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STUDYING MOISTURE CONTENT OF SPONGE CAKE PRODUCTS STORED IN VARIOUS CONDITIONS, CONTAINING DIFFERENT LEAVENING AGENT®

Badanie zawartości wody w ciastach biszkoptowych przechowywanych w zmiennych warunkach, zawierających różny środek spulchniający®

The aim of the study was to evaluate sponge cakes containing various leavening agents. *Sponge cakes with the addition of sodium bicarbonate and ammonium bicarbonate as a leavening agent and without leavening agent have been subjected to a moisture test. Determinants at work were variable ambient conditions, storage time, and the type of packaging in which the cakes were stored. Moisture determination was carried out using a standardized method, and then the method of testing moisture in cakes using a moisture analyzer was validated against this method. The work also carried out sensory evaluation of cakes made. A relationship was found between the conditions for storage of sponge cakes and the type of leavening agent. Given the storage conditions of cakes, biscuits stored in refrigeration conditions were characterized by a higher water content compared to biscuits stored in room conditions. Considering the type of packaging, it was found that the biscuits stored in breakfast paper had the lowest water content (cooling and room conditions). Among sponge cakes stored in aluminum foil, the lowest water content was found in cakes with the addition of sodium bicarbonate. Among the biscuits stored in food film, the lowest water content was found for biscuits without a leavening agent (day 8 and 10) and cakes with sodium bicarbonate (day 15 and 22). Generally, according to respondents, sponge cake with ammonium bicarbonate stored in room conditions in aluminum foil showed the best sensory properties on the 8th and 15th day of storage.*

Key words: sponge cakes, water content, leavening agent, moisture analyzer.

Celem artykułu jest przedstawienie uzyskanych wyników badań dotyczących oceny ciast biszkoptowych zawierających różny środek spulchniający. *Ciasta biszkoptowe z dodatkiem wodorowęglanu sodu i wodorowęglanu amonu jako środka spulchniającego oraz bez dodatku środka spulchniającego zostały poddane badaniu na zawartość wilgoci. Determinantami w pracy były zmienne warunki otoczenia, czas przechowywania oraz rodzaj opakowania w jakim ciasta były przechowywane. Oznaczenie wilgoci przeprowadzono metodą znormalizowaną a następnie względem tej metody zwalidowano metodę badania wilgoci w ciastach, wykorzystującą wagosuszarkę. W pracy przeprowadzono również ocenę sensoryczną wytworzonych ciast. Stwierdzono zależność pomiędzy warunkami przechowywania biszkoptów, a rodzajem środka spulchniającego. Biorąc po uwagę warunki przechowywania ciast, biszkopty przechowywane w warunkach chłodniczych charakteryzowały się większą zawartością wody w porównaniu z biszkoptami przechowywanymi w warunkach pokojowych. Biorąc pod uwagę rodzaj opakowania stwierdzono, że biszkopty przechowywane w papierze śniadaniowym charakteryzowały się najniższą zawartością wody (warunki chłodnicze i pokojowe). Wśród ciast biszkoptowych przechowywanych w folii aluminiowej najniższą zawartością wody charakteryzowały się ciasta z dodatkiem wodorowęglanu sodu. Wśród biszkoptów przechowywanych w folii spożywczej najniższą zawartość wody wykazały biszkopty bez środka spulchniającego (8 i 10 dzień oznaczenia) oraz ciasta z wodorowęglanem sodu (15 i 22 dzień oznaczenia). Generalnie w opinii respondentów ciasto biszkoptowe z wodorowęglanem amonu przechowywane w warunkach pokojowych w foli aluminiowej wykazywało najlepsze właściwości sensoryczne w 8,10 i 15 dniu przechowywania.*

Słowa kluczowe: ciasta biszkoptowe, zawartość wody, środek spulchniający, wagosuszarka.

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INTRODUCTION

Water is present in practically every food product. The water content has significant importance for a number of reasons. Determination of water content is the most common general analysis carried out on foodstuffs and sponge cakes in them [9]. The water content and water activity correlated with it affect the texture of the cakes, i.e. their crispness, brittleness and plasticity. In cakes with a water content higher than the relative humidity corresponding to the capacity of the monomolecular layer, there are many adverse changes leading to loss of quality. There may be a feeling of loss of tenderness, hardening, foreign taste and smell, as well as microbial growth may occur [13]. Many components are used in the production of cakes such as flour, water, sugar, milk, salt, leavening agent, flavors, additives and other food are allowed in the specifications. The quality and quantity of these components are important and influence on the properties of the final product as well as the stability of quality during shelf life [1]. The quality of biscuits is significantly affected by its ingredients, production parameters and storage conditions. Sponge cakes owe their typical texture and structure to their high egg content, absence of fat and a combination of three main methods during production: the use of chemical raising agents at the stage of formulation, whipping or steam injection during mixing, and thermal expansion during baking [2, 3].

The goal of sponge cake producers is to obtain products with porosity, volume, appearance and composition satisfying consumers. Nowadays, the consumer interest in durable products that are visually attractive is clearly visible [8, 4]. At the same time, the storage method and the type of packaging are not insignificant in this respect.

However it is important to know that cakes stored at increased relative humidities can lost a negligible amount of moisture but continued to increase in firmness and adhesiveness [14].

In general, the texture of sponge cakes is of great importance for both consumers and producers, because it greatly affects our eating habits, shapes our preferences and is an indicator of freshness. Obtaining the desired texture and at the same time maintaining it for a specific period of time requires, among others, the use of suitable substances, e.g. leavening agents, followed by the use of appropriate storage methods and conditions. Taking the above into consideration in the presented work, research was undertaken that allowed to obtain information by answering the cited issues [7].

The aim of the study was to assess the effect of leavening agents on the quality of sponge cakes stored in different conditions.

MATERIAL AND METHODS

Material

Sponge cakes with the addition of sodium bicarbonate and ammonium bicarbonate as a leavening agent and without the addition of a leavening agent were prepared according to the cold method as follows: the yolks were separated from the proteins; the foam with the addition of sugar was whipped with a mixer (ZELMER Robi Mix ", type 381.6) operating in the highest speed range; to the whipped foam, yolks and wheat flour are alternately added mixed with a leavening agent and aerated by sieving it into the mass; the dough was gently mixed with a wooden spoon and laid out into a 40x25 cm mold. The dough was baked in the laboratory in an oven (BOSCH "HBA 43T350) at 180°C for 13 minutes with the hot air function on. After removing from the oven, the sponge cake was allowed to cool at room temperature.

The cooled sponge cakes, after cutting lengthwise (in half), were wrapped in three different packaging materials (aluminum foil, food foil, breakfast paper). The cakes were stored in various conditions, i.e. in the fridge-freezer (POLAR "type CZ250 version 3007), in which the following conditions were present: temperature 5.30°C, relative humidity 55% and in ambient conditions at 21.10°C and relative humidity 35,8% (Table 1). The research material consisted of sponge cakes baked based on our own recipe. The composition of the recipe was as follows: 5 chicken eggs from own breeding; 150 g white sugar (Polski Cukier – Krajowa Spółka Cukrowa S.A.); 150 g wheat flour (Queen of Cuisine type 390, PZZ Kraków); leavening agent: sodium bicarbonate about 5g (PHU "MARSYL" s.c.) or ammonium bicarbonate about 3g (APETTITA – home secrets, "COLIAN" sp.z o.o.).

Table 1. Types of sponge cake and codes assigned to them

Tabela 1. Rodzaje ciasta biszkoptowego i przypisane im kody

Cake types / Sample code	
Storage Conditions	
Room temperature*	Refrigerator conditions*
Sponge cake without the leavening agent	
C1FA	C2FA
C1FS	C2FS
C1PS	C2PS
Sponge cake with the addition of ammonium bicarbonate	
C1FAA	C2FAA
C1FSA	C2FSA
C1PSA	C2PSA
Sponge cake with the addition of sodium bicarbonate	
C1FAS	C2FAS
C1FSS	C2FSS
C1PSS	C2PSS

Legend: FA, FAA, FAS – aluminum foil;
FS, FSA, FSS – food wrap;
PS, PSA, PSS – breakfast paper
* conditions in which the sponge cake was stored

Legenda: FA, FAA, FAS – folia aluminiowa;
FS, FSA, FSS – folia spożywcza;
PS, PSA, PSS – papier śniadaniowy
* warunki w jakich ciasto było przechowywane

Source: Own study

Źródło: Opracowanie własne

Methods

A cyclical organoleptic assessment and cyclical examination of the water content of stored cakes were carried out.

Organoleptic assessment

Sponge cakes were subjected to an organoleptic assessment made by a group of people who are students of the third semester of Master's studies in Commodity Science at the University of Technology and Humanities. Kazimierz Pulawski in Radom. After baking and cooling the sponge cakes they were subjected to visual assessment (without the help of other senses such as smell or touch). From among the three samples presented, the respondents chose the one that best suited their visual impressions. Then, cakes containing a different leavening agent and sponge cake not containing this agent were subjected to organoleptic assessment. Respondents evaluated the following parameters: porosity, color, smell, texture, elasticity, taste, fragility, solubility in the mouth. The assessment was made on a numerical scale from 1 to 5. The assessment was carried out after baking, 48 hours after baking on 3, 8, 10, 15 and 22 days of storage of sponge cakes at ambient temperature and in the fridge in three different packages.

Determination of water content

Technical method (130oC/1h)

The water content in all types of sponge cakes was tested using the technical method. The test was carried out after baking and cooling the sponge cake. Determination of water content was carried out as follows: weighing of vessels; measuring approx. 5 g of sample (each type of dough, three samples); inserting the vessels with the sample into the laboratory balance (AS 220 R.2 checked with mass standards No. K-1493/18 having calibration certificate No. 1755/608/18) (vessels without cover); drying the samples at 130°C for 1 hour; cooling the samples in a desiccator (covered vessels); weighing the dishes, together with the sample and lid. The water content is the average value obtained from three measurements and calculated according to the formula:

$$x = \frac{(b - c) \cdot 100}{b - a} \quad (1)$$

where:

- cell mass [g]
- cell mass with the sample before drying [g]
- cell mass with the sample after drying [g].

Standardized method [11]

The examination was carried out on the 3rd day of storage of the sponge cake. Samples stored under refrigeration conditions in aluminum foil were taken for determination. Determination of the water content was carried out in the same way as in the technical method (weighing of vessels, measuring the sample, drying, cooling the samples, weighing the vessels with the sample). The exceptions were a drying temperature of 105°C and a drying time of 3 hours.

Moisture dryer method

The test consisted of crushing the biscuit in a coffee grinder, measuring off approx. 3 g of the sample and drying in a MAX500 moisture analyzer (RADWAG), checking the correct temperature indications of the device using control thermometer No. 0811/13 having calibration certificate No. 6/2014. The analysis temperature was 90°C, the end of the analysis was set at automatic point 2 meaning product stability of 1 mg/25 seconds. The results of the determinations were the average value of three water content measurements calculated according to the formula:

$$x = \frac{W_1 + W_2 + W_3}{3} \ \% \quad (2)$$

where: W1, W2, W3 – water content determined in individual measurements.

The test duration lasted on average about 10 minutes. Measurements of the water content in the sponge cake by means of the moisture analyzer method were carried out on 3, 8, 10, 15, 15 and 22 days of storage of the biscuits at ambient temperature and in the fridge. The products were stored in three different packages.

Preparation of the sample for the determination of watercontent

A sample was taken from each type of sponge cake stored in different conditions and packages immediately before the measurement. Each sample was taken as follows: cutting a sample about 2 cm wide from the stored sponge cake; fragmentation of the sample (entirely without division into crumb and „crust") in a coffee grinder type RK-0145 by OPTIMUM; measuring the appropriate amount (depending on the method of determination) of the test sample.

RESULTS AND DISCUSSION

Determinations for water content in sponge cakes were carried out using the PN 98/A-74252 [11] standard method and, alternatively, a moisture analyzer. The standardized test requires 3 hours of drying the product at 105°C, which is sometimes quite long, especially when the analysis concerns many unit products with a deliberately modified structure stored under ambient conditions and refrigerated conditions.

According to the authors [5, 12], the type of product structure significantly affects water migration. For this reason, the work attempts to determine the water content of sponge cakes using the technical method by which the product is analyzed at 130°C for 1 hour. At the end of the study, the product color changed from light yellow to brown. This indicated the surface combustion of the analyzed product, which in turn suggested that the technical drying method could not be used for sponge cake. Water content of sponge cake was determined according to standardized test PN 98/A-74252 measuring at 105°C and time 3 hours. The result of the water content in the sponge cakes obtained by the standardized method was the starting point (reference) for the optimization of the moisture analyzer method based on infrared radiation.

The method based on infrared radiation according to the authors [6, 15] is less time consuming, which means that it can

be used for quick determination of water content in products with different structures. A moisture analyzer device was used for the above determinations at work. Thanks to the optimized measurement using a moisture analyzer, each subsequent determination of water content was carried out on 3, 8, 10, 15 and 22 days on the storage of sponge cakes at ambient temperature and in the fridge. The authors [10, 16] came to similar conclusions indicating the legitimacy of using the moisture analyzer, indicating at the same time, the short test time, repeatability and reliability of the results. Determination of water content of sponge cakes using a standardized method was carried out on the third day after baking the sponge cake. In each of the three types of dough, the water content was determined above 20%. The smallest differences were noted between a sponge cake without the addition of a leavening agent (28.74%) and a sponge cake with the addition of ammonium bicarbonate (28.09%) (Table 2).

Table 2. Content of water in the sponge cake determined according to PN 98/A-74252

Tabela 2. Zawartość wody w cieście biszkoptowym oznaczona wg PN 98/A-74252

Type of sponge cake	Content of water [%]
Sponge cake without the leavening agent	28.74
Sponge cake with the addition of ammonium bicarbonate	28.09
Sponge cake with the addition of sodium bicarbonate	25.39

Source: Own study

Źródło: Opracowanie własne

Subsequent determinations of water content were carried out on days 8, 10, 15 and 22 of the storage of sponge cakes in various conditions and packaging. Determinations were carried out using a moisture analyzer.

Cakes with the addition of ammonium bicarbonate stored in room conditions were characterized by a lower water content compared to the same biscuits stored in refrigeration conditions. The highest water content each day of the study (from 8 to 22 days) was determined in a sponge cake stored in a food foil in room and refrigerated conditions (C1FSA, C2FSA). Changes in the moisture content of sponge cakes packed in food foil and stored at both room temperature and refrigeration conditions showed comparable decreases in the value of this parameter over the entire storage period, on average about 9%. The lowest water content was found in the cakes stored in breakfast paper in room and refrigeration conditions (C1PSA, C2PSA).

In this product, also the smallest changes in moisture content were recorded especially for sponge stored at room temperature (0.5%). In sponge dough stored at room temperature in aluminum foil (C1FAA) on the 22nd day of the test, the water content was not determined due to the appearance of mold on the product. In the same sponge cake, but stored under refrigeration conditions, the largest differences in the moisture content parameter were noted during the entire storage period (Fig. 1 A).

On the 8th and 22nd day of the test, the cake with the addition of sodium bicarbonate stored in aluminum foil and in food foil under refrigerated conditions (C2FAS, C2FSS) had the highest water content compared to all cakes stored in room and refrigerated conditions. It was also observed that after 8 days of storage of the C2FSS sponge cake, slight changes in moisture content were noted. Similarly, C2FAS, C1FAS and C2PSS cake behaved on day 15 and 22 - no significant changes in moisture content in the dough. A practically unchanged value of the parameter described above was recorded for the C1PSS cake, slightly by 0.3% of the value between the measurement made on the 8th day of storage and the last day of storage (Fig. 1 B).

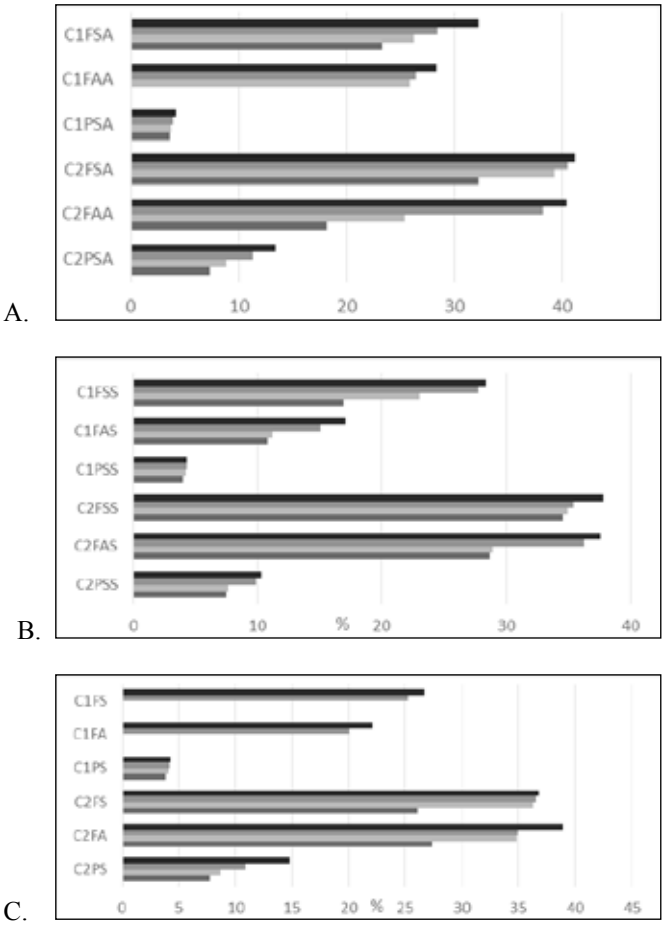

Fig. 1. Average water content in a sponge cake stored in room and cooling conditions [%] (A. sponge cake with the addition of ammonium bicarbonate, B-sponge cake with the addition of sodium bicarbonate; C-sponge cake without the addition of a leavening agent. Legend: (first measurement 8 days after making the dough, next 10, 15, 22 from the top of the picture).

Rys. 1. Średnia zawartość wody w biszkopcie przechowywanym w warunkach pokojowych i chłodniczych [%] (A. biszkopt z dodatkiem wodorowęglanu amonu, B-biszkopt z dodatkiem wodorowęglanu sodu; C-biszkopt bez dodatku środka spulchniającego. Legenda: (pierwszy pomiar 8 dzień od wytworzenia ciasta, kolejne 10, 15, 22 licząc od góry rysunku).

Source: Own study

Źródło: Opracowanie własne

Among sponge cakes without the addition of leavening agent, the highest content of water on the 8th day of storage was characterized by sponge cake stored in refrigerated conditions in aluminum foil (C2FA). In the next days of the study, i.e. the 10th and 15th, the C2FS product had the highest water content. On day 22 of the study, the highest water content was recorded for the C2FA product. In general, the C2FS cake was characterized by a slight variation in water content up to 22 days of refrigerated storage. Similar behavior was observed in C1PS sample stored at room temperature in which only on the last day of measurement a greater change was observed compared to the values obtained on 8, 10 and 15 days of storage.

In the cake stored at room conditions in food and aluminum foil (C1FS, C1FA) on the 15 and 22 day of the test the water content was not determined because mold appeared on the cake.

On the other hand, when comparing the type of cake packaging (breakfast paper), it was observed that the highest water content was characteristic for the product without the addition of leavening agent stored in refrigeration conditions (C2PS) in the first measurement period - on the eighth day after manufacturing the product. On the 22nd day of the test, the water content of cakes stored in refrigerated conditions wrapped in breakfast paper oscillated around 7% regardless of the type of leavening agent used. Sponge cakes stored at room conditions and wrapped in breakfast paper had comparable water content ranging from 3.59 to 4.33 throughout the entire storage period. Cakes prepared on the basis of sodium bicarbonate remained practically unchanged. Figure 2A presents the average water content of sponge cakes stored in breakfast paper for a period of 22 days.

Among sponge cakes stored in aluminum foil, the highest content of water was found in the C2FAA cake on the 8th and 10th day of the study (40.4% and 38.26%, respectively). The lowest water content was recorded on the 8th day of the test in a C1FAS sponge cake (17.09%). The dough stored at room conditions without leavening agent on the 15th and 22nd day of the test was not evaluated due to mold (C1FA) present on the product. Sponge cake with the addition of ammonium bicarbonate on the 22nd day of the test also showed the presence of mold (C1FAA). It was generally found that the dough packed in aluminum foil and stored in room conditions showed lower values of this parameter and smaller decreases during all measurements (Fig. 2B). Definitely, the refrigeration conditions had a larger impact on this parameter. A similar trend was observed for products wrapped in breakfast paper (Fig. 2A). Among the sponge cakes stored in food foil, the cake with the addition of ammonium bicarbonate (C1FSA, C2FSA) was characterized by the highest water content in the case of sponge cakes stored in room and refrigeration conditions. In the cake containing no leavening agent stored at room conditions, mold was observed. Therefore, it was not tested on the 15th and 22nd day of the study (C1FS). The lowest water content was found in the C1FSS sponge cake during the 15th and 22nd day of the determination (23.03%; 16.89%) (Fig. 2C). It was generally found that the C2FSS product was best protected. Changes in moisture content between the first and last measurement were at 3.26% (Fig. 2C). Unsignificant change in the moisture content of the cake, stored under refrigeration was observed for the product without any leavening agent for 15 days of storage (0.48% change). The above information sets that the food foil would be indicated for storing the cake without adding leavening agent for a specified time but not longer than two weeks. Generally, comparing the same cakes (stored at different conditions), higher water content was always recorded for those stored in refrigeration conditions (Fig. 2C).

The largest differences in water content between the first and last day of the test were recorded in the biscuit stored in aluminum foil under refrigeration conditions with the addition of ammonium bicarbonate (C2FAA). This sponge cake lost 22.26% of its water content throughout the entire study period (from 8 to 22 days). The smallest water loss showed cakes stored in breakfast paper under room conditions (C1PS, C1PSS, C1PSA). Among sponge cakes stored in refrigeration

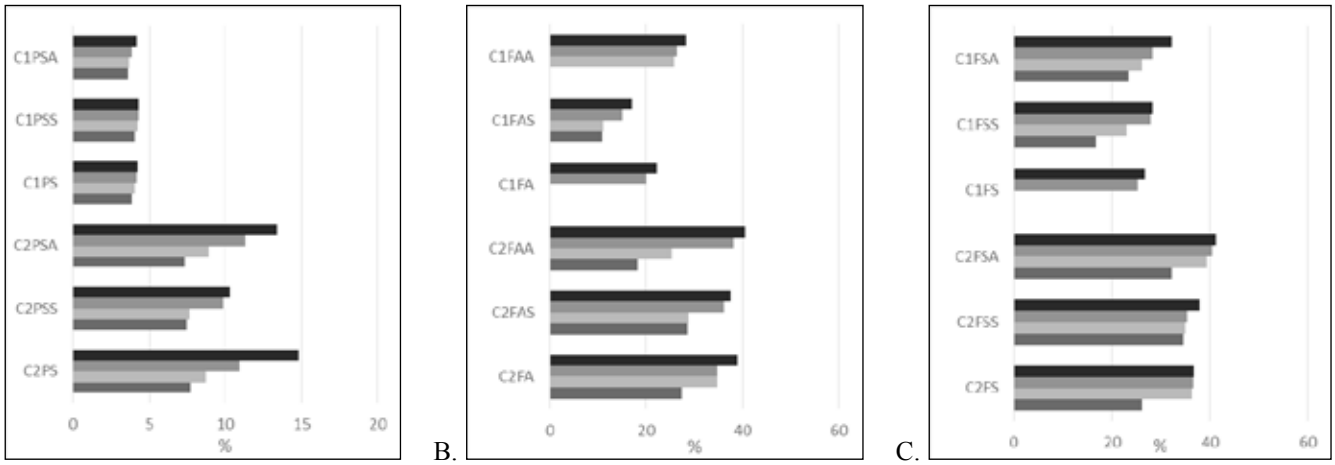

Fig. 2. Average water content in sponge cakes stored in A. breakfast paper, B. aluminum foil, C. food foil. Legend the same as Figure 1.

Rys. 2. Średnia zawartość wody w ciastach biszkoptowych przechowywanych w A. papierze śniadaniowym, B. folii aluminiowej, C. folii spożywczej. Legenda taka sama jak na rysunku 1.

Source: Own study

Źródło: Opracowanie własne

conditions, the smallest water loss showed a product with the addition of sodium bicarbonate (C2PSS) stored in breakfast paper. Considering the type of leavening agent used in cakes stored in refrigerated conditions, the smallest losses of water content were recorded in a product with the addition of sodium bicarbonate, while the largest in cakes without the addition of a leavening agent (C2FS, C2PS). Among the cakes stored at room conditions, the largest loss of water content was observed in the food foil with sodium bicarbonate (C1FSS) (Fig. 3).

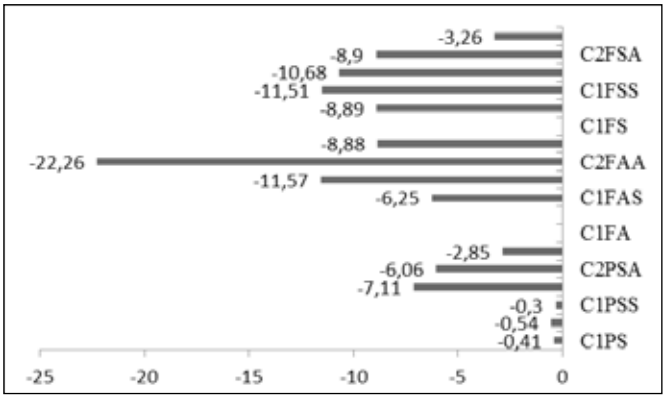

Fig. 3. The difference in water content in sponge cakes between the first and last day of determination.

Rys. 3. Różnica zawartości wody w ciastach biszkoptowych między pierwszym, a ostatnim dniem oznaczenia.

Source: Own study

Źródło: Opracowanie własne

The respondents made a visual assessment immediately after baking cakes, choosing from three products the one that best suited their visual impressions (the respondents did not evaluate the samples by smell or taste). The highest score was obtained by a cake sample in which sodium bicarbonate was used as a leavening agent. This was also confirmed in the organoleptic assessment of baked products in which respondents assessed such features as: porosity, color, smell, texture, elasticity, taste, brittleness and solubility in the mouth on a scale of 1 to 5. Respondents gave the highest access of product elasticity (5.0). The following features were also highly rated: color (4.67), texture (4.67) and porosity (4.33). The fragrance and crispness of sponge cake (3.0) were rated the lowest by respondents. The average of the above ratings was 3.83.

The biscuit product without the addition of leavening agent was rated the lowest (3.67). Especially low marks were given for the fragrance. Texture and flexibility were rated he highest. In the cake with the addition of ammonium bicarbonate, the solubility in the mouth was accessed the lowest, while features such as elasticity, texture and color were rated higher. The average rating for this product was 3.71.

Among the sponge cakes with the addition of ammonium bicarbonate, the dough stored for 8 days in breakfast paper in refrigerated conditions (C2PSA) was rated the highest. In turn, respondents rated the dough stored in aluminum foil at room conditions (C1FAA) the lowest (2.75). However, it should be noted that the assessment on day 22 of storage was absolutely influenced by the appearance of mold on the product. According to respondents the best protected product stored in room conditions was a sponge cake packed in aluminum foil (C1FAA) (3.88). However, in cooling conditions, the

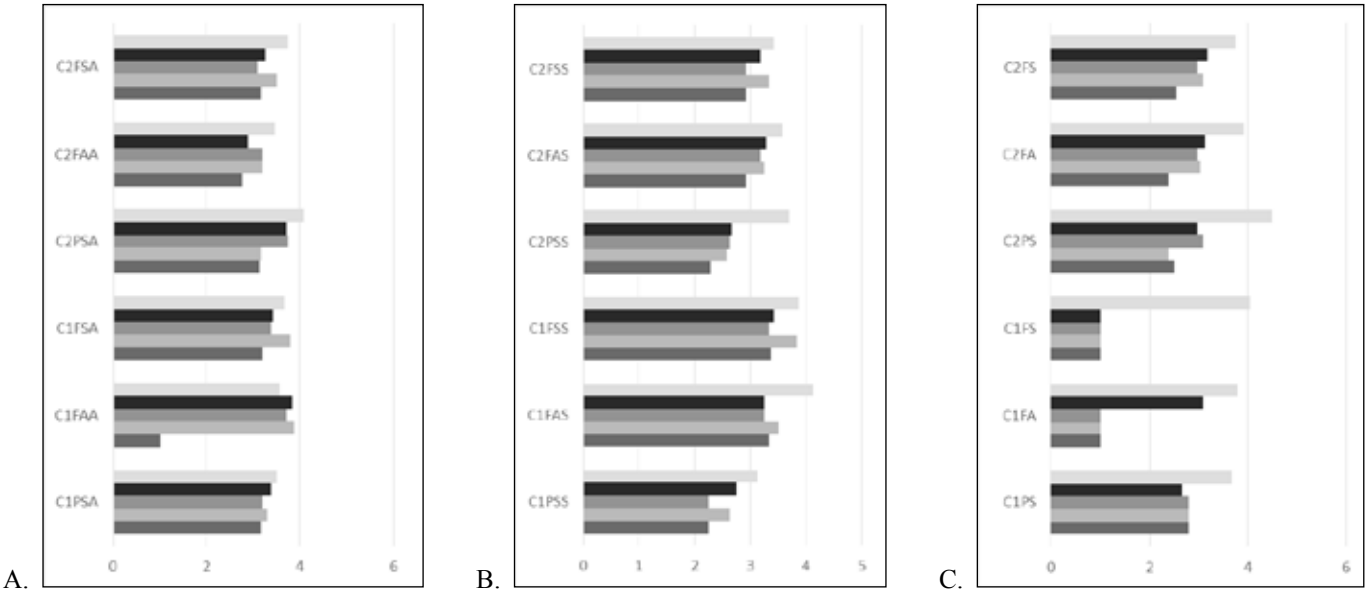

Fig. 4. Average grades of sponge cake with the addition of: A. ammonium bicarbonate, B. sodium bicarbonate, C. without leavening agent. Legend (first measurement 3 days after making the dough, next 8, 10, 15, 22 from the top of the picture).

Rys. 4. Średnie oceny ciasta biszkoptowego z dodatkiem: A. wodorowęglanu amonu, B. wodorowęglanu sodu, C. bez środka spulchniającego. Legenda (pierwszy pomiar 3 dzień od wytworzenia ciasta, kolejne 8, 10, 15, 22 licząc od góry rysunku).

Source: Own study

Źródło: Opracowanie własne

dough was the best stored when packaged in breakfast paper (C2PSA) (4.08) (Fig 4.) Considering the storage time, on the 10th day of the cake's storage the best quality was observed for the product packed in aluminum foil and stored at room temperature. In turn, cakes stored in refrigerated conditions and wrapped in breakfast paper received the highest marks. On the 15th day of the study, amongst sponge cakes stored in room conditions, those that were wrapped in aluminum foil was rated the highest. Among the cakes stored in refrigeration conditions, the respondents rated the highest cake packed in food foil (Fig. 4A). It should be noted, however, that it was not possible to clearly determine the decrease in cake ratings during storage. In general, the passage of time did not mean a negative impact on the quality of this product.

Among the sponge cakes with the addition of sodium bicarbonate, the sponge cakes stored in breakfast paper at room conditions were rated the lowest (C1PSS). Cake kept in room conditions wrapped in aluminum foil was rated the highest by respondents (C1FAS) (4.13). According to the respondents, for both sponge cakes stored in room and cooling conditions, the packaging from breakfast paper was the least favorable. (C1PSS, C2PSS) (Fig.4B). The exception was the 3rd day of assessment, on which cakes stored in breakfast paper were evaluated similarly to other cakes on that day of study, obtaining a note above 3.1. Except for one sponge cake (C2PSS), it was not possible, (similarly to the case of sponge cakes based on ammonium bicarbonate), to determine the decrease in ratings during the entire storage period. This means that the decrease in moisture that was recorded for these products during storage did not affect the lower rating given to these products by respondents.

In the group of cakes without the addition of leavening agent, stored in refrigeration conditions, the respondents rated the cake wrapped in breakfast paper (note 4.5) as the best on the third day of storage. On the same day, a C1FS sponge cake (4.04) got a slightly lower note. Unfortunately, in the following days of the study, the sponge cake received the lowest marks due to the development of mold on the product. A similar situation occurred for the C1FA product for which the rating was equal to 1 from the 10th day of storage (Fig. 4C).

The respondents pointed out the cake with the addition of ammonium bicarbonate as a sponge cake with the best sensory properties (this concerned 8th, 10th and 15th day of storage). On the other hand, on the 3rd and 22nd day of research, the respondents indicated a sponge cake with the addition of sodium bicarbonate as the cake with the best sensory properties [7] came to similar conclusions. She observed that sponge cake with the addition of baking powder had the best sensory properties. In addition, the same author said that a slightly worse sensory properties had sponge cake without the addition of leavening agent.

SUMMARY AND CONCLUSIONS

The effect of adding ammonium bicarbonate on sponge cake quality was observed. The product with this type of leavening agent stored in room conditions in aluminum foil showed the best sensory properties on 8, 10 and 15 days of storage. Considering the assessment of the respondents, it can be concluded that aluminum foil best protected sponge cake in room conditions. In refrigeration conditions, this packaging was food film and breakfast paper (regardless of the type of leavening agent in the cake), which, in turn, in room conditions did not completely protect the biscuit. This conclusion can be made based on the assessment of the respondents, who 3, 8, 10, 15 and 22 studies rated the cakes stored in breakfast paper the lowest.

In sponge cakes stored in room conditions in aluminum and food foil, mold growth was found on the surface of the cakes. Mold was observed in samples wrapped in food foil (test day 8) and aluminum foil (test day 10), which proves that both aluminum foil and food foil create favorable conditions for mold development, probably due to increased water content compared to products stored in paper breakfast and less air available for the product.

A relationship was found between the conditions for storage of sponge cakes and the type of used leavening agent. Given the storage conditions, cakes stored in refrigeration conditions were characterized by a higher water content compared to products stored in room conditions. Such a relationship occurred throughout the entire study cycle (days 8-22) regardless of the leaving agent used. Probably the reason for this relationship was the conditions in the refrigerator (temperature 5.3^{o}C, relative humidity 55%). Lower temperature and higher humidity compared to ambient conditions (temp. 21.1^{o}C, relative humidity 35.8%) prevented water from being drained.

Sponge cakes stored in breakfast paper had the lowest water content (cooling and room conditions). The effect of the type of leavening agent on the water content of sponge cakes stored in breakfast paper was observed. Among cakes stored on breakfast paper on the 10th and 15th day of the test, the highest content of water was found in sponge cake with the addition of ammonium bicarbonate. On the other hand, on the 8th and 22nd day of evaluation, the maximum content of water was characterized by cakes without the addition of leavening agent stored in breakfast paper.

Among sponge cakes stored in aluminum foil, the lowest water content was found in cakes with the addition of sodium bicarbonate. The highest water content was recorded for cakes with the addition of ammonium bicarbonate (test days 8 and 10). The high water content of these products may have been caused by the structure of the dough (a large number of air bubbles).

The effect of the leavening agent on the water content of cakes stored in food foil was also observed. The highest water content in this group was characteristic for product with the addition of ammonium bicarbonate. Among the cakes stored in food foil, the lowest water content was found for products without a leavening agent (day 8 and 10) and cakes with sodium bicarbonate (days 15 and 22).

It is not recommended to use chemical leavening agents for baking sponge cakes, but referring to the results obtained, it can be concluded that sponge cakes with leavening agents have better organoleptic properties. The research shows that a sponge cake based on ammonium bicarbonate was rated best by respondents.

PODSUMOWANIE I WNIOSKI

Zaobserwowano wpływ dodatku wodorowęglanu amonu na jakość ciasta. Wyrób z tym rodzajem środka spulchniającego przechowywany w warunkach pokojowych w foli aluminiowej wykazywał najlepsze właściwości sensoryczne w 8,10 i 15 dniu przechowywania.

Uwzględniając ocenę ankietowanych można wnioskować, że folia aluminiowa najlepiej chroniła ciasto biszkoptowe w warunkach pokojowych. W warunkach chłodniczych tym opakowaniem była folia spożywcza i papier śniadaniowy (bez względu na rodzaj środka spulchniającego), który z kolei w warunkach pokojowych zupełnie nie chronił biszkoptu. Wniosek ten można wysunąć na podstawie oceny ankietowanych, którzy 3,8,10,15 i 22 badania najniżej oceniali ciasta przechowywane w papierze śniadaniowym.

W ciastach biszkoptowych przechowywanych w warunkach pokojowych w foli aluminiowej i spożywczej stwierdzono rozwój pleśni na powierzchni ciast. Pleśń zaobserwowano w próbkach opakowanych w folię spożywczą (8 dzień badania) oraz w folię aluminiową (10 dzień badania) co dowodzi, że zarówno folia aluminiowa i folia spożywcza stwarzają dogodne warunki dla rozwoju pleśni prawdopodobnie spowodowane zwiększoną zawartością wody w porównaniu do biszkoptów przechowywanych w papierze śniadaniowym i mniejszą dostępnością powietrza do wyrobu.

Stwierdzono zależność pomiędzy warunkami przechowywania biszkoptów, a rodzajem środka spulchniającego. Biorąc po uwagę warunki przechowywania ciast, biszkopty przechowywane w warunkach chłodniczych charakteryzowały się większą zawartością wody w porównaniu z biszkoptami przechowywanymi w warunkach pokojowych. Taka zależność występowała w całym cyklu badań (8-22 dzień oceny) niezależnie od użytego środka spulchniającego. Prawdopodobnie powodem wystąpienia takiej zależności były warunki panujące w lodówce (temp.5,30C, wilgotność względna 55%). Niższa temperatura oraz większa wilgotność w porównaniu z warunkami otoczenia (temp.21,10C wilgotność względna 35,8%) przeciwdziałała oddawaniu wody z produktu.

Biszkopty przechowywane w papierze śniadaniowym charakteryzowały się najniższą zawartością wody (warunki chłodnicze i pokojowe). Zaobserwowano wpływ rodzaju środka spulchniającego na zawartość wody w ciastach biszkoptowych przechowywanych w papierze śniadaniowym. Wśród ciast przechowywanych w papierze 10 i 15 dnia oznaczenia najwyższą zawartością wody charakteryzował się biszkopt z dodatkiem wodorowęglanu amonu. Natomiast 8 i 22 dnia oceny maksymalną zawartością wody charakteryzowały się biszkopty bez dodatku środka spulchniającego przechowywane w papierze śniadaniowym.

Wśród ciast biszkoptowych przechowywanych w folii aluminiowej najniższą zawartością wody charakteryzowały się ciasta z dodatkiem wodorowęglanu sodu. Najwyższą zawartość wody wykazały biszkopty z dodatkiem wodorowęglanu amonu (8 i 10 dzień badania). Duża zawartość wody w tych biszkoptach mogła być powodowana strukturą ciasta (duża ilość pęcherzyków powietrza).Zaobserwowano również wpływ środka spulchniającego na zawartość wody w biszkoptach przechowywanych w folii spożywczej. Najwyższą zawartością wody w tej grupie charakteryzowało się ciasto z dodatkiem wodorowęglanu amonu. Wśród biszkoptów przechowywanych w folii spożywczej najniższą zawartość wody wykazały biszkopty bez środka spulchniającego (8 i 10 dzień oznaczenia) oraz ciasta z wodorowęglanem sodu (15 i 22 dzień oznaczenia).

Do wypieku ciast biszkoptowych nie jest zalecane używanie chemicznych środków spulchniających ale odnosząc się do uzyskanych rezultatów można wnioskować, że biszkopty z środkami spulchniającymi charakteryzują się lepszymi właściwościami organoleptycznymi. Z przeprowadzonych badań wynika, że ciasto biszkoptowe na bazie wodorowęglanu amonu zostało najlepiej ocenione przez ankietowanych.

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