

## THE EFFECT OF FAT SUBSTITUTION WITH FIBER PREPARATIONS ON SELECTED QUALITY CHARACTERISTICS OF BAKED POULTRY PÂTÉS

Adam Zwolan<sup>✉</sup>, Andrzej Tyburcy, Aneta Cegiełka, Dorota Pietrzak  
Warsaw University of Life Sciences – SGGW

**Summary.** The aim of this study was to determine the effect of fat substitution with various fiber preparations on selected quality characteristics of baked poultry pâtés. Five variants of pâtés were produced: a control variant and four experimental variants, in which 33% or 66% of poultry fat was replaced by hydrated (in a ratio of 1:5) inulin or potato fiber. In ready products, cooking loss was determined, basic chemical composition was analyzed, color and texture parameters were measured, and sensory evaluation was performed. The substitution of fat with hydrated inulin and potato fiber in the recipe composition of pâté made it possible to produce pâtés with reduced fat content – on average by 20–34%. These pâtés were characterized by lower cooking loss, which is advantageous from both a technological and an economical point of view. In the sensory evaluation, pâtés containing added fiber scored comparable to the control variant, also for color, despite significant differences in instrumental measurements.

**Key words:** fat substitutes, inulin, potato fiber, pâté, quality

### INTRODUCTION

Consumers are increasingly interested in foods with healthy properties, especially low-fat products. Thereby, meat producers are looking for ways to satisfy their needs [Martin et al. 2008, Shekhuk 2012, Shan et al. 2017]. In accordance with Regulation (EC) 1924/2006, the category of fat-reduced meat products may include those in which the fat content is at least 30% lower than that in the traditional product. Removing fat from the recipe composition of meat products is difficult to achieve, as this ingredient is responsible for appropriate texture and gives flavor and juiciness to meat products [Cierach and Szaciło 2004, Florowski et al. 2008]. In the Polish market, meat products with reduced fat

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<sup>✉</sup>adam\_zwolan@sggw.pl

content, such as homogenized sausages, are already available which in terms of sensory characteristics do not differ significantly from their “full-fat” counterparts [Słowiński and Jankiewicz 2011].

Meat products that consumers are keen on include poultry pâtés [Delgado-Pando et al. 2011, Olszak et al. 2012], which according to the non-obligatory standard [PN-A-86528: 1996] belong to the group of gourmet food. Pâtés may be made from poultry meat, liver, and other pre-cooked meat and fat raw materials, which are then ground and mixed with other supplementary materials and spices. The resulting meat batter is placed into molds, and afterwards baked or scalded. An analysis of market products has shown that the quality of pâtés is very varied. This is due to both the type of raw materials and additives used in production, as well as the course of the heat treatment. Commercially available pâtés are characterized by high fat content, which ranges from 9% to almost 33% according to Makala and Tyszkiewicz [2011]. Therefore, especially in this type of product, it would be worthwhile to limit the fat content. In order to meet the expectations of consumers, good quality raw materials (excluding mechanically separated meat – MSM) and appropriate functional additives should be used, which not only has positive technological impact but can also enrich the product with selected health promoting ingredients [Cegiełka 2012].

Among the fat substitutes used in the meat industry, fiber preparations are an important group. They are characterized by desirable technological properties, including stabilization of the texture of ready product, reducing drip loss during heat treatment, vacuum packing, and cold storage. At the same time, they can have an advantageous effect on the human body by regulating the functions of the digestive system and binding and facilitating the excretion of harmful substances. Inulin also stimulates the growth of beneficial microflora of the colon and lowers the level of cholesterol in blood cholesterol [Makala 2003, Cegiełka 2012].

The aim of this study was to determine the effect of fat substitution with hydrated fiber preparations (inulin and potato fiber) on selected quality characteristics of baked poultry pâtés.

## MATERIALS AND METHODS

The research material, baked poultry pâtés, was produced in industrial conditions according to the recipe of the meat plant. The composition of the pâté was 41% poultry meat, 23% poultry skin, 12% poultry fat, 6% broth (meat, skins, and vegetables), 5% vegetables (carrots, parsley, celery), 4.5% egg mass, 2.5% pork liver, 1.2% salt, and 4.8% other components (bread crumbs, yeast extract, spices). In order to obtain products with reduced fat content, 33–66% of poultry fat was replaced by a hydrated ratio of 1:5 potato fiber (Potex Crown from Carlestam Company) or inulin (Orafti GR from Agnex Company). Three replications of the experiment were performed. Each time, cooked meat and vegetables were ground in a grinder with a mesh, 3 mm in diameter, and then minced with the remaining ingredients for 5 minutes at a blade speed of 1500 rpm. Meat, liver, hydrated inulin or potato fiber, poultry fat and poultry skins, vegetables, and other ingredients were placed in the same order in the bowl of the cutter. Aluminum molds with a capacity of 1 dm<sup>3</sup> were filled with batter. The products were baked at 145°C for about 45 min to

reach a temperature of 74°C in the geometric center of the meat block. Thereafter, the pâtés were blast cooled in an air-cooled chamber at (1–2)°C for 6 h. Two molds (each with a weight of about 0.5 kg) were used for further tests from each recipe composition, resulting in five variants: WK – control variant; I-33 – pâté, in which 33% of poultry fat was replaced with hydrated inulin; I-66 – pâté, in which 66% of poultry fat was replaced by hydrated inulin; B-33 – pâté, in which 33% of poultry fat was replaced with hydrated potato fiber; B-66 – pâté, in which 66% of poultry fat was replaced with hydrated potato fiber.

In pâtés, cooking loss was evaluated by the weight method. Chemical composition was determined using a FoodScan™ near-infrared spectrometer (Foss Analytical A/S, Denmark). Color parameters were measured in the CIE  $L^*a^*b^*$  system, using the Minolta CR-200 (Konica Minolta, Japan) colorimeter (light source D<sub>65</sub>, observer 2°, 8-mm gauge hole). Then, the absolute color difference was calculated between the pâté produced according to the recipe of control variant and pâtés produced with the addition of fiber preparations. For this purpose, the following equation was used:

$$\Delta E = \sqrt{(L^*_1 - L^*_2)^2 + (a^*_1 - a^*_2)^2 + (b^*_1 - b^*_2)^2}$$

where:  $\Delta E$  – absolute color difference,

$L^*_1, a^*_1, b^*_1$  – color parameters of pâté produced according to the recipe of the control variant,

$L^*_2, a^*_2, b^*_2$  – color parameters of pâtés produced with the addition of fiber preparations.

The criterion of the International Illumination Commission was used to develop the results of the color measurements. It classifies the absolute color differences ( $\Delta E$ ) corresponding to the human perception of colors. It was assumed that the absolute differences  $\Delta E$  in colors between 0 and 2 are unrecognizable, from 2 to 3.5 can be recognized by an inexperienced observer, while over 3.5 distinct color differences are commonly observed [Heidelberg-Anonymous 1999]. In pâtés, compression force was also measured using a Zwick 1140 device (Zwick GmbH & Co., Germany). For texture measurements, samples of pâtés were prepared in sizes of 20 × 30 × 40 mm. The samples were compressed to 50% of their original height. The maximum compression force that occurred during the test was recorded. The crosshead speed was  $3 \times 10^{-2} \text{ m} \cdot \text{min}^{-1}$  resulting in a preload of 0.5 N and  $5 \times 10^{-2} \text{ m} \cdot \text{min}^{-1}$  during the test. All instrumental measurements (color and texture) in each variant of the product were repeated five times, taking the mean value as the measurement result. The sensory evaluation of pâtés [Baryłko-Pikielna and Matuszewska 2009] was performed by twenty trained people. It took place in a room with a temperature of about 20°C, in daylight conditions. Prior to the evaluation, panelists were trained in the scope of the method used in sensory evaluation. During discussion optimal (i.e. the most desirable) quality characteristics of pâtés were determined. The following characteristics were evaluated: taste, aroma, juiciness, texture, color on cross-section, and overall quality, using a 5-point linear non-structured scale, where 1 point meant the lowest and 5 points the highest desirability level of a given feature.

## STATISTICAL METHODS

The results obtained were analyzed using the Statgraphics Centurion program using one-way analysis of variance and a detailed comparison of Tukey HSD mean scores (significant difference  $\alpha = 0.05$ ). Kruskal-Wallis test was used to examine the significance of differentiating variance between groups of results.

## RESULTS AND DISCUSSION

Replacing poultry fat with inulin and potato fiber had a significant ( $\alpha = 0.05$ ) effect on weight loss during thermal treatment of pâtés, on average from about 34% to 50% compared to the control variant (Figure 1). Keenan et al. [2014b] also found lower heat losses in finely minced meat products, in which a part of the recipe fat was replaced with inulin. Reducing the share of fat in meat products may, however, result in greater leakage during heat treatment and consequently lower yield of the ready product [Krzywdzińska-Bartkowiak et al. 2008]. Various functional additives are available in the market to reduce heat losses in meat products, for example phosphates, carrageenans, modified starches. Such activity is also presented by dietary fiber preparations, the usage of which is increasing in the meat industry due to the trend toward the use of natural components [Gwiazda et al. 2011]. In literary sources, however, it was found that replacement of 1/3, 2/3, and total fat content by 25% (w / w) inulin solution resulted in an increase in thermal loss in model meat preserves [Florowski and Adamczak 2010], comminuted sausages [Florowski et al. 2010], and baked pâtés with MSM [Florowski et al. 2008], especially with a higher degree of substitution. According to Dolata et al. [2002], addition of hydrated potato fiber increases the amount of thermal loss in model pork meat pâtés. The amount of leakage during heat treatment of meat products depends highly on the type of raw material used and the thermal parameters during heating, especially temperature, as confirmed by Miazek et al. [2017].

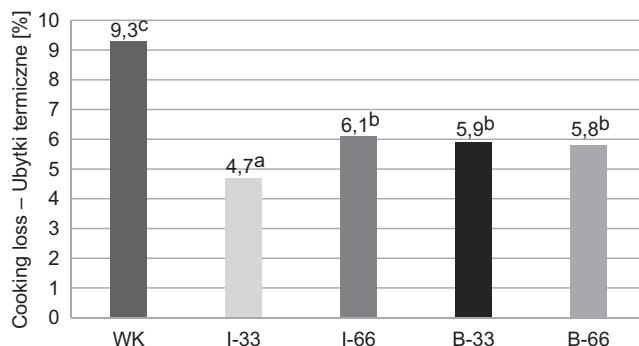


Fig. 1. The effect of inulin and potato fiber addition on cooking loss [%] of baked poultry pâtés

Rys. 1. Ubytki podczas obróbki cieplnej drobiowych pasztetów pieczonych [%]

a, b, c – means with different letters differ significantly ( $P \leq 0.05$ ).

a, b, c – wartości średnie oznaczone różnymi literami różnią się istotnie statystycznie ( $P \leq 0.05$ ).

As expected, pâtés in which a part of the poultry fat was substituted with inulin or potato fiber had a significantly ( $\alpha = 0.05$ ) lower amount of fat compared to the control product, in average about 20–34%. These pâtés also contained less protein and more water, which may be caused by differences in their recipe composition and lower mass losses during thermal treatment.

Table 1. Basic chemical composition [%] of baked poultry pâtés

Tabela 1. Podstawowy skład chemiczny [%] drobiowych pasztetów pieczonych

Content – Zawartość	WK	I-33	I-66	B-33	B-66
Fat – Tłuszcz	28.9 <sup>d</sup>	22.6 <sup>c</sup>	20.4 <sup>b</sup>	22.6 <sup>c</sup>	19.0 <sup>a</sup>
Protein – Białko	17.2 <sup>c</sup>	16.4 <sup>b</sup>	15.7 <sup>a</sup>	15.7 <sup>a</sup>	15.2 <sup>a</sup>
Water – Woda	52.5 <sup>a</sup>	59.3 <sup>b</sup>	62.0 <sup>bc</sup>	60.2 <sup>b</sup>	64.1 <sup>c</sup>
Salt – Sól	1.0 <sup>a</sup>	0.9 <sup>a</sup>	1.1 <sup>a</sup>	1.0 <sup>a</sup>	1.1 <sup>a</sup>

a, b, c, d – means on the same row with different letters differ significantly ( $P \leq 0.05$ ).

a, b, c – wartości średnie w rzędach oznaczone różnymi literami różnią się istotnie statystycznie ( $P \leq 0.05$ ).

Similar relations as in the present study have been shown for fat substitution with potato fiber, wheat fiber, or inulin in standard meat preserves [Makała 2003] and baked pâtés with added MSM [Florowski et al. 2008]. Keenan et al. [2014b] also observed a tendency to increase the water content in the comminuted meat products while increasing the degree of substitution of fat with inulin. All the tested pâtés were characterized by low salt content, which is beneficial from a nutritional point of view. Excessive consumption of sodium can increase blood pressure and cause vascular changes in the heart [Strazzullo et al. 2012].

Pâtés in which some fat was replaced by fiber preparations were characterized by a lighter color compared to the control product (Table 2), as evidenced by the higher value of  $L^*$  parameter ( $\alpha = 0.05$ ). The color differences between the control product and pâtés with fiber preparations were visible even to an unexperienced observer ( $\Delta E > 2$ ).

Table 2. Color and texture parameters of baked poultry pâtés

Tabela 2. Parametry barwy i tekstury pasztetów pieczonych

Color parameters and texture Parametry barwy i tekstury	WK	I-33	I-66	B-33	B-66
$L^*$	62.59 <sup>a</sup>	64.29 <sup>b</sup>	66.66 <sup>b</sup>	65.98 <sup>c</sup>	65.60 <sup>c</sup>
$a^*$	3.92 <sup>a</sup>	4.70 <sup>b</sup>	4.42 <sup>a</sup>	3.68 <sup>a</sup>	3.85 <sup>a</sup>
$b^*$	14.09 <sup>a</sup>	15.65 <sup>b</sup>	16.11 <sup>b</sup>	15.56 <sup>b</sup>	16.19 <sup>b</sup>
$\Delta E$	–	2.4	4.6	3.7	3.7
Compression force Siła ściskania [N]	37.6 <sup>a</sup>	35.0 <sup>a</sup>	32.7 <sup>a</sup>	35.9 <sup>a</sup>	41.9 <sup>a</sup>

a, b, c – means on the same row with different letters differ significantly ( $P \leq 0.05$ ).

a, b, c – wartości średnie w rzędach oznaczone różnymi literami różnią się istotnie statystycznie ( $P \leq 0.05$ ).

Other authors have shown that the influence of fiber preparations on the color of meat products is not unequivocal. According to Florowski et al. [2008], the addition of inulin did not significantly differentiate the color of baked pâtés with MSM added. But, the authors noted a tendency to slightly decrease the  $L^*$  color value along with reducing the fat content in the ready product. There was also no significant effect of 1/3, 2/3, and whole fat replacement by 25% inulin gel on the color of comminuted sausages [Florowski et al. 2010]. On the contrary, Jimenez-Colmenero et al. [2010] found that replacing a portion of fat with konjac flour resulted in a lighter color of comminuted sausages.

Modification of the recipe composition applied in the production of low-fat products may affect their rheological properties. But, no significant ( $\alpha = 0.05$ ) influence of substitution of fatty raw material with inulin and potato fiber on the texture of baked poultry pâtés was found in the present study (Tab. 2).

Fiber preparations usually have a beneficial effect on texture, emulsion formation, and water binding in comminuted meat products [Krzywdzińska-Bartkowiak et al. 2008]. Sometimes, however, they may increase hardness of the ready products, as shown by the research of Keenan et al. [2014a] and Schmiele et al. [2015]. In meat products that contain fiber preparations used as a fat substitute, an improvement in the texture is not always accomplished. According to Troeger et al. [2005], scalded sausages, in which a part of the fat was substituted with inulin gel, were described as ones with softer consistency than the control product. Such texture deterioration could have been caused by a higher amount of water added to the batter in the form of the inulin gel. The tendency to weaken the structure as a result of replacing animal fat with inulin was also observed by other authors in model comminuted sausages [Florowski et al. 2010] and meat preserves [Makała 2003, Florowski and Adamczak 2010]. Dolata et al. [2002] have also shown that the use of potato fiber as a fat substitute adversely affected the rheological properties of batter and model pork meat preserves.

Replacement of fat with hydrated fiber preparations did not significantly influence ( $\alpha = 0.05$ ) the sensory characteristics of baked pâtés (Tab. 3). The quality of all the pâté variants was accepted by the evaluation panel. Referring to the obtained results, both inulin and potato fiber can be successfully used as fat replacers in the manufacture of

Table 3. Results of sensory evaluation [points] of baked pâtés

Tabela 3. Wyniki oceny sensorycznej [punkty] pasztetów pieczonych

Attributes – Wyróżniki jakości	WK	I-33	I-66	B-33	B-66
Taste – Smak	3.8 <sup>a</sup>	4.2 <sup>a</sup>	3.8 <sup>a</sup>	3.8 <sup>a</sup>	3.7 <sup>a</sup>
Aroma – Zapach	4.4 <sup>a</sup>	4.5 <sup>a</sup>	3.9 <sup>a</sup>	4.2 <sup>a</sup>	4.2 <sup>a</sup>
Juiciness – Soczystość	4.3 <sup>a</sup>	4.4 <sup>a</sup>	4.2 <sup>a</sup>	4.1 <sup>a</sup>	4.3 <sup>a</sup>
Hardness – Twardość	4.2 <sup>a</sup>	4.1 <sup>a</sup>	4.4 <sup>a</sup>	4.2 <sup>a</sup>	4.1 <sup>a</sup>
Color – Barwa	4.2 <sup>a</sup>	4.2 <sup>a</sup>	4.6 <sup>a</sup>	4.2 <sup>a</sup>	4.0 <sup>a</sup>
Overall desirability – Ogólna pożądalność	4.0 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>	4.0 <sup>a</sup>	3.8 <sup>a</sup>

<sup>a</sup> – means on the same row with the same letter do not differ significantly ( $P > 0.05$ ).

<sup>a</sup> – wartości średnie w rzędach oznaczone tą samą liter nie różnią się istotnie statystycznie ( $P \leq 0.05$ ).

such products. Relatively high scores obtained in the evaluation conducted by the trained sensory panel allows to assume that these products will also be accepted by consumers.

In the literature, both the reduction of the fat content in the recipe composition of meat products and the use of various additives may affect the color, palatability, and consistency of the ready product. According to Keenan et al. [2014a], along with the increase for inulin (used as fat substitute), the sausages scored lower in the sensory evaluation. The authors found that for consumers the most important selection criterion was the appearance of the ready product, and especially color, rather than its health value. Florowski et al. [2008] demonstrated a significant reduction in the scores observed for the overall desirability of baked pâtés with MSM addition, in which 2/3 yowl was replaced using inulin solution. This was caused by the watery structure and a deterioration in the bound of pâtés blocks. The undesirable effect of inulin gel usage as a fat substitute in meat products includes the brighter color and a decrease in the intensity of odor and taste [Florowski et al. 2008].

## CONCLUSIONS

1. Baked poultry pâtés, in which a part of the fat was replaced by hydrated fiber preparations, were characterized by lower thermal loss during heat treatment than the control product, regardless of the type of preparation. It is very important not only due to the good quality of the ready product but also from the economic point of view.
2. The use of inulin and potato fiber made it possible to produce pâtés with reduced fat content (from 20% to 34%), without significant deterioration in their quality. Only the color of these pâtés was brighter, but that did not influence their scores in sensory evaluation.

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## WPŁYW WYMIANY TŁUSZCZU PREPARATAMI BŁONNIKOWYMI NA WYBRANE WYRÓZNIKI JAKOŚCI PIECZONYCH PASZTETÓW DROBIOWYCH

**Streszczenie.** Konsumenci wykazują coraz większe zainteresowanie żywnością o właściwościach prozdrowotnych, w tym szczególnie produktami o niskiej zawartości tłuszczu. Obniżenie zawartości tłuszczu w przetworach mięsnych jest trudnym przedsięwzięciem, ponieważ składnik ten kształtuje ich teksturę oraz nadaje smakowitość i soczystość. Chcąc wytworzyć produkt dobrej jakości, konieczne jest zastosowanie dodatku odpowiednich substancji funkcjonalnych, np. preparatów błonnikowych, które oprócz pozytywnego oddziaływania technologicznego, mogą w korzystny sposób oddziaływać na organizm człowieka. Celem pracy było określenie wpływu stopnia wymiany tłuszczu preparatami błonnikowymi na wybrane wyróżniki jakości pieczonych pasztetów drobiowych. Wykonano trzy serie badań w warunkach przemysłowych, każdorazowo wytwarzając pięć wariantów pasztetów zgodnie z recepturą zakładu mięsnego (wariant kontrolny i cztery warianty doświadczalne, w których odpowiednio 33% lub 66% surowca tłuszczowego zastąpiono uwodnionymi w stosunku 1:5 preparatami inuliny lub błonnika ziemniaczanego). W pasztetach oznaczano ubytki masy podczas obróbki cieplnej metodą wagową, skład chemiczny metodą pomiaru absorbancji promieniowania NIR przy zastosowaniu aparatu FoodScan firmy FOSS, dokonano pomiaru parametrów barwy w systemie CIE  $L^*a^*b^*$  przy użyciu kolorymetru Minolta CR-200 oraz siły ściskania przy użyciu aparatu ZWICKI 1140, a także przeprowadzono ocenę sensoryczną, w której uwzględniono następujące wyróżniki: smak, zapach, soczystość, teksturę, barwę na przekroju i ogólną pożądalność. Stwierdzono, iż zastąpienie w recepturze 33% lub 66% surowca tłuszczowego uwodnionymi preparatami inuliny i błonnika ziemniaczanego umożliwiło wytworzenie pieczonych pasztetów drobiowych o obniżonej zawartości tłuszczu (od 20% do 34%), bez pogorszenia ich jakości. Nie wykazano istotnego ( $\alpha = 0,05$ ) wpływu wymiany tłuszczu preparatami błonnikowymi na teksturę oraz wyniki oceny sensorycznej pasztetów. Zgodnie z oczekiwaniami zawierały one mniej białka oraz więcej wody, co wynikało zarówno z różnic w składzie recepturowym pasztetów, jak i mniejszych ubytków podczas obróbki cieplnej. Barwa pasztetów z dodatkiem inuliny i błonnika ziemniaczanego była jaśniejsza w porównaniu z wyrobem kontrolnym, o czym świadczą istotnie ( $\alpha = 0,05$ ) wyższe wartości parametru barwy  $L^*$  ( $\alpha = 0,05$ ). Nie wpłynęło to jednak na obniżenie not za ten wyróżnik w ocenie sensorycznej. Ponadto wykazano, iż pasztety, w których część surowca tłuszczowego zastąpiono preparatami błonnikowymi charakteryzowały mniejsze ubytki podczas obróbki cieplnej niż wyrób kontrolny, niezależnie od rodzaju i wielkości dodatku, co jest bardzo ważne nie tylko ze względu na cechy jakościowe gotowego produktu, ale także z ekonomicznego punktu widzenia.

**Słowa kluczowe:** zamienniki tłuszczu, inulina, błonnik ziemniaczany, paszтет, jakość