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# ASSESSMENT OF FUNCTIONAL PROPERTIES OF VEGETABLE AND FRUIT MOUSSES ENRICHED WITH A FIBER PREPARATION FROM POTATO STARCH

S u m m a r y

**Background.** Vegetable and fruit mousses have become very popular among consumers. These products are a source of complete nutrients, providing the body with vitamins, minerals and dietary fiber. However, the overall fiber content in a single serving of mousse has turned out to be insufficient. The aim of the study was to examine the functional properties of vegetable and fruit mousses before and after enriching them with a fiber preparation from potato starch (SDexF). The research material consisted of three mousse flavors: apple-peach-parsnip, apple-cherry-carrot and apple-carrot-quince. The research included pH measurement, analysis of CIE L*a*b* color parameters and pasting characteristics of vegetable and fruit mousses. The content of total dietary fiber (TDF) in vegetable and fruit mousses was also determined using the enzymatic-gravimetric AOAC 991.43. method.

**Results and conclusion.** The addition of SDexF resulted in a slight decrease in the pH of the apple-cherry-carrot mousse. For each flavor, a change in color was observed, with the largest difference in color parameters (ΔE) observed in the apple-carrot-quince flavored mousse. The vegetable and fruit mousses enriched with SDexF were characterized by a higher total fiber content compared to the unenriched mousses. The preserves with the addition of SDexF were characterized by lower pasting parameters compared to the control mousses. Based on the functional tests being carried out, no negative impact of the enriching of vegetable and fruit mousses with SDexF on the final product was observed. It can therefore be concluded that the use of SDexF affects the functional properties of vegetable and fruit mousses, increasing their nutritional and health value.

**Keywords:** vegetable and fruit mousses, dietary fiber, food enrichment, potato starch

## Introduction

In recent times, there has been a growing interest among consumers in food having functional properties. As the nutritional knowledge of society expands, there is also

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an increasing interest in food products that not only serve a nutritional function but additionally demonstrate beneficial effects on the effective functioning of the body [22].

One of the many bioactive components having a positive impact on human health is dietary fiber. Numerous studies indicate that consuming an adequate amount of fiber contributes to the prevention of cardiovascular diseases and reduces the risk of obesity, diabetes, cancer and gastrointestinal diseases [15]. However, the amount of dietary fiber typically consumed in the daily diet is often inadequate [24]. Therefore, there is a necessity for innovative products with higher nutritional and health values, which can be obtained by adding dietary fiber [7].

Consuming fruit and vegetables, as well as products made from them, is the basis of a balanced diet [9]. Vegetable and fruit preserves, due to frequent consumption, can be excellent products for enrichment with bioactive ingredients [25]. Currently, the key task of the fruit and vegetable industry is to design innovative products that display high quality and ensure safety [28].

An increasing number of vegetable and fruit processed products, such as mousses, are appearing on store shelves. These products represent an innovative area in the field of healthy nutrition, combining not only flavorful combinations but also being nutrient-rich. In recent years, mousses have gained immense popularity as a healthier alternative to traditional preserves such as jams [30].

Mousses are food products obtained through minimal processing of fruit and vegetables, which makes them a valuable source of antioxidants [30]. The mousse production process typically involves crushing raw materials, which are then mixed and subjectedto thermal processing to achieve the desired consistency [26]. Mousses can be prepared from various combinations of fruit and vegetables. Based on a review of the vegetable and fruit mousse market, it can be concluded that the types of fruit which are the most commonly used for the production of such products are apples, bananas, pears and mangoes. As for vegetables, they include carrots, beets and pumpkins. Vegetable and fruit mousses contain dietary fiber in their composition. However, an analysis of products available on the Polish market indicates that the total fiber content in one serving of a product is insufficient [20]. Examples of the flavors of vegetable and fruit mousses along with fiber content (per 100 g of product) available on the Polish market are presented in Table 1.

At the Jan Dlugosz University in Czestochowa, a project titled "Development and implementation of an innovative technology for the production of new generation vegetable and fruit products enriched with a fiber preparation from potato starch with prebiotic properties intended for children and adolescents" (with the acronym PreST-Fibre4kids) was implemented. The project was carried out in cooperation between JDU and: Tymbark MWS Sp. z o. o., the Children's Memorial Health Institute, the Faculty of Biotechnology and Food Sciences of the Lodz University of Technology and the Maria Sklodowska-Curie National Research Institute of Oncology. The aim of the project was to use a patent-protected fiber preparation from potato starch with prebiotic properties [19] for the purpose of creating innovative vegetable and fruit products without added sugars, intended for consumption by children and adolescents. The resulting products can be classified as functional food, as fortifying daily diet with dietary fiber and prebiotic preparations may contribute to preventing overweight and obesity [16].

Table 1. Examples of flavors of vegetable and fruit mousses along with fiber content (g/100 g of product) available on the Polish market (presented in ascending order, i.e. from the lowest to the highest content of dietary fiber)

Tabela 1. Przykładowe smaki musów warzywno-owocowych wraz z zawartością błonnika (g/100 g produktu) dostępne na polskim rynku (ułożone od najmniejszej do największej zawartości błonnika pokarmowego)

| Mousse taste / Smak musu | Brand name / Nazwa handlowa | Fiber content / Zawartość błonnika [g/100 g] |
|---|---|---|
| apple-blueberry-black carrot / jabłko-borówka-czarna marchew | Freche Freunde | 0.9 |
| apple-green peas-fennel-broccoli / jabłko-zielony groszek-koper włoski-brokuł | Kubuś Baby | 1.4 |
| apple-peach-pumpkin / jabłko-brzoskwinia-dynia | BoboVita | 1.5 |
| apple-banana-cherry-beetroot / jabłko-banan-wiśnia-burak | Hortex | 1.5 |
| apple-blackcurrant-beetroot / jabłko-czarna porzeczka-burak | Kubuś Baby | 1.7 |
| zucchini-spinach-kiwi-apple-banana / cukinia-szpinak-kiwi-jabłko-banan | Dawtona | 1.7 |
| apple-beetroot-strawberry / jabłko-burak-truskawka | Tymbark | 1.8 |
| apple-pear-spinach / jabłko-gruszka-szpinak | Babydream | 2.2 |
| carrot-mango-apple / marchew-mango-jabłko | Dawtona | 2.4 |
| apple-pumpkin-carrot / jabłko-dynia-marchew | Kubuś Baby | 2.5 |
| apple-pear-white carrot-parsnip-banana / jabłko-gruszka-biała marchew-pasternak-banan | Tymbark | 2.7 |

Obesity affects an increasing part of society, including children and adolescents [31]. Currently, combating excess body weight is one of the most serious global health challenges. The prevalence of obesity has significantly increased over the last decade, as a result of which it has been called the 21st-century epidemic [13]. Fundamental causes of obesity include the consumption of excessive calories and insufficient physical activity, leading to inadequate energy expenditure [18]. In recent times, there has been a growing recognition of the connection between gut microbiota and obesity [8]. Research indicates that the gut microbiota of obese individuals is characterized by lower abundance and diversity of beneficial bacteria, with a predominance of pathogenic microorganisms. It is acknowledged that the *Firmicutes* to *Bacteroidetes* (F/B) ratio plays a crucial role in maintaining gut homeostasis [27]. In individuals with excess adipose tissue, there is a lower quantity of *Bacteroides* bacteria and an abundance of *Firmicutes* compared to lean individuals. As a result of tests carried out on the feces of obese children, it was found that a fiber preparation from potato starch stimulated the growth of *Bacteroidetes* and *Actinobacteria* and reduced *Firmicutes* [4].

One of the factors influencing the state of gut microbiota is the dietary pattern. Therefore, it is advisable to supplement meals with prebiotic and probiotic products [1].

The aim of this study was to examine the functional properties of vegetable and fruit mousses before and after enriching them with a dietary fiber preparation having prebiotic properties from potato starch.

## Material and methods

### *Materials*

The research material included three vegetable and fruit mousses to which a dietary fiber preparation from potato starch (SDexF) was added and three without the addition of that preparation. The mousses were produced by Tymbark MWS Sp. z o.o. (Poland) as part of the PreSTFibre4kids project. The production of SDexF on a semi-industrial scale was carried out using specially designed equipment at the Jan Dlugosz University in Czestochowa. The fiber preparation was obtained according to the patent [19]. Briefly, 10 kg of potato starch was sprayed with hydrochloric and citric acid at the final concentration of 0.1 % of each acid, mixed mechanically while spraying/heating at 55/75 Hz, dried at 110 °C to the moisture content below 5 %, and finally heated at 130 °C for 4h. Three flavors of the vegetable and fruit mousses were analyzed: apple-peach-parsnip (APP), apple-cherry-carrot (ACC) and apple-carrot-quince (ACQ), as well as their enriched counterparts (APP+, ACC+ and ACQ+). All the analyzed mousses underwent the pasteurization process. The research material comprised a total of six samples of mousses, as presented in Figure 1.

### *pH measurement*

The measurement was performed using a SevenCompact TM S210 pH meter (Mettler Toledo, Greifensee, Switzerland). The mousses were put into beakers. Subsequently, the pH meter was calibrated and the measurement was made by placing an electrode in a beaker containing the analyzed vegetable and fruit mousse. For each sample, pH was determined three times, and then the arithmetic mean and standard deviation were calculated.

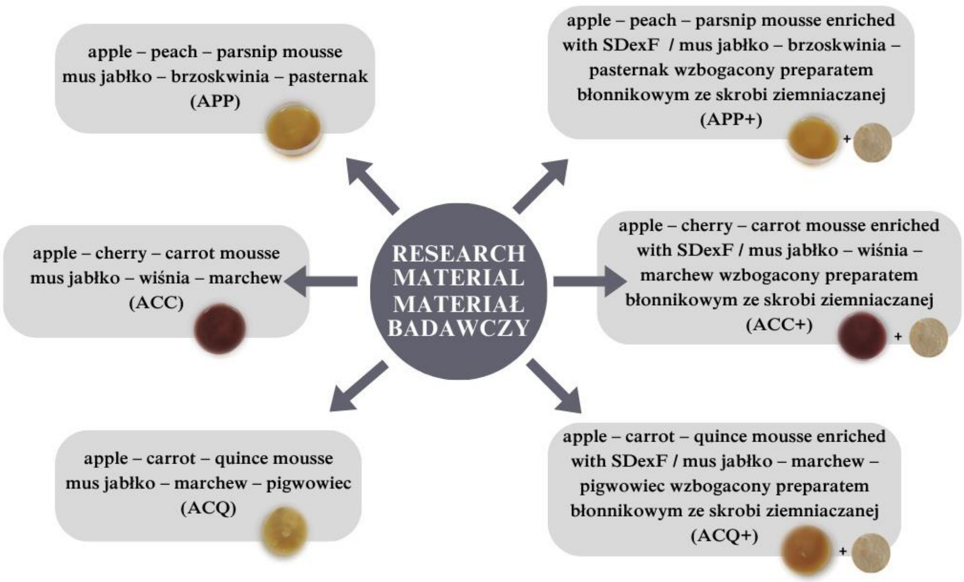


Fig. 1. Research material
Rys. 1. Materiał badawczy

*Analysis of color parameters*

The color of vegetable and fruit mousses was assessed using the Chroma Meter CR-400 colorimeter (Konica Minolta Sensing, Osaka, Japan) relative to the standard illuminant D65. CIE L*a*b* color parameters were recorded as L* - brightness, a* - green (-)/red (+) balance and b* - blue (-)/yellow (+) balance. For each sample, ten independent measurements were performed. Subsequently, the arithmetic mean of the L*a*b* parameters, standard deviation and color differences (ΔE) between the same flavors of mousses with and without the addition of the fiber preparation were calculated. The total color difference (ΔE) was computed using the following equation:

$$\Delta E = [(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2]^{1/2}$$

Explanatory notes / Objaśnienia:
1 - means values for vegetable and fruit mousses without the addition of fiber preparation from potato starch; 2 - means values for vegetable and fruit mousses with the addition of fiber preparation from potato starch;

1 - oznacza wartości dla musów warzywno-owocowych bez dodatku preparatu błonnikowego ze skrobi ziemniaczanej; 2 - oznacza wartości dla musów warzywno-owocowych z dodatkiem preparatu błonnikowego ze skrobi ziemniaczanej.

*Determination of total dietary fiber content (TDF)*

The total dietary fiber (TDF) was determined using the enzymatic-gravimetric method AOAC 991.43. [3] with the use of enzymatic assay for determining total dietary fiber from Megazyme International Ltd. (Wicklow, Ireland). To achieve this, vegetable and fruit mousses were subjected to a water removal process by placing them in a LyoQuest -55 freeze dryer (Telstar, Azbil, Japan) at a temperature of -50 °C for approximately two days. Freeze-dried mousses of 1 g were dissolved in the MES-TRIS buffer solution and then subjected to enzymatic digestion using thermostable α-amylase, protease and amyloglucosidase. An appropriate amount of ethyl alcohol was added to the hydrolyzate in order to precipitate water-soluble fibers (the volumetric ratio of ethyl alcohol to the volume of the hydrolyzate should be 4:1). In the next stage, the resulting sediment was filtered through a Gooch-type glass crucible of known mass. The residue remaining in the crucible was washed twice with 78 % and 95 % ethanol and once with acetone. The crucibles with the remaining sediment were left overnight in an oven at 103 °C and then weighed. After taking into account the protein and ash content, the total dietary fiber content in the freeze-dried vegetable and fruit mousses was calculated. The analysis was performed three times for each tested sample.

*Effect of temperature on the apparent viscosity of mousses*

The viscosity of vegetable and fruit mousses was measured using a rotational viscometer RVA 4500 (Perten Instruments, Hägersten, Sweden). A 25 g sample of each mousse was weighed into a measuring vessel. Subsequently, the vessel with the analyzed sample was placed in the heating mantle of the viscometer. A 15-minute temperature profile was used to measure changes in viscosity during heating and cooling. Initially, the suspensions were adjusted to a temperature of 25 °C for a period of 1 minute. Subsequently, heating continued, with temperature being raised from 25 to 95 °C at a rate of 14 °C/min and then at 95 °C for 3 minutes. The next step entailed cooling to 25 °C at the identical rate, and finally, equilibration at 25 °C for 1 minute. During the first 10 seconds of the mixing process, a speed of 960 rpm was reached and then reduced to 160 rpm for the rest of the measurement. Viscosity measurement was performed three times for each sample. Based on the measurement, the following parameters were determined: peak viscosity (PV), hot sample viscosity (HPV), breakdown (BD = PV − HPV), final viscosity (FV) and setback (SB = FV − HPV).

*Statistical analysis*

Each measurement was performed at least three times. Next, an analysis of variance was performed. Means were compared using the Duncan's new multiple range test ($p < 0.05$). The values of the analyzed variables were presented as mean ± standard deviation. The results were statistically analyzed using Statistica 13.3 software (StatSoft, Tulsa, OK, USA).

## Results and discussion

*pH of vegetable and fruit mousses*

The pH index is an important parameter determining the quality and freshness of vegetable and fruit products. The pH values of vegetable and fruit mousses without and with the addition of SDexF are shown in Figure 2. The acidity of all the tested vegetable and fruit products ranged from 3.32 to 3.80.

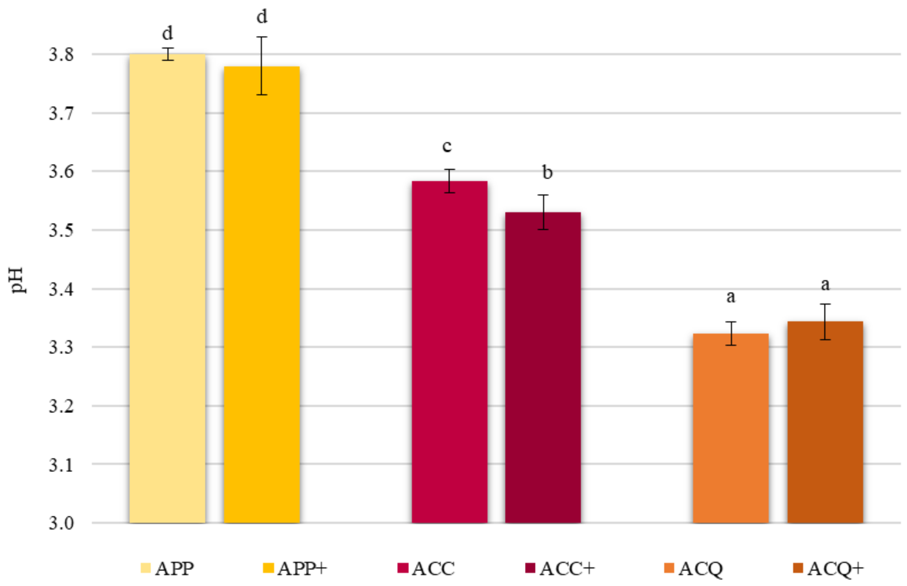


Fig. 2. pH values of vegetable and fruit mousses
Rys. 2. Wartości pH musów warzywno-owocowych
Explanatory notes / Objaśnienia:
The figure shows mean values ± standard deviations. Variants: APP (apple – peach – parsnip mousse); APP+ (apple – peach – parsnip mousse enriched with SDexF); ACC (apple – cherry – carrot mousse); ACC+ (apple – cherry – carrot mousse enriched with SDexF); ACQ (apple – carrot – quince mousse); ACQ+ (apple – carrot – quince mousse enriched with SDexF). Statistically different pH values ($p < 0.05$) for individual mousses are marked with different letters. /
Na rysunku przedstawiono wartości średnie ± odchylenia standardowe. Warianty: APP (mus jabłko – brzoskwinia – pasternak); APP+ (mus jabłko – brzoskwinia – pasternak wzbogacony preparatem błonni-

kowym ze skrobi ziemniaczanej); ACC (mus jabłko – wiśnia – marchew); ACC+ (mus jabłko – wiśnia – marchew wzbogacony preparatem błonnikowym ze skrobi ziemniaczanej); ACQ (mus jabłko – marchew – pigwowiec); ACQ+ (mus jabłko – marchew – pigwowiec wzbogacony preparatem błonnikowym ze skrobi ziemniaczanej). Wartości różniące się statystycznie ($p < 0,05$) dla poszczególnych musów oznaczono różnymi literami.

The apple-cherry-carrot flavored mousse with the addition of SDexF (ACC+) was characterized by a statistically significantly lower pH value compared to the unenriched mousse (ACC). In the case of the remaining two flavors of mousses, no significant differences were observed. The range of permissible pH values for the tested mousses is not prescribed by legal regulations. Active acidity values depend primarily on raw materials used in production. Preserves containing only fruit have lower pH values compared to products consisting only of vegetables. Differences in pH parameters are also observed in the case of individual varieties of fruit and vegetables [23]. The highest pH value was demonstrated by the unenriched mousse consisting of apples, peaches and parsnips (APP). However, the apple, carrot and quince flavored mousse (ACQ) had the lowest pH level. This may be due to the fact that quince fruit has low general acidity and the pH of quince pulp is 3.43 [2]. The pH value may also be influenced by biochemical reactions taking place. The pasteurization process allows to inhibit these changes and consolidate the finished product, thus maintaining its durability and freshness for longer.

*Analysis of color parameters*

The color of food products is influenced by the chemical composition, physical state and structure of food [29]. Table 2 presents individual color parameters of vegetable and fruit mousses. The use of SDexF had a significant impact on the L*a*b* color parameters of the vegetable and fruit mousses. It was observed that colors changed, being darker, in the case of each mousse flavor with the addition of SDexF, as the L* value responsible for lightness decreased. In the APP, APP+, ACC, ACC+ mousses, a* values were positive, which indicated the affinity of the mousses for the red color. However, the addition of SDexF to the apple-carrot-quince mousse (ACQ) caused a change in affinity from slightly green to lightly red. In turn, the b* values of all the analyzed mousses were positive, which had a significant impact on the share of yellow color. The color change could be caused by high temperature during the pasteurization process of the mousses, during which a non-enzymatic browning reaction probably occurred due to sugar caramelization and Maillard reactions [17]. The color modification could also result from light scattering by the particles of the fiber preparation and its natural hue (slightly beige-yellow), as indicated by research conducted by Figueroa and Genovese [12].

Table 2. CIE L*a*b* color parameters of the analyzed vegetable and fruit mousses
Tabela 2. Parametry barwy CIE L*a*b* analizowanych musów warzywno-owocowych

| Sample code / Kod próbki | L* | a* | b* | ΔE |
|---|---|---|---|---|
| APP | $45.29^{f} \pm 0.41$ | $3.31^{c} \pm 0.08$ | $19.11^{e} \pm 0.53$ | 2.33 |
| APP+ | $43.10^{d} \pm 0.09$ | $4.11^{d} \pm 0.08$ | $19.24^{e} \pm 0.17$ | |
| ACC | $32.80^{b} \pm 0.05$ | $9.03^{f} \pm 0.05$ | $6.06^{b} \pm 0.05$ | 1.33 |
| ACC+ | $32.20^{a} \pm 0.04$ | $8.24^{e} \pm 0,08$ | $5.53^{a} \pm 0.06$ | |
| ACQ | $44.23^{e} \pm 0.22$ | $-0.60^{a} \pm 0.08$ | $12.35^{d} \pm 0.32$ | 4.60 |
| ACQ+ | $39.98^{c} \pm 0.13$ | $1.02^{b} \pm 0.17$ | $11.70^{c} \pm 0.43$ | |

Explanatory notes as in Fig. 2. / Objaśnienia jak na Rys. 2.

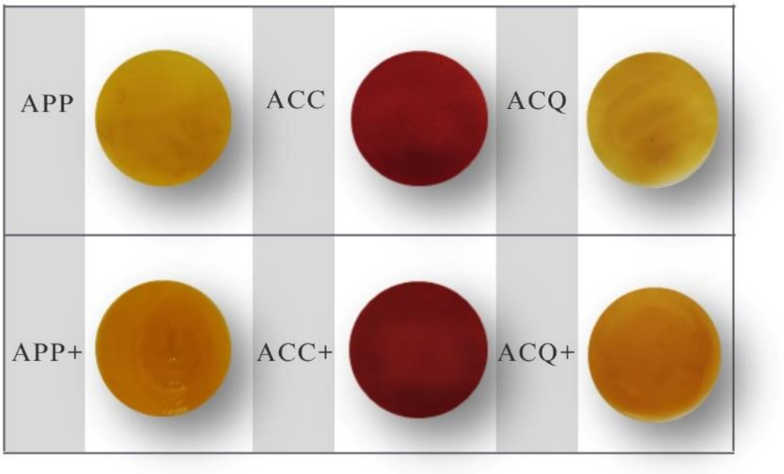


Fig. 3. Color of vegetable and fruit mousses without and with the addition of SDexF
Rys. 3. Barwa musów warzywno-owocowych bez i z dodatkiem preparatu błonnikowego ze skrobi ziemniaczanej
Explanatory notes as in Fig. 2. / Objaśnienia jak na Rys. 2.

The color difference (ΔE) of individual mousse flavors was calculated to characterize the variability of color parameters. The apple-cherry-carrot mousse enriched with SDexF (ACC+) was characterized by the smallest color difference compared to the unenriched mousse, which was 1.33. However, the highest color contrast was observed in the apple-carrot-quince flavored mousse, as (ΔE) was 4.6. When ΔE is below

3, differences in color parameters are visible to humans mainly when products are next to each other, which can be seen in Fig. 3.

Taking into account the results obtained, it can be concluded that, most of all, the addition of SDexF caused changes in the mousse colors, which became darker. In a study conducted by Igual et al. [17], it was also shown that fruit jams enriched with fiber showed color differences compared to traditional preserves. Mousses are most often packed in tubes. Their color, as well as the color difference (ΔE), is not the most important parameter for consumers when they make a choice.

*Total dietary fiber content (TDF) in vegetable and fruit mousses*

The total content of dietary fiber in 100 g of vegetable and fruit mousses, measured using the enzymatic-gravimetric method AOAC 991.43, is shown in Figure 4. The AOAC 991.43 method is commonly used for declaring total dietary fiber on food labels in both the United States and the European Union [6]. However, this method has certain limitations because it allows for the determination of only high-molecular fractions resistant to enzymatic digestion. Therefore, the results obtained do not take into account low molecular weight dietary fiber particles soluble in ethanol [11].

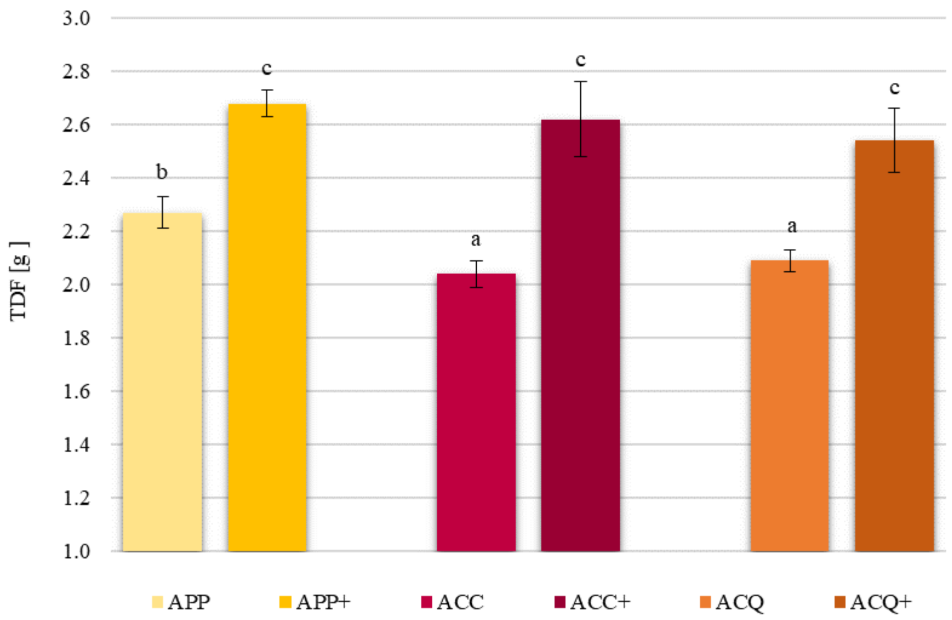


Fig. 4. Total dietary fiber content [g] in 100 g of vegetable and fruit mousses
Rys. 4. Całkowita zawartość błonnika pokarmowego [g] w 100 g musów warzywno-owocowych
Explanatory notes as in Figure 2. / Objaśnienia jak na Rys. 2

All the vegetable and fruit mousses enriched with SDexF were characterized by a comparable total dietary fiber content. Taking into account the amounts of fiber in the samples of the unenriched products, the mousse containing apple, peach and parsnip (APP) had the highest total fiber content. This may be due to the presence of parsnip. This raw material is a valuable source of dietary fiber, as its amount in 100 g of this vegetable is approximately 4.9 g [10].

The greatest differences in fiber content before and after enriching vegetable and fruit mousses were observed in the case of the apple-cherry-carrot (ACC) and apple-carrot-quince (ACQ) flavors. Whereas, the smallest was observed for the mousse containing apple, peach and parsnip (APP). These differences may result from numerous interactions that occur between dietary fiber and other bioactive ingredients present in such products as polyphenols [14].

The results obtained suggest that the addition of SDexF to vegetable and fruit mousses increases the total dietary fiber content in these products. Research conducted by Belovic et al. [5] also demonstrated that enriching apricot jam with tomato pomace resulted in an increase in the dietary fiber content compared to the traditional jam. Kosiorowska et al. [21] also reported that cranberry jams with the addition of flax and chia seeds contained a significantly higher TDF content compared to the control jam.

At a further stage of the research, it is also planned to determine the total dietary fiber content of vegetable and fruit mousses using the integrated enzymatic-gravimetric-chromatographic method AOAC 2009.01, 2011.25. or 2017.16. These methods are more accurate because they additionally allow for the determination of low molecular weight fractions of dietary fiber, as a result of which even higher values of dietary fiber can be expected in enriched vegetable and fruit mousses [11].

*Effect of temperature on the apparent viscosity of mousses*

After a visual assessment of the vegetable and fruit mousses, it could be concluded that the products with the addition of SDexF were characterized by a more uniform structure and seemed more liquid. The results obtained, concerning thepasting characteristics of the vegetable and fruit mousses measured using RVA, presented in Figure 5, confirm a significant reduction in viscosity in each of the enriched mousses compared to the control mousse. Table 3 shows the pasting parameters of vegetable and fruit mousses. For each type of the enriched mousse, a reduction in all pasting parameters was observed compared to the control mousse. The exception were the BD and SB parameters, which retained similar values for one type of the mousses (APP and APP+). The maximum viscosity of the mousses was observed at a temperature of 25°C during the first minute of mixing. The greatest differences in peak viscosity between the control and enriched mousses were recorded in the case of apple-carrot-quince flavored mousse.

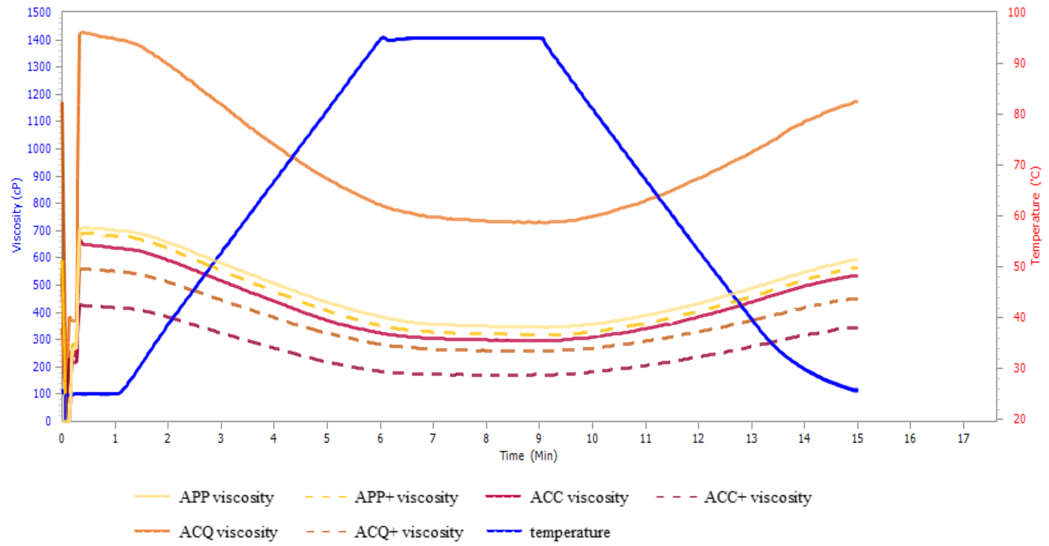


Fig. 5. Effect of temperature on apparent viscosity of vegetable and fruit mousses without and with the addition of SDexF

Rys. 5. Wpływ temperatury na lepkość pozorną musów warzywno-owocowych bez i z dodatkiem preparatu błonnikowego ze skrobi ziemniaczanej

Explanatory notes as in Figure 2. / Objaśnienia jak na Rys. 2

Table 3. Parameters characterizing the effect of temperature on apparent viscosity of vegetable and fruit mousses

Tabela 3. Parametry charakteryzujące wpływ temperatury na lepkość pozorną musów warzywno-owocowych

| Sample code / Kod próbki | PV (mPas) | HPV (mPas) | BD = PV-HPV (mPas) | FV (mPas) | SB = FV - HPV (mPas) |
|---|---|---|---|---|---|
| APP | $713^{e} \pm 17$ | $355^{e} \pm 13$ | $359^{d} \pm 4$ | $609^{e} \pm 21$ | $254^{d} \pm 7$ |
| APP+ | $676^{d} \pm 8$ | $317^{d} \pm 0$ | $359^{d} \pm 8$ | $565^{d} \pm 2$ | $248^{d} \pm 2$ |
| ACC | $625^{c} \pm 16$ | $291^{c} \pm 6$ | $334^{c} \pm 10$ | $529^{c} \pm 7$ | $238^{c} \pm 1$ |
| ACC+ | $412^{a} \pm 8$ | $168^{a} \pm 3$ | $244^{a} \pm 5$ | $344^{a} \pm 1$ | $176^{a} \pm 1$ |
| ACQ | $1400^{f} \pm 2$ | $723^{f} \pm 10$ | $677^{e} \pm 8$ | $1164^{f} \pm 13$ | $441^{e} \pm 3$ |
| ACQ+ | $548^{b} \pm 6$ | $257^{b} \pm 2$ | $292^{b} \pm 4$ | $451^{b} \pm 1$ | $194^{b} \pm 1$ |

Explanatory notes / Objaśnienia:

PV (peak viscosity), HPV (hot paste viscosity), BD (breakdown = PV-HPV), FV (final viscosity), SB (setback = FV-HPV). The figure shows mean values ± standard deviations. Statistically different ($p < 0.05$) for individual mousses are marked with different letters. /

PV (lepkość maksymalna podczas ogrzewania), HPV (najniższa lepkość w temperaturze 95°C), BD (spadek lepkości przy ogrzewaniu = PV-HPV), FV (lepkość końcowa), SB (wzrost lepkości w trakcie chłodzenia = FV-HPV). Na rysunku przedstawiono wartości średnie ± odchylenia standardowe. Różnice statystyczne ($p < 0,05$) dla poszczególnych musów oznaczono różnymi literami.

The lower viscosity of the enriched mousses, while maintaining the shape of the gelatinization curve, does not seem to be a problem that could be negatively perceived by consumers, unlike the increase in viscosity. Moreover, no significant segregation processes of ingredients were observed. The results clearly indicate the technological possibility of the addition of fiber preparation with no adverse effect on its consistency. Lower viscosity may be the result of better dispersion of ingredients in the mousse, which may be important for the consistency and quality of the final product. A very low viscosity ingredient was also added to the mousse, hence the viscosity of the enriched mousse was reduced. The results obtained were consistent with the results of the research conducted by Kapuśniak et al. [20].

## Conclusions

The article examines for the first time the functional properties of vegetable and fruit mousses industrially enriched by a food manufacturer with a fiber preparation from potato starch. Based on the research conducted, the following conclusions can be drawn and final statements can be made:

1. Adding SDexF to vegetable and fruit mousses affects various sensory and physicochemical parameters. Although the reduction in pH is minimal, the change in color, increase in total fiber content and reduction in viscosity may be important aspects.
2. Based on the functional tests carried out, it was not observed that enriching vegetable and fruit mousses with SDexF had a negative impact on the final product.
3. It can therefore be concluded that the addition of SDexF affects the functional properties of vegetable and fruit mousses, improving their nutritional and health value.
4. There is a need to conduct further research, including the determination of low molecular weight fiber fractions and a more comprehensive characterization of enriched mousses.
5. The emergence of innovative sources of dietary fiber offers new possibilities for their use in the food industry.

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## OCENA WŁAŚCIWOŚCI FUNKCJONALNYCH MUSÓW WARZYWNO-OWOCOWYCH WZBOGACONYCH PREPARATEM BŁONNIKOWYM ZE SKROBI ZIEMNIACZANEJ

S t r e s z c z e n i e

**Wprowadzenie:** Musy warzywno-owocowe cieszą się dużym zainteresowaniem wśród konsumentów. Produkty te stanowią źródło pełnowartościowych składników odżywczych, dostarczając organizmowi witaminy, składniki mineralne oraz błonnik pokarmowy. Niemniej jednak, ogólna zawartość błonnika w pojedynczej porcji musu okazuje się niewystarczająca. Celem pracy było zbadanie właściwości funkcjonalnych musów warzywno-owocowych przed i po wzbogaceniu błonnikowym preparatem ze skrobi ziemniaczanej. Materiał badawczy stanowiły 3 smaki musów: jabłko-brzoskwinia-pasternak, jabłko-wiśnia-marchew i jabłko-marchew-pigwowiec. Badania obejmowały pomiar pH, analizę parametrów barwy CIE L*a*b* oraz charakterystykę kleikowania musów warzywno-owocowych. Oznaczono także zawartości całkowitego błonnika pokarmowego (TDF) w musach warzywno-owocowych przy użyciu metody enzymatyczno-grawimetrycznej AOAC 991.43.

**Wyniki i wnioski**: Dodatek preparatu błonnikowego ze skrobi ziemniaczanej spowodował nieznaczne obniżenie pH musu jabłko-wiśnia-marchew. Dla każdego smaku zaobserwowano zmianę barwy na ciemniejszą, przy czym największą różnicą parametrów barwy ($\Delta E$) wykazywał się mus o smaku jabłko-marchew-pigwowiec. Musy warzywno-owocowe wzbogacone preparatem błonnikowym ze skrobi ziemniaczanej charakteryzowały się wyższą całkowitą zawartością błonnika w porównaniu z musami niewzbogacanymi. Przetwory z dodatkiem błonnikowego preparatu odznaczały się niższymi parametrami kleikowania w porównaniu do musów kontrolnych. Na podstawie przeprowadzonych badań funkcjonalnych nie zaobserwowano, aby wzbogacanie musów warzywno-owocowych preparatem błonnikowym ze skrobi ziemniaczanej miało negatywny wpływ na produkt końcowy. Można zatem wnioskować, że zastosowanie błonnikowego preparatu ze skrobi ziemniaczanej wpływa na cechy funkcjonalne musów warzywno-owocowych, podnosząc ich wartość żywieniową oraz zdrowotną.

**Słowa kluczowe:** musy warzywno-owocowe, błonnik pokarmowy, wzbogacanie żywności, skrobia ziemniaczana