

## RASPBERRY POMACE AS A POTENTIAL FIBER SOURCE FOR COOKIES ENRICHMENT

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**Background.** Dietary fiber is not only used for its nutritional properties, but also for its functional and technological properties. The food industry produces significant amounts of by-products which are problems in their disposal. Usually, these products are used in animal feeding. However, the high content of dietary fiber could permit their usage in food products. The dietary fiber in the diet has been recommended on the level 25-30 g/day. Thus, to supplement daily diet, dietary fiber should be incorporated into frequently consumed foods. The objective of this study was an effort to use raspberry pomace, by-product of food processing, in cookies.

**Material and methods.** The material of the study was raspberry pomace sourced directly from a fruit processing plant. Pomace is obtained in a dried form. Two sorts of raspberry pomace were applied: crumbled (ME) and non-crumbled (NM). These preparations were used as replacement of flour at the level 25 and 50%. The baked goods were sensory evaluated by a consumer method. Contents of neutral detergent dietary fibre (NDF) and its fractions were determined by the detergent method according to Van Soest and total dietary fibre (TDF), soluble dietary fibre (SDF) and insoluble dietary fibre (IDF) according to Asp et al.

**Results.** The content of dietary fiber in raspberry pomace was very higher. These by-products were found to be rich in cellulose and lignin. Cookies with dietary fiber preparations contained much more dietary fiber – NDF (from 10.1 g/100 g – 25% NM to 24.7 g/100 g of products – 50% NM) in comparison with the control sample (1.7 g/100 g of product). The use of raspberry pomace in cookies resulted in fiber contents increase. Moreover, the addition did not have negative influence on organoleptic characteristics of the product and was accepted by consumers.

**Conclusions.** The substantial dietary fiber content of fruit by-products and, in particular, fruit seeds, should attract the interest of dieticians.

**Key words:** high-fiber preparations, cookies, sensory assessment

## INTRODUCTION

Because of the rising interest in functional food, especially bioactive substances, food producers look for new sources and carriers of those substances. Consumers search products which would allow them to maintain their physical and mental fitness. Among many bioactive substances to be found in food – such as antioxidants, plant sterols, pro- and prebiotics and vitamins – a crucial role is played by dietary fibre [Rodríguez et al. 2006]. Varied structure and chemical composition of fibre substances [Marlett and Vollandorf 1994] determine their specific functional properties such as the ability to bind water, the ability to exchange cations and fat absorption [Thebaudin et al. 1997, Górecka 2004]. This also translates into different forms of physiological and technological impact. The kind of fibre eaten has direct influence on the human digestive tract, i.e. it increases faeces mass, shortens passage time, lowers glucose level in the blood, binds bile acid and lowers the level of cholesterol [Górecka et al. 2002, Kahlon and Woodruff 2003]. Over the last years, there has been a tendency to look for new sources of dietary fibre which could be used as components in food of different functional properties. One possibility to increase the content of fibre in the diet is to enrich products with pure isolated fibre. Fibre-rich preparations are produced primarily with the use of parts of cereals, fruit and vegetables which are by-products from the grain and mill, as well as fruit and vegetable industries rich in non-digestible carbohydrates [Massoi et al. 2002, Borycka and Górecka 2005, Lundberg 2005, Sudha et al. 2007, Nassar et al. 2008]. Dietary fibre has different functions in the human system. It binds water and bile acid, absorbs metals, influences the speed with which the chyme passes through intestines, lowers glucose and cholesterol levels in blood, as well as increases faeces mass [Kritchevsky 1997, Kahlon and Chow 2000, Górecka et al. 2002, Kahlon and Woodruff 2003].

The fibre-rich products present on the market are primarily those of natural origin (oat, peas, maize, grain bran) which may be added to food without modifications, as well as those that must be modified before they are added. Industrial by-products are used because of convenience, profitability, accessibility of the raw material, its low cost and also the possibility to manage cumbersome post-production waste [Górecka and Anioła 1999, Borycka and Górecka 2001, Figuerola et al. 2005, Nawirska and Kwasniewska 2005, Nawirska and Uklanska 2008, Borycka and Górecka 2005, Anioła and Górecka 2006]. Concentrated dietary fibre sources may be used directly as meal supplements, as well as components of fibre-rich preparations. The preparations obtained from cereal sources, in addition to considerable quantities of  $\beta$ -glucans (oat and barley) that they contain, are primarily characteristic for the high content of insoluble dietary fibre, especially cellulose and hemicelluloses. This is related to activating the peristaltic motion and shortening the time it takes stomach content to pass through the digestive tract [Newman et al. 1989, Kalra and Jood 2000]. Conversely, preparations obtained from fruit and vegetables contain a lot of soluble fibre, especially pectines, which lowers the level of glucose in the blood and influences lipid metabolism. By-products from fruit processing are pomace, spent fruit or fruit stones. These contain considerable amounts of bioactive components including dietary fibre which is highly desirable for dietary purposes. Using by-product raw materials such as raspberry and blackcurrant seeds in the form of food additives is one of the ways to increase health properties of food and prolong their shelf life. The results of the research study on the model systems

with the use of bulk and emulsified rapeseed oil and rapeseed oil triacylglycerols show that blackcurrant and raspberry seeds extracts may be appropriate source of antioxidants for food lipids stabilization [Pacholek and Małecka 2000, 2001, 2005, Małecka et al. 2003, Samotyja and Małecka 2007]. Many fibre preparations may be used as a substitute for flour in bread and pasta production, but they may also be applied, depending on their form and solubility, in soups, sauces, mayonnaises, drinks, processed meat, desserts and cheeses [Tood et al. 1989, Pszczola 1991, Kawka et al. 1999, Adamczak et al. 2003, Hać-Szymańczuk 2006].

The objective of this study was an effort to use raspberry pomace, by-product of food processing, in shortcrust cookies.

## **MATERIAL AND METHODS**

The material of the study was dried dietary fibre-rich raspberry pomace sourced directly from a fruit processing plant. Two different forms of pomace were used: crumbled form (ME) and non-crumbled (NM). These preparations were used as a partial replacement of flour in shortcrust cookies at the level 25 and 50%. Shortcrust cookies were prepared in accordance with current bakery recipes [Dojutrek and Pietrzyk 2000], changed only in terms of replacing a defined percentage of flour with a fibre preparation. Once the cookies have been baked, they underwent a sensory test. The evaluation was performed with the use of the scaling method. A group of 9 to 12 sensory assessor evaluated the cookies using a 100 mm unstructured unipolar scale with marked borders prepared in accordance with PN-ISO 4121:1998.

In order to assess consumer palatability, a group of 67 students was used. Assessed was overall palatability and specific palatability of colour, smell, taste and texture. The scale used was hedonistic, linear, unstructured and unipolar with marked borders.

The amounts of neutral detergent dietary fibre (NDF), acid detergent fibre (ADF) and the fraction composition of fibre, i.e. cellulose (C) and lignin (L) were marked with the use of the Van Soest method [1963, 1967] modified by Mc Queen and Nicholson [1979]. The difference between NDF and ADF was used to calculate the content of hemicelluloses (H). The content of total dietary fibre (TDF), soluble (SDF) and insoluble (IDF) was determined by the Asp et al. [1983] with the use of the FIBERTEC machine by Tecator. The results presented in the paper are an average of three repetitions expressed in g/100 g of product. To determine significance of differences between the averages, a one-way ANOVA was performed using the Scheffe test with the  $p \leq 0.05$  significance level.

## **RESULTS AND DISCUSSION**

### **Sensory analysis of shortcrust cookies**

Sensory qualities of baked cookies were sensory evaluated with the use of the scaling method. A group of 9 to 12 sensory assessor performed the evaluation using a 100 mm unstructured unipolar scale with marked borders. The test was performed twice. In order to verify evaluator reliability, in each sample set to be evaluated there was one

control sample (repeated sample). Figure 1 shows how sensory qualities of evaluated cookies were influenced by adding crumbled and non-crumbled raspberry pomace. During evaluation it was noticed that higher percentage of raspberry pomace in short-crust cookies increases their fruity smell and taste, as well as sour taste while the sweet taste is less perceptible. The appearance of the sweet taste elicited positive reactions among evaluators. The evaluators also reported foreign smell and taste, most often described as “grassy”. Similar phenomena were observed when pomace was powdered as raw material were being prepared for the production of cookies. It was only after adding the whole seed raspberry pomace in the amount of 50% that crumbliness of cookies significantly increased.

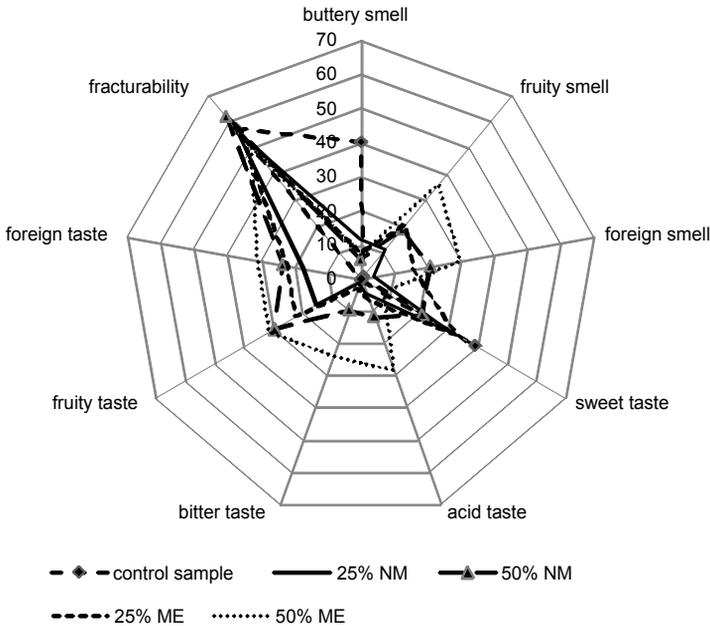


Fig. 1. The influence of adding by-products raspberry pomace on sensory qualities of shortcrust cookies

### Study on customer palatability

Prepared and cooked cookies were submitted to a customer palatability study – results of the study are shown on Figure 2. On the basis of the studies conducted, it may be concluded that general palatability and palatability specific depended on the quantity and form of the applied raspberry pomace. General palatability was highest in the case of cookies samples with 50 and 25% of non-crumbled pomace added (60 and 57 respectively), a tendency also true for specific palatability of taste (69.7 and 61.9). The addition of ground raspberry pomace resulted in decidedly lower scores for both general desirability and specific desirability (except for consistency palatability). Anioła et al. [2008] and others [Grigelmo-Miguel and Martin-Belloso 1999, Dziugan et al. 2006, Mielcarz 2006, Nassar et al. 2008, Gómez et al. 2010] noticed similar relationship

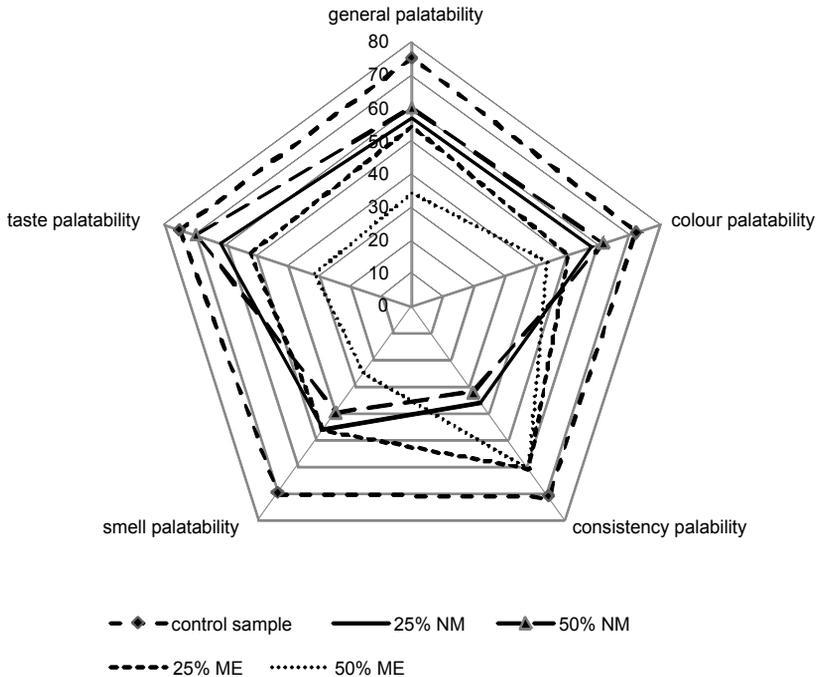


Fig. 2. Evaluation of general and specific palatability for shortcrust cookies with or without the addition of raspberry pomace

in their studies. After enriching shortcrust cookies with a ground commercial fibre-rich preparation obtained from aronia and blackcurrant pomace in the amount of 40 and 50%, sensory qualities were ranked low at the detriment to palatability.

Cookies with the addition of crumbled raspberry pomace (in the amount of 25 and 50%), when evaluated for general and specific palatability, obtained slightly lower scores compared to shortcrust cookies without the pomace (control sample). Given the fact that, during customer studies, customers declare that they can accept food products of higher health quality at the expense of organoleptic qualities, it is justified to continue research into improving the recipe of the cookies and their baking technology.

### Assessment of dietary fibre content

Dietary fibre and its fractions in cookies are presented in Table 1. Raspberry pomace displayed high content of total dietary fibre – TDF (77.5% d.m.) and insoluble fraction (75% d.m.). The content of lignin and cellulose fractions was at a similar level – 24.6 and 24.2% d.m. respectively. The hemicelluloses fraction was the one with the lowest content (6.0% d.m.). Dry mass content, expressed in g/100 g of the product, varied from 95.33% (25% ME) to 96.21% (control sample). Many other studies also showed a high content of dietary fibre in preparations of fruit and vegetable origin [Grigelmo-Miguel and Martín-Belloso 1999, Borycka and Górecka 2001, Aniola et al. 2005, Aniola and Górecka 2006, Nassar et al. 2008, Nawirska and Uklanska 2008]. The studies conducted

Table 1. The dietary fiber content of raw materials, % d.m.

Indices	Wheat flour type 550	Raspberry pomace
Insoluble dietary fiber (IDF)	1.6 ±0.2	75.0 ±0.2
Soluble dietary fiber (SDF)	1.5 ±0.1	2.5 ±0.1
Total dietary fiber (TDF)	3.1 ±0.1	77.5 ±0.2
Hemicelluloses (H)	1.30 ±0.1	6.0 ±0.1
Lignin (L)	0.26 ±0.05	24.6 ±0.2
Cellulose (C)	0.43 ±0.01	24.2 ±0.2
Neutral detergent fiber (NDF)	1.99 ±0.08	54.9 ±0.3

Mean values (n = 3) ±standard deviation.

on apple pomace proved that it contains large amounts of soluble fibre which may mean a high content of pectins in apple pomace [Grigelmo-Miguel and Martín-Belloso 1999, Figuerola et al. 2005; Nawirska and Uklanska 2008].

The results obtained for the content of dietary fibre and its fractions in cookies with the addition of raspberry pomace presented in Table 2 show that the products studied differ in terms of the presence of these components. The highest content of dietary fibre (TDF and NDF) expressed in g/100 g of the product was to be found in cookies with 50% of the NM preparation, 35.98% and 24.68% respectively – the lowest in cookies with 25% of the NM preparation, 14.24% and 10.14% respectively.

Cookies with raspberry pomace had much more dietary fibre TDF (from 14.24% – 25% NM to 35.98% – 50% NM) and NDF (from 10.14% – 25% NM to 24.68% – 50% NM) compared to the control sample (TDF – 2.52%, NDF – 1.47%). In all cookies

Table 2. The content of dietary fiber (NDF) and its fraction in cookies with addition of raspberry pomace, g/100 g cookies

Indicates	Control sample	25% NM	50% NM	25% ME	50% ME
NDF	1.47 <sup>a</sup>	10.14 <sup>b</sup>	24.68 <sup>c</sup>	11.87 <sup>c</sup>	17.90 <sup>d</sup>
ADF	1.11 <sup>a</sup>	9.68 <sup>c</sup>	18.89 <sup>c</sup>	8.05 <sup>b</sup>	15.72 <sup>d</sup>
Hemicelluloses	0.37 <sup>a</sup>	0.45 <sup>a</sup>	5.78 <sup>d</sup>	3.82 <sup>c</sup>	2.18 <sup>b</sup>
Lignin	1.08 <sup>a</sup>	5.28 <sup>c</sup>	9.43 <sup>c</sup>	3.98 <sup>b</sup>	8.06 <sup>d</sup>
Cellulose	0.02	4.40 <sup>b</sup>	9.46 <sup>d</sup>	4.07 <sup>b</sup>	7.66 <sup>c</sup>
TDF	2.52 <sup>a</sup>	14.24 <sup>b</sup>	35.98 <sup>d</sup>	15.25 <sup>b</sup>	29.22 <sup>c</sup>
IDF	2.44 <sup>a</sup>	13.77 <sup>b</sup>	34.50 <sup>d</sup>	13.50 <sup>b</sup>	27.50 <sup>c</sup>
SDF	0.08 <sup>a</sup>	0.46 <sup>b</sup>	1.48 <sup>c</sup>	1.75 <sup>d</sup>	1.68 <sup>cd</sup>

NDF – neutral detergent fiber, ADF – acid detergent fiber, hemicelluloses – calculated as difference NDF-ADF, TDF – total dietary fiber, SDF – soluble dietary fiber, IDF – insoluble dietary fiber. Averages in rows followed by different letters indicate significant difference at the level  $p \leq 0.05$ .

the insoluble fraction (IDF) prevailed ranging from 13.5% (25% ME) to 34.5% (50% NM). In the control sample this fraction stood at 2.44%. When analysing the fraction composition of the dietary fibre in the products studied, it was discovered that the content of particular fractions is very much varied. The level of the hemicelluloses fraction was at its highest in cookies with 50% NM (5.78%), and lowest in cookies with 25% NM (0.45%). Similarly, the level of lignin and cellulose fraction was highest in products with 50% NM, 9.43 and 9.46% respectively, and lowest in cookies with 25% ME, 3.98 and 4.07% respectively. The products studied had low levels of soluble fraction amounting to from 0.46% (25% NM) to 1.75% (25% ME).

In terms of the percentage share of particular fractions in the dietary fibre of products with raspberry pomace, the biggest share was the one of IDF (from 88.5% – 25% ME to 96.7% – 25% NM) – Figure 3. The high content of insoluble fraction (over 81.7%) was also shown in the studies by Figuerola et al. [2005] in tropical fruit and apples. Dietary fibre of the cookies studied displayed a large presence of the lignin fraction (from 33.5% – 25% ME to 52.1% – 25% NM) and cellulose fraction (from 34.3% – 25% ME to 43.4% – 25% NM), whereas in the control sample the share of the lignin fraction amounted to 73.5%, hemicelluloses fraction to 25.2%, and cellulose fraction, the lowest, to 1.35% (Fig. 4).

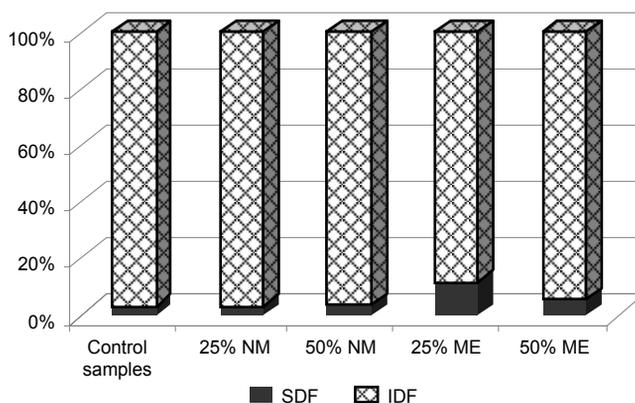


Fig. 3. Percentage content of fraction in dietary fiber (TDF)

It was discovered that the proportion of particular fractions varied considerably in the obtained cookies (Table 3). The highest ratio of lignin to hemicelluloses (L/H) and insoluble fraction to the soluble fraction (IDF/SDF) was present in cookies with 25% NM, 11.7 and 29.9 respectively – the highest ratio of hemicelluloses to cellulose (H/C) in cookies with 25% ME (0.9). The products studied displayed a similar proportion of the lignin fraction to the cellulose fraction (L/C). Cookies without raspberry pomace had a considerably higher ratio of fractions L/C (54), H/C (18.5) as well as IDF/SDF (30.5) when compared to other products. Such varied composition of the dietary fibre in the products studied may indicate its different functional qualities and physiological impact. The varied ratio of fractions IDF/SDF was also highlighted in other studies [Figuerola et al. 2005, Jaime et al. 2002]. From the nutritional point of view, fibre of fruit origin has better qualities when compared to cereal fibre because of its high content of bioactive substances and a higher ratio of fractions SDF/IDF.

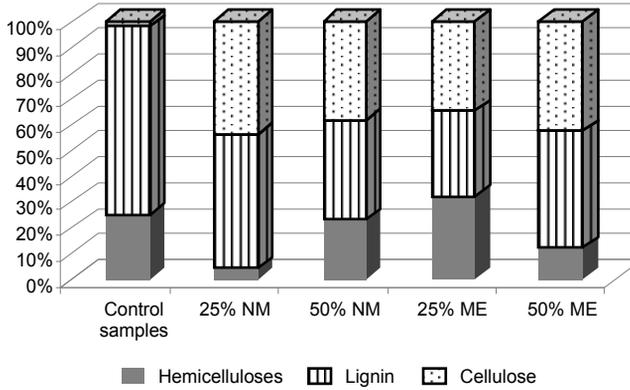


Fig. 4. Percentage content of fraction in dietary fiber (NDF)

Table 3. Proportion of dietary fiber fraction

Kind of product	L/C	L/H	H/C	IDF/SDF
Control sample	54	2.9	18.5	30.5
25% NM	1.2	11.7	0.10	29.9
50% NM	1.0	1.6	0.6	23.3
25% ME	1.0	1.0	0.9	7.7
50% ME	1.1	3.7	0.3	16.4

L – lignin, H – hemicelluloses, C – cellulose, IDF – insoluble dietary fiber, SDF – soluble dietary fiber.

Dietary fibre provided in mixed diet contains on average 66-75% of insoluble and 25-33% of soluble fibre. Insoluble fibre has a positive influence on the colon and diseases related to it, e.g. constipation, colon cancer, haemorrhoids as well as breast and prostate cancer. It also shortens the time of intestine passage. Soluble fibre, on the other hand, reduces the risk of heart diseases and lowers the level of cholesterol, triglycerides and glucose in the blood [Marlett et al. 2002]. What is very important from the nutritional point of view is the right proportion of soluble (SDF) and insoluble (IDF) fibre in the diet. The proportion should be 1:4 to 1:3. Because of the fact that fibre increases water retention in the colon influencing the volume and softness of faeces, it is recommended that higher intake of dietary fibre should be accompanied by increased consumption of water. According to Schneeman [1987] products in which the ratio of SDF/IDF is 1:2 are a good source of fibre both from the physiological and technological point of view.

Other studies put forward the possibility to use fibre-rich preparations as replacements of wheat flour. What was highlighted was high sensory value of the cookies with fibre preparations added. Because of the large amount of dietary fibre in shortcrust cookies with the addition of raspberry pomace, such products may be considered as health food.

## CONCLUSIONS

1. The addition of raspberry pomace influences organoleptic qualities of shortcrust cookies. Cookies had different flavour depending on the quantity and form of pomace used. The more raspberry pomace is added the stronger the fruity smell, fruity taste and sour taste. At the same time sweet taste is less perceptible and there are reports of a “grassy” smell and taste.

2. General desirability and specific desirability depended on the quantity and form of the pomace used. In terms of general desirability cookies with 50 and 25% of non-crumbled pomace were rated highest.

3. Shortcrust cookies with raspberry pomace had large quantities of dietary fibre. Among the cookies tested, the largest amount of dietary fibre was to be found in cookies with 50% of non-crumbled raspberry pomace.

4. Shortcrust cookies with raspberry pomace displayed varied fraction composition. In all the cookies, depending on the ratio of flour replacement, the lignin and cellulose fractions prevailed. The most common fibre fraction was insoluble fibre.

5. Partial replacement of flour in cookies with the raspberry pomace is one of the possible ways to increase the amount of dietary fibre in the diet.

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## WYKORZYSTANIE WYTŁOKÓW Z MALIN DO WZBOGACANIA CIASTEK KRUCHYCH W BŁONNIK POKARMOWY

**Wprowadzenie.** Błonnik pokarmowy jest pożądanym składnikiem żywności, ale również właściwościami funkcjonalnymi i technologicznymi. Przemysł spożywczy wytwarza znaczne ilości produktów odpadowych, powstaje więc problem w ich zagospodarowaniu. Zazwyczaj są wykorzystywane w żywieniu zwierząt. Jednakże ze względu na dużą zawartość błonnika pokarmowego mogłyby być zastosowane w produktach spożywczych. Zalecane spożycie błonnika pokarmowego kształtuje się na poziomie 25-30 g/dzień. Dlatego w celu uzupełnienia codziennej diety w błonnik pokarmowy należałoby wprowadzić substancje błonnikowe do żywności często spożywanej. Celem pracy była ocena możliwości zastosowania w wyrobach ciastkarskich wytloku malinowego, będącego odpadem w przetwórstwie owoców.

**Materiał i metody.** Materiałem badawczym był wysuszony wytlók malinowy uzyskany bezpośrednio z zakładu przetwórstwa owoców. W badaniach stosowano dwie formy wytloku: rozdrobnioną (ME) i nierozdrobnioną (NM). Preparaty wykorzystano jako częściowy zamiennik mąki w półkruchych ciastkach na poziomie 25 i 50%. Ciastka bezpo-

średnio po wypieku poddano ocenie konsumenckiej metodą skalowania. Zawartość neutralnego detergentowego błonnika pokarmowego (NDF) i jego skład frakcyjny oznaczono metodą Van Soesta, całkowitego błonnika pokarmowego (TDF), rozpuszczalnego (SDF) i nierozpuszczalnego (IDF) według metody Aspa i in.

**Wyniki.** W wytloku malinowym była duża zawartość błonnika pokarmowego (NDF). W największej ilości występowała frakcja ligninowa i celulozowa. Ciastka z wytlukiem malinowym cechowały się znacznie większą zawartością błonnika pokarmowego – NDF (od 10,1 g/100 g – 25% NM do 24,7 g/100 g produktu – 50% NM) w porównaniu z próbą kontrolną (1,7 g/100 g wyrobu). Dodatek wyluku z malin do wyrobów ciastkarskich pozwolił na zwiększenie zawartości błonnika, nie wpłynął negatywnie na cechy organoleptyczne produktu i był akceptowalny przez konsumentów.

**Wnioski.** Ze względu na znaczną zawartość błonnika pokarmowego w odpadach owocowych, a szczególnie w pestkach, powinny one być przedmiotem zainteresowania technologów żywności.

**Słowa kluczowe:** preparaty wysokobłonnikowe, wyroby ciastkarskie, ocena konsumencka

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