. Fast freezing and keeping a constant temperature enabled preservation of the proper cake structure and the changes found were insignificant so that the cake was fit for marketing.

Key words: starch retrogradation, staling, water keeping in the product, inside shrinkage

INTRODUCTION

Yeast cake is a product that keeps the desired properties only for several hours following the baking. The cake crumb plays a major role in the occurrence of the changes to the product properties, where the water evaporation process starts ever since it has been taken out of the oven and it starts to cool down, which starts on the surface and goes deeper. The main cause for the unfavourable changes is the transformation of starch from the amorphous form into a crystalline structure. For the purpose of restricting this process many techniques have been adopted. In the light of this problem, the freezing method seems to be gaining importance among bread and cake bakers (Barcenas *et al.* 2006, Varianno-Morston *et al.* 1974).

Freezing is one of the most efficient techniques of food preservation. Almost all food products are nowadays subjected to freezing, mainly because of the health and quality issues, because what makes them such is the lesser level of

physical, biochemical and microbiological activity at the time of freezing and storing. The freezing method becomes more and more of interest to confectionery producers. From the point of view of slowing down the staling process, freezing has been one of best identified techniques so far. Freezing, however, does not mean complete stopping of this process. While stored, yeast cake undergoes physical and chemical changes of varied intensity which depends on many factors (Postolski *et al.* 1992).

Among the many parameters shaping up the quality of frozen cake while stored is the temperature at which it is kept. Temperature makes the factor likely to affect many physical and chemical processes that occur in yeast cake, including those depending on water content as it constitutes an important criterion for food quality and durability. While frozen, water may undergo partial evaporation due to sublimation, and sediment on the inside of the packing thus forming the inside shrinkage (Ceglińska *et al.* 2003, Postolski *et al.* 1992). Further, systematic water depletion is likely to bring about starch retrogradation and, eventually, cause worsened ability to bind and keep water in the product (Lionetto *et al.* 2005, Scanlon *et al.* 2001).

The aim of this study was to determine the impact of storage temperature on the quality of yeast cake, depending on the water content in the product.

The study involved the following:

- determination of changes to the water content during storage under variable temperatures,
- determination of the amount of the inside shrinkage formed in the course of storage,
- determination of changes to the water binding ability during storage under variable temperatures.

MATERIALS AND METHODS

The study material consisted of yeast cake made of wheat flour, plant fat, sugar, eggs, yeast, powdered milk, vanilla sugar, salt, fragrance identical to natural and beta-carotene, by two bakers, X and Y, and packed in polyethylene film (Tab. 1). It was stored for 6 months in three different freezing compartments:

- at variable temperatures (-12°C , -22°C), initiated every 72 hours,
- at constant temperature of -12°C ,
- at constant temperature of -22°C .

Most of the frozen cake available on the market are fit for consumption from four to six months, that is why the research was carried out for 180 days. Over the said period, the water content was determined every 30 days with the use of the drying method following the standard PN-84/A-88027 (Krełowska-Kułas 1993),

the amount of the inside shrinkage on the basis of the difference in mass, and also the ability to bind and keep water with the use of a method suggested by the author of this study. The said method involved dipping a bite of cake in water at 20°C for 20 seconds. Then the said bite of cake was left hanging on a sieve

for 3 minutes. The difference in mass of the cake bite before and after the dipping allowed to determine the percentage increase in water content in the product, which revealed the ability of the said bite to absorb and keep water.

Table 1. Chemical composition of yeast cake produced by bakers X and Y

Chemical composition	Producer X (g)	Producer Y (g)
Protein	6.5	7.2
Carbohydrates	53.6	50.2
Fat	12.3	10.5
Salt	0.052	0.065
Water content	25.4	30.2

RESULTS AND DISCUSSION

Water content in the studied products declined on a systematic basis over the storage time, despite the vapour-proof package as declared by both manufacturers. The phenomenon was an effect of the product striving to achieve humidity equilibrium with the environment (Xin *et al.* 2004).

The distribution of the study results (Fig. 1 and 2) showed that the changes in water content over time depended on the storage temperature. The temperatures adopted for the experiment and their oscillations could control the changed amount of water in the product, in the heart of the crumb in particular, where the samples were taken from. Changes occurring due to water migration inside the product and its loss outside could have affected the yeast cake durability and quality.

While storing at the constant -22°C, the loss of water was minor: 5.78% and 6.84% for X and Y baker, respectively; under fluctuating temperature (-12°C, -22°C) the loss of water content was definitely greater: 10.79 and 12.62 percentage points for the respective bakers. Comparable data was found in the cake stored at -12°C – water loss in the studied cake bites was 10.31 and 11.93 percentage points, respectively.

Changes in water content triggered also changes in the physical and chemical properties of the studied yeast cake pieces. At the time of water migration from the deeper cake layers to its surface and its partial evaporation, starch structure altered due to the sublimation process. Systematic loss of water led to starch retrogradation, which consequently made the cake go stale.

Changes in environment temperature in the course of storage and the cake storage at -12°C made the cake lose significant amounts of water, which was reflected in the amount of thus formed inside shrinkage determining the quality and life of frozen food products.

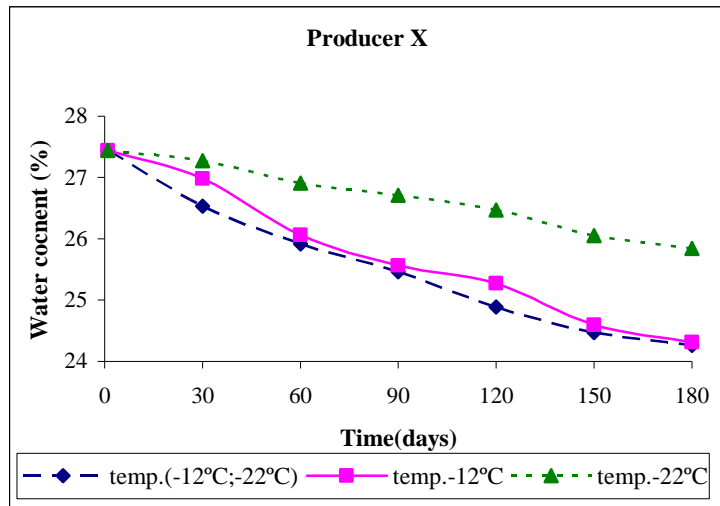


Fig. 1. Dependence of changes in water content in the function of time for baker X

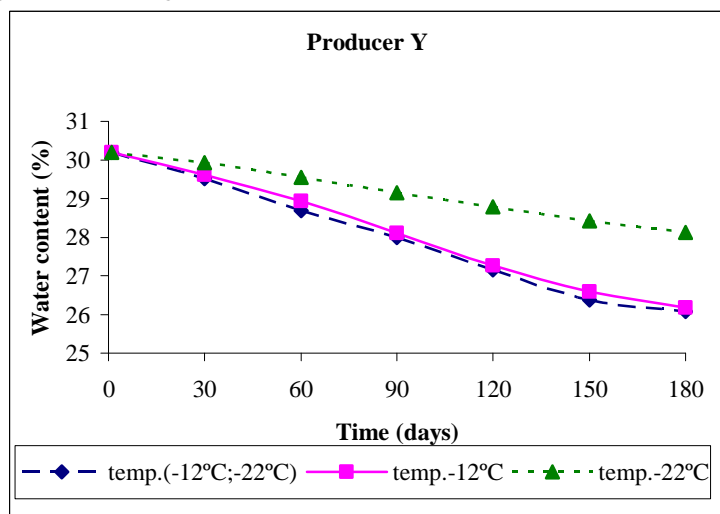


Fig. 2. Dependence of changes in water content in the function of time for baker Y

Proper packing makes an important factor minimising the loss of water in frozen food. Vapour-proof packing, tightly adhering to the product, eliminates completely the shrinkage. In the case of the products used for the experiment, the packing did not adhere to the product and so the so called inside shrinkage oc-

curred which was due to the temperature oscillations. This phenomenon could have been a result of vapour sublimation out of the product surface and its crystallising in the form of frost on the inside of the package (Ceglińska *et al.* 2000, Postolski *et al.* 1992).

Yeast cake stored under forced fluctuation was characterised by notable shrinkage, making up 6% in the case of baker X and 5% for baker Y. Normally, the shrinkage amount should not be more than 1.5%, depending on the product type and freezing method (Postolski *et al.* 1992), as it is only under such conditions that a product maintains its good quality. Basing on the obtained data it is possible to state that the big amount of the inside shrinkage resulted from unfavourable changes occurring in the product structure. Temperature fluctuation in the course of storage made bigger and bigger ice crystals form on the surface whose temperature was closer to the package temperature than the product temperature, which – in turn – stimulated sublimation.

Storing the yeast cakes at a constant temperature of -12°C or at variable temp. from -12°C to -22°C caused water migration from deeper parts of the crumb to the surface, thus shaping visible inside shrinkage in the form of frost.

The impact of the conditions of storage on the extent of the inside shrinkage in frozen yeast cake is presented in Figures 3 and 4. The diagrams show that the loss of product mass was lesser respective of more constant storing temperature. As the study shows, drop in the storage temperature from -12°C to -22°C caused the inside shrinkage to double in both cakes.

A relatively big share of the inside shrinkage (5.7% and 4.8%) was found in cakes stored at -12°C . At fluctuating temperatures, the extent of the shrinkage was slightly bigger and its dispersion was more regular than in the case of the cakes stored at constant temp. of -12°C .

The moment the product was thawed, the frost in the form of the inside shrinkage gathered on the product surface and made the water drip down the walls of the package to the bottom, making the cake wet underneath. As a result, the top of the cake was dry and firm while the bottom was watery and sticky.

This condition was strictly connected with the package nature and the storage temperatures, as with the same package the changes to water content and the extent of the resultant inside shrinkage at -22°C were the least.

Yeast cake by baker X, however, was characterised by a much bigger inside shrinkage at all temperature variants as compared to the cake by baker Y. The changes found under the same storing and packaging conditions were due to the shrinkage size and chemical composition along with the technological process of that yeast cake.

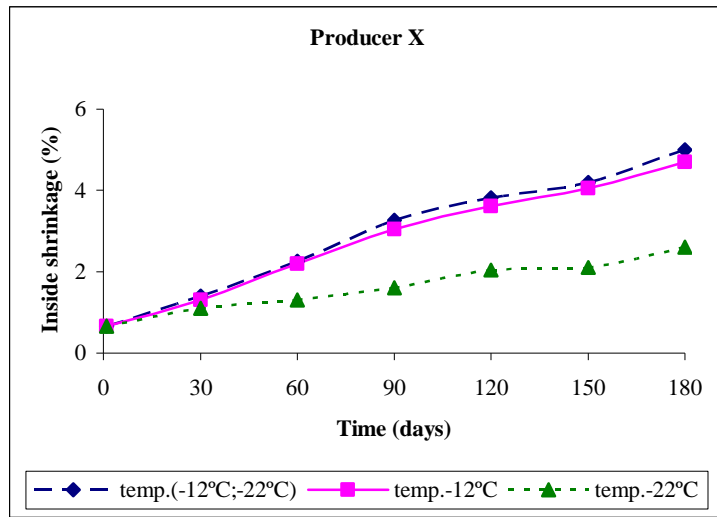


Fig. 3. Dependence of the shrinkage amount on the time factor in the case of baker X

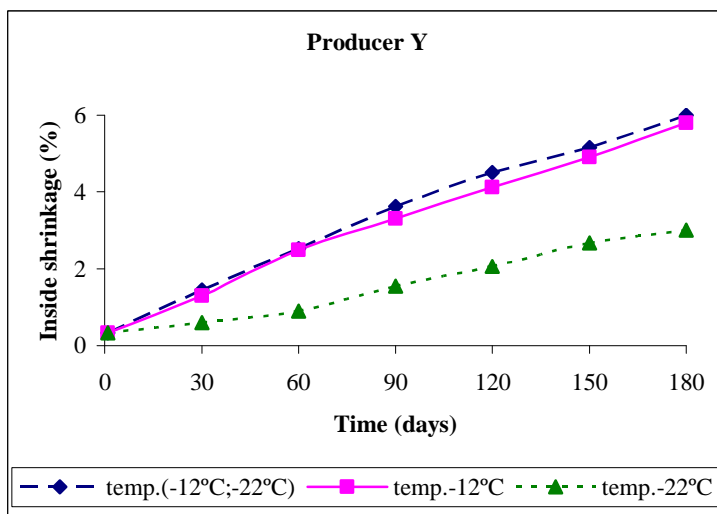


Fig. 4. Dependence of the shrinkage amount on the time factor in the case of baker Y

While stored, bakery products undergo drying and lose the flavour as well as get stale. Bakery staling triggers a number of unfavourable organoleptic changes which decrease the product quality. The skin softens and becomes opaque, and the crumb hardens becoming dry and crumbling, which is primarily due to water

redistribution at the time of storage (Fik *et al.* 2000, Varianno-Morston *et al.* 1974). The staling rate depends on many factors resulting from the technological process and the storage conditions. The staling extent frequently makes the major parameter in assessing the quality and fitness for consumption. Literature quotes many indirect methods of measuring the staleness of bakery products. Changes to the degree of staleness at the time of storing are presented in this paper basing on the changes to the cake bite ability to absorb and keep the water.

Figures 5 and 6 present the changes in water binding and keeping ability at the time of storage. In this case, the ability to bind water is meant as the amount of water the cake bite was able to absorb and keep. The water absorbance value is presented by means of the cake bite weight difference before and after the dip in water. A decreased ability to bind water usually means deteriorated product quality. While storing the cake frozen, the water binding ability deteriorated gradually, which could have resulted from the cake turning stale and indirectly from the loss of water. The dynamics of water binding and keeping abilities firmly depended on the storage temperature conditions.

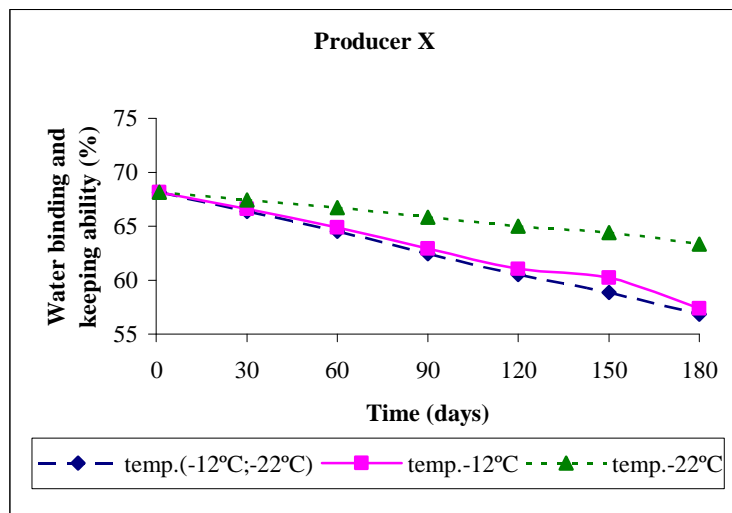


Fig. 5. Dependence of absorbing and keeping ability on storage time for baker X

In the compartments with temperature of -22°C , following 180 days of storage, a slight decline in the crumb water absorbing ability was found. Most probably the product structure was affected in the least by changes as compared to other analysed temperature conditions. The application of low yeast cake storage temperatures kept the desired quality for almost the whole storage time. Fast

freezing and keeping a constant low temperature allowed for maintaining the proper cake structure (Ceglińska *et al.* 2003).

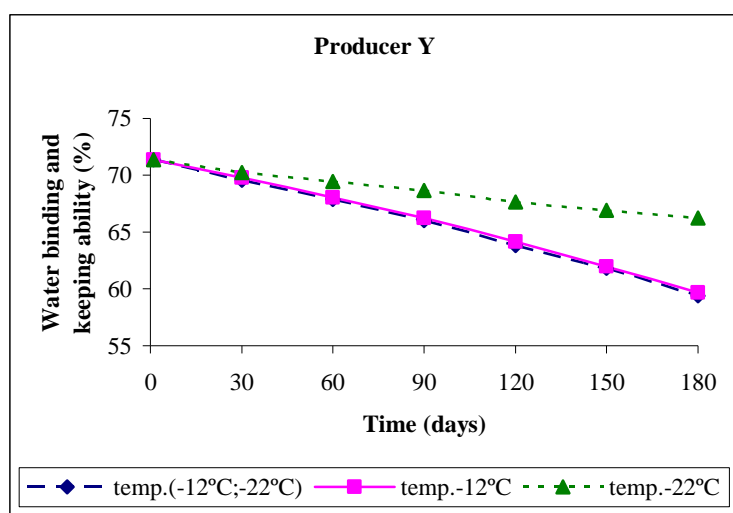


Fig. 6. Dependence of absorbing and keeping ability on storage time for baker Y

Storing at fluctuating temperatures and at constant -12°C required a significant decline in water binding and keeping ability. Once thawed, the cakes were dry and hard. Having dipped the samples in water, the cake bites fell apart. They absorbed large amounts of water yet they were unable to keep it. Such a situation could have largely been a result of ongoing staling process during which starch retrogradation occurred, having it turn from amorphous condition to the organised form by shaping a crystalline web. This phenomenon was accompanied by water release which migrated towards gluten and cross linkage was formed in the starch molecule (Ottenhof *et al.* 2004, Xin *et al.* 2004). This allows for an assumption that with ongoing starch retrogradation there was less and less room for water in the free spaces while the experimentally supplied water was not able to either bind or stay by any physical or chemical forces at the time of storage.

On the basis of the study it can be stated that temperature and its stability has always been an important factor determining the frozen yeast cake quality. The cakes stored at -22°C showed the best quality in both types of the studied cake while the dynamics of the examined parameters was the least.

The suggested temperature of -22°C was optimal from the point of view of the product quality. The inside shrinkage was much smaller than in other tempera-

tures and the relatively high water binding and keeping performance allowed for a statement that the starch forms control processes were not terribly advanced, which eventually ensured post thawing high quality.

Yeast cake is a product where structural changes are of strategic importance for the quality shaping and therefore the monitoring of changes in the product reology is a priority. The application of the suggested method of water keeping and absorbing ability measurement might contribute to the determination of yeast cake staleness extent. Basing on the changes to the water keeping ability, it is possible to make conclusions on other unfavourable changes going in the yeast cake, primarily those in connection with the product structure.

CONCLUSIONS

1. Temperature and its stability makes the factor responsible for the frozen yeast cake quality.
2. The least dynamics of changes in the studied parameters was noted in the yeast cake stored at -22°C ,
3. The extent of the inside shrinkage as well as the ability of water absorption and keeping are the parameters which allow for yeast cake staling process monitoring at the time of storage.
4. Yeast cake by baker X displayed greater dynamics of changes to the studied properties than the cake by baker Y.

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WPŁYW WARUNKÓW TERMICZNYCH PRZECHOWYWANIA NA WYBRANE PARAMETRY JAKOŚCI MROŻONYCH CIAST DROŻDŻOWYCH

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Streszczenie. Przedmiotem podjętych badań było określenie wpływu temperatury przechowywania na wybrane parametry jakości mrożonych ciast drożdżowych dwóch producentów X i Y. Oznaczono zawartość wody, wielkość powstałej ususzki wewnętrznej i zdolność pochłaniania i utrzymywania wody przez mięksiz ciasta. Przeprowadzone badania wykazały, że temperatura i jej stałość w funkcji czasu znacząco determinowały badane właściwości produktu. Najbardziej korzystnym wariantem temperaturowym przechowywania, była temperatura -22°C . Ciasta drożdżowe składowane w takich warunkach charakteryzowały się najmniejszą wielkością ususzki wewnętrznej oraz najwyższym poziomem zdolności pochłaniania i utrzymywania wody ciast obu producentów. Szybkie zamrażanie i utrzymywanie stałej niskiej temperatury pozwoliło na zachowanie właściwej struktury ciasta, a stwierdzone zmiany nie były na tyle duże, aby dyskwalifikowały produkt z obrotu.

Słowa kluczowe: retrogradacja skrobi, czerstwienie, zdolność pochłaniania i utrzymywania wody w produkcie, ususzka wewnętrzna