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EFFECT OF THE TYPE OF FILLING ON WATER CONTENT AND ACTIVITY IN MULTI-LAYER SHORT DOUGH BISCUITS

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Key words: short dough biscuits, water activity, extract, pectin

The study was undertaken to determine the effect of the type and composition of filling on changes in the content and activity of water in biscuits. The experimental materials were multi-layer short dough biscuits composed of three layers: bottom made of short dough, filling in the form fruit jelly or flavors mousse, and one-sided chocolate glazing. It was demonstrated that in the samples examined water content depended on the content of extract, whereas it was not affected by the content of pectin in the filling. The presence and content of extract and pectin in the samples analyzed had no significant effect on water activity of the multi-layer short dough biscuits.

INTRODUCTION

Most food products constitute multi-component and multi-phase systems. Properties of complex systems are a resultant of properties of particular components of the mixture, yet they are affected by their interactions [Gallagher *et al.*, 2003a,b,c; O'Brien *et al.*, 2003] as well as by parameters of technological processes they are subjected to. Water that fills the empty spaces in the examined material is also a structural element constituting, simultaneously, its liquid phase [Slade & Levine, 1993; Piazza & Masi, 1997]. At specified water content, the product is subject to plasticization, which makes consumption and digestion of food easier and affects its palatability. In the case of bakery products water provides optimal conditions for starch gelatinization and gluten denaturation during baking [Klimek-Poliszko & Poliszko, 2002; Scanlon & Zghal, 2001].

Changes in water content of a product during storage [Kita, 2002] exert a significant effect on its properties resulting from microbiological, biochemical, chemical and physical changes. In the case of short dough biscuits, one of more important elements of consumer acceptance is their hardness and tenderness that are linked with water content of the product [Marzec & Lewicki, 2006]. Thus, in food quality assessment, examination of the effect of the chemical composition of food products on the content and activity of water is of great significance [Lenart, 1991].

The research was aimed at determining the effect of the type and composition of filling on the content and activity of water in multi-layer short dough biscuits.

MATERIAL AND METHODS

The experimental materials were multi-layer short dough biscuits made of three layers: bottom from short dough biscuit, filling in the form of fruit jelly or flavors mousse, and single-sided chocolate glazing. Analyses were carried out on biscuits originating directly from a production line (samples 1, 2 and 5) and those prepared from original components in the research laboratory in order to modify contents of extract and pectin in fruit jelly (samples 3, 4, 6 and 7), (Table 1). The content and activity of water differed in the samples depending on the type of filling. In all cases of material collected from the production line and that produced in the laboratory water content of the chocolate glazing accounted for 0.030 g H_2O g d.m. and its activity – for 0.619. Those values remained unchanged, irrespective of the type of batch examined and storage period. Water content was determined with the dry method according to Polish Standard [PN-84/A-88027] in the whole biscuit as well as its particular layers: short dough, filling (jelly or mousse) and chocolate glazing. In the case of determining water content in the whole biscuit (short dough, filling and chocolate glazing), the material was mixed, dried with purified sand, whereas short dough bottom, filling (jelly or mousse) and chocolate glazing were dried without the addition of sand.

Determination of water activity was carried out with the use of a Rotronic apparatus type Hygroskop DT, at a temperature of 25±1°C. Measurements of water activity were performed for whole biscuits and for their particular layers (short dough bottom, jelly, mousse and chocolate glazing). Results obtained were analyzed statistically and mathematically using the following software: Microsoft - Excel 7.0 package, Jandel

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TABLE 1. Numeration and types of biscuits examined.

Sample no.	Type of material
1	Biscuits filled with jelly with extract content of 73.5% and pectin content of 1.05%
2	Biscuits filled with mousse
3	Biscuits filled with jelly with extract content of 75.4% and pectin content of 1.03%
4	Biscuits filled with jelly with extract content of 73.5% and pectin content of 1.01%
5	Biscuits filled with jelly with extract content of 73.9% and pectin content of 1.05%
6	Biscuits filled with jelly with extract content of 73.9% and pectin content of 0.94%
7	Biscuits filled with jelly with extract content of 66.0% and pectin content of 0.89%

- Table Curve 2D v. 3 and StatSoft - Statistica 6.0. The statistical analysis was carried out by means of the analysis of variance based on ANOVA summary table.

All measurements were performed in three replications for a single-collected batch from the production line and that prepared in the laboratory, whereas storage analyses were carried out in two repetitive series of 180 and 135 days in original packages, at a temperature of 25±1.5°C. The samples were stored as whole, then separated into layers and analyzed. The content and activity of water were analyzed in the samples 1, 14, 30, 90, 135 and 180 days since production.

RESULTS AND DISCUSSION

Analyses of whole biscuits carried out directly after production to characterize the material demonstrated that the type of filling (Table 1) had no significant effect on water content of the samples examined (Figure 1A). Simultaneously, determinations of water activity of the biscuits showed that despite significant differences in that trait between jelly and mousse, the type of filling had no significant effect on water activity of whole multi-layer biscuits (Table 1, Figure 1B). During storage, the greatest changes in water content of both whole biscuits and their particular components (filling and short dough bottom) were observed within 30 days since production (Figure 2). Once storage was continued, both in the short dough bottom and the whole biscuits the content of water was remaining at a stable level. In the filling, irrespective of its content, the content of water was observed to decrease until the end of the storage period. However, the variable water content of the filling did not affect water content of the whole biscuits. Due to marginal fluctuation in water content of the short dough bottom during storage of biscuits with different composition of the filling the other figures depict changes in the content of water occurring only in the filling and in the whole biscuits examined.

Jelly used in the production of biscuits had various contents of extract and pectin (Table 1). In the examination of the effect of contents of extract and pectin on the content and activity of water in multi-layer short dough biscuits, first analyses were carried out for the samples with pectin content of 1.05% and the following contents of extracts: 73.5% for sample 1 and 73.9% for sample 5. An increase of extract content at a level of 0.4 percentage points affected a decrease in water content both in the filling and in whole biscuits. In addition, the statistical analysis demonstrated a significant effect of the increase in extract content on water content of the filling, which was found to decrease by *ca*. 12.7%, as well as on that of the whole biscuits, *i.e.* a decrease by *ca*. 9.6% (Figure 3A). Figure 4 presents changes in the content of water during storage of biscuits with the filling prepared from jelly with various contents of extract. Also in the case of such a material the most intensive changes in water content were observed within 30 days of storage. Simultaneously, lower water content was observed in biscuits filled with jelly with a higher content of extract. This resulted from the fact that in the entire storage period and after production the jelly with

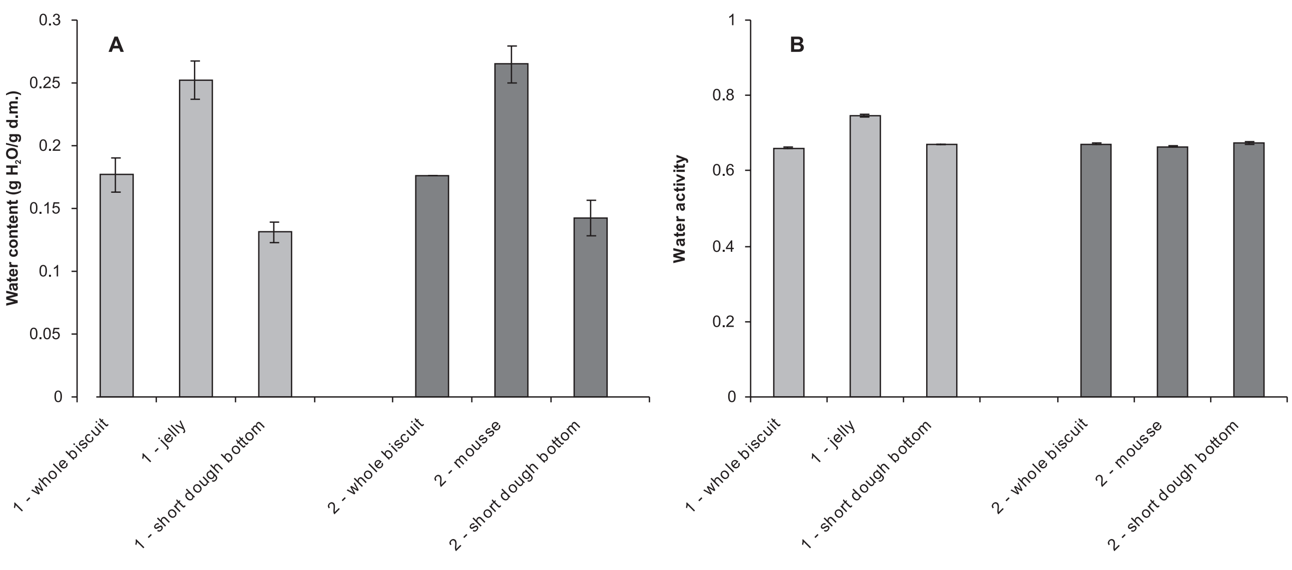

FIGURE 1. Effect of the type of filling on the content (A) and activity (B) of water in multi-layer short dough biscuits (for type of material see Table 1).

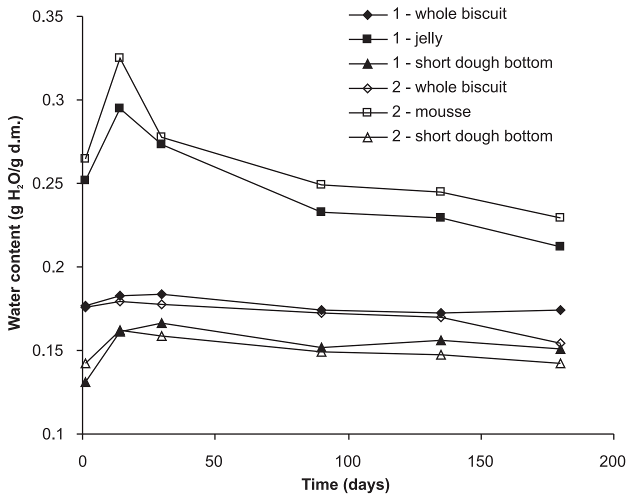

FIGURE 2. Effect of the type of filling on water content of multi-layer short dough biscuits during storage (for type of material see Table 1).

extract content of 73.9% was characterised by the lowest content of water and its changes in the entire period of storage were less intensive than in the case of jelly with extract content of 73.5% (Figure 4A).

Modification of the chemical composition of the examined multi-layer short dough biscuits referred not only to a change in extract content at a level over 0.4 percentage points but also to changes in the content of pectin. In comparing biscuits determined in pairs 3 and 4 as well as 6 and 7 (Table 1), it was found that, irrespective of pectin content in the filling, the increase in extract content was accompanied by a decrease in the content of water of both the filling and the whole biscuit. The extent of those changes ranged from *ca*. 6% to over 30% depending on both extract and pectin contents in the filling. For all the analyzed pairs of samples, the differences appeared to be statistically significant (Figure 3A). It was observed that with the increasing contents of extract and pectin in the jelly (samples 3 and 4 as well as 6 and 7, Table 1), a decrease in water content magnifies in both the filling (from 5.8 to 30.56%) and in the whole biscuits (from 14.8 to 17.4%). The increase in extract content at almost unchanged content of pectin caused that both the filling and the whole biscuits were characterised by a lower content of water over the entire storage period (Figure 4B). At the higher content of extract (73.9%) and pectin (0.94%) in the jelly (sample 6), as compared to sample 7, both the filling and the whole biscuits were characterised by lower contents of water. That tendency was observed to maintain over the entire storage period (Figure 5A).

Samples determined respectively in pairs 1 and 4 as well as 5 and 6 differed in the content of pectin (variable depending on the pair), whereas the content of extract in the filling was kept at a constant level. In the case of the first pair of biscuits it accounted for 73.5% whereas in the case of the second pair – for 73.9% (Table 1).

A change in the content of pectin at a level of 0.04 percentage point, at extract content of the filling kept constant (samples 1 and 4, Table 1), had a significant effect on the content of water both in the jelly being the filling and in the whole biscuits. An increase in water content of filling and whole biscuits was demonstrated along with a decreasing content of pectin (Figure 3A). In turn, a constant level of extract and increasing the difference in pectin content to 0.11 percentage points results in disturbance of that tendency and changes correlations between the contents of water in the whole biscuits and in the filling. Yet, the statistical analysis carried out for both pairs examined did not demonstrate any significant effect of a change in pectin content of the filling on water content determined in the filling and in the while biscuits. Analyses of water activity linked with changes in contents of both extract and

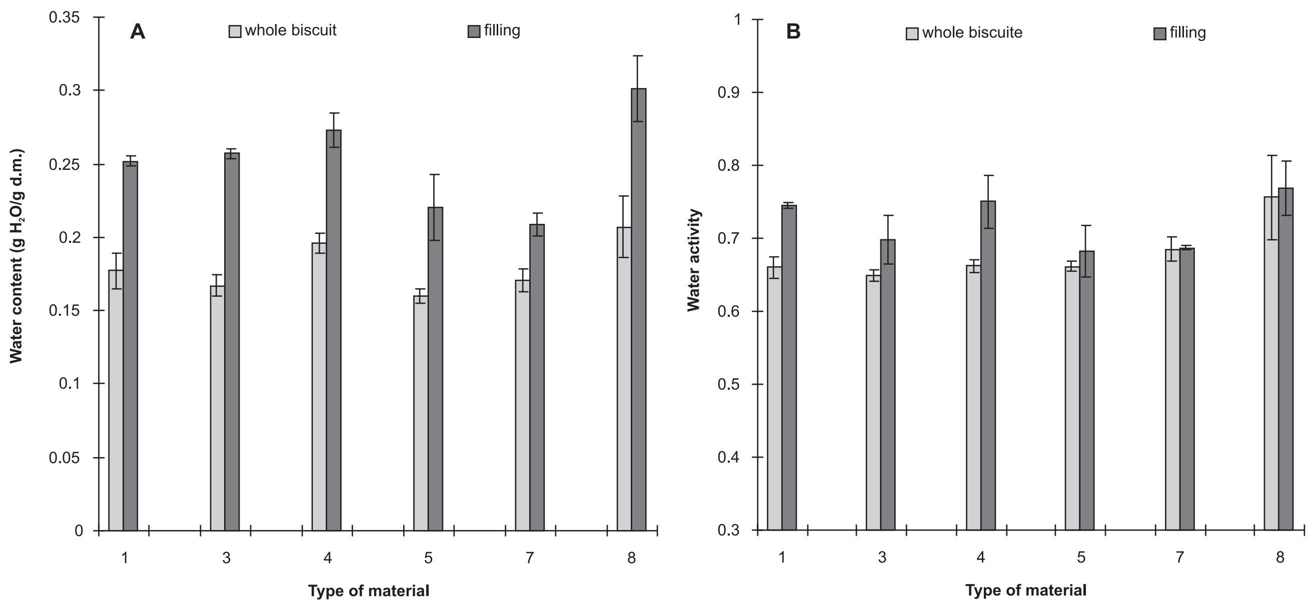

FIGURE 3. Effect of extract and pectin contents on the content (A) and activity (B) of water in multi-layer short dough biscuits (for type of material see Table 1).

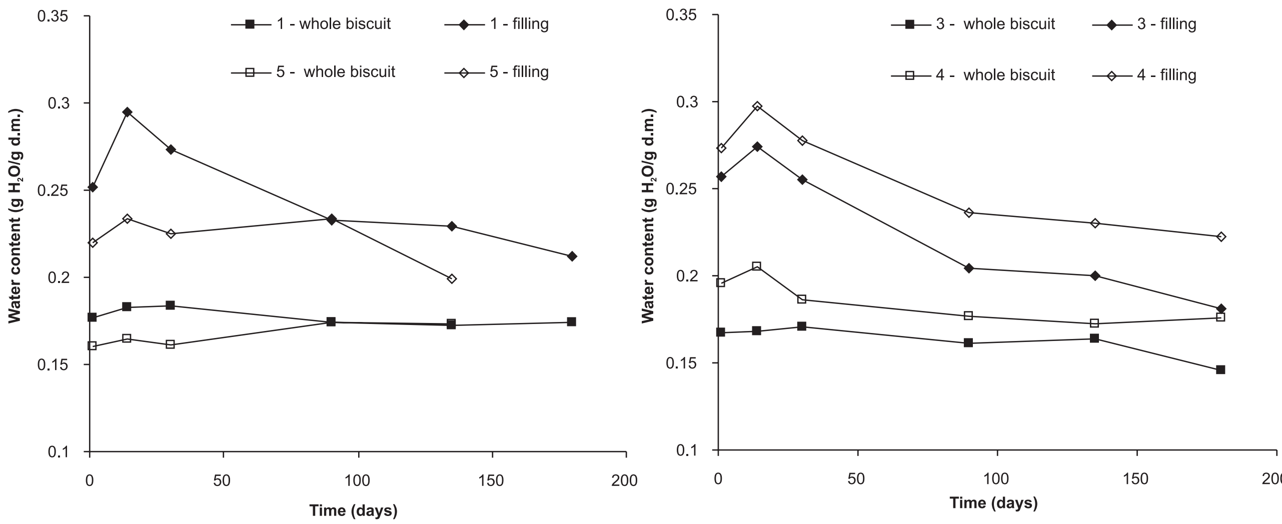

FIGURE 4. Effect of extract and pectin contents in jelly constituting the filling on water content of multi-layer short dough biscuits during storage (for type of material see Table 1).

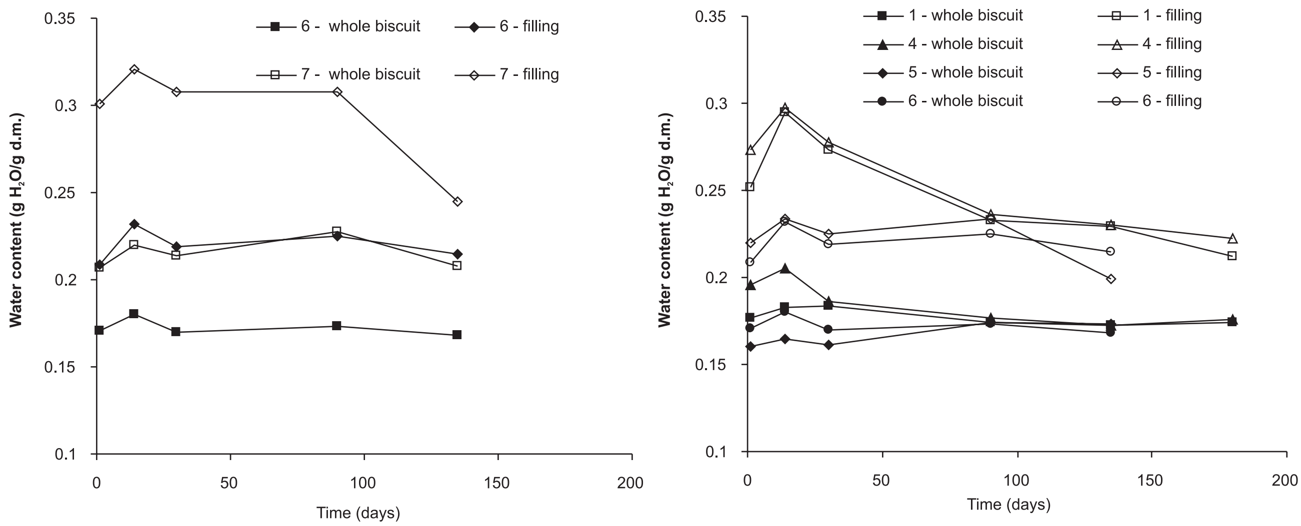

FIGURE 5. Effect of extract and pectin contents in jelly constituting the filling on water content of multi-layer short dough biscuits during storage (for type of material see Table 1).

pectin did not show any significant differences (Figure 3B). A change in pectin content at a level of 0.94-1.05%, at extract content remaining constant, *i.e.* 73.5% for sample 1 and 4 and 73.9% for sample 5 and 6, had no significant effect on the content of water in stored jelly. Simultaneously, the greatest changes in water content were observed in the whole biscuits within 30 days of storage since production (Figure 5B).

CONCLUSIONS

1. The type of filling had no significant impact on the content of water in the samples examined. Also the direction of changes proceeding in the sorption properties during storage of multi-layer short dough biscuit was not affected by the type of filling.

2. In multi-layer short dough biscuits the content of water is determined by the content of extract in the filling (at a level of 66-75.4%), whereas it remains unaffected by the content of pectin (at a level of 0.89-1.05%). An increase in the content of extract is accompanied by a decrease in the content of water in the material examined, and the extent of those changes is directly proportional to the content of extract in the filling.

3. The most intensive changes in water content of stored biscuits proceed within the first 30 days, irrespective of the type and composition of the filling.

4. A change in the content of extract at a level of 66.0-73.9% and that of pectin at a level of 0.89-1.05% had no significant effect on water activity of the multi-layer short dough biscuits examined.

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WPŁYW RODZAJU WYPEŁNIENIA NA STAN WODY W WIELOWARSTWOWYCH CIASTKACH BISZKOPTOWYCH

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Celem pracy było określenie wpływu rodzaju wypełnienia oraz jego składu na zmiany zawartości oraz aktywności wody w ciastkach. Materiałem badawczym wykorzystywanym w niniejszej pracy były ciastka biszkoptowe wielowarstwowe złożone z trzech warstw - spodu z ciasta biszkoptowego, wypełnienia w postaci galaretki owocowej lub pianki smakowej oraz polewy czekoladowej nakładanej jednostronnie. Wykazano, że zawartość wody w badanych próbkach zależy od ilości ekstraktu, natomiast nie zależy od ilości pektyny w wypełnieniu. Obecność oraz ilość ekstraktu i pektyny w badanych próbkach nie wpływają istotnie na aktywność wody wielowarstwowych ciastek biszkoptowych.