

EWA FLACZYK, DANUTA GÓRECKA, JOANNA KOBUS,
KRYSTYNA SZYMANDERA-BUSZKA

THE INFLUENCE OF INULIN ADDITION AS FAT SUBSTITUTE ON REDUCING ENERGY VALUE AND CONSUMER ACCEPTANCE OF MODEL PORK MEATBALLS

Summary

The aim of the study was to examine the effect of inulin gel, used as a fat substitute, on energy value and consumer acceptance of model meatballs fresh and cold-stored.

The experimental material consisted of pork meatballs with two inulin levels. Replacement of part pork fat with inulin resulted in reducing level of fat and calorie contents. Moreover, after 14 day of cold storage of meatballs, consumer acceptance of these products with a 25% replacement of pork back fat by inulin was higher in comparison with the control sample. During 14 day of cold storage of such pork meatballs the delay of adverse sensory attributes were observed.

Key words: inulin, substitution of fat, meatballs, consumer acceptance

Introduction

Rapid development of the food market, increased consumer awareness concerning nutrition, and interest in maintaining good health have contributed to the development of food of special nutritional requirements. Products of this type are also referred to as functional food. Such food is ascribed the role supporting the human organism in the maintenance of good health, as well as prevention and treatment of some diseases. At present one of the most common nutritional mistakes is the consumption of excessive amount of calories coming mainly from animal origin fats. In relation with the fact that consumers are increasingly interested in food of reduced energy value, food producers constantly strive to supply products with probiotic value, and appropriate sensory attributes. Major elements affecting food acceptance by consumers are its consistency and juiciness, especially significant in case of products with a reduced fat content. Inu-

*Dr hab. E. Flaczyk, mgr inż. D. Górecka, mgr inż. J. Kobus, dr inż. K. Szymandera-Buszka,
Katedra Technologii Żywności Człowieka, Uniwersytet Przyrodniczy, ul. Wojska Polskiego 31,
60-624 Poznań*

lin is a substance meeting the requirements of both producers and consumers, because reduced energy value and has an advantageous effect on product texture [1-5].

Inulin is an oligosaccharide belonging to the group of fructanes, constituting storage material in plants. In inulin molecule fructose are combined with β -2-1 glycoside bonds. At the end of inulin chain there is a glucose molecule exhibiting reducing capacity. The inulin molecule consists of 20 – 50 fructopiranosose molecules with β -2-1 glycoside bonds [1, 4]. The human organism is not equipped with enzymes capable of degrading these bonds, thus inulin passes unchanged to the large intestine, in which it becomes a substrate for the beneficial flora of *Bifidobacterium bifidum* [1, 3, 4, 6]. Almost all inulin undergoes fermentation by colon microflora. As it is not hydrolyzed by human digestive enzymes, it is included into soluble dietary fibre. In nature inulin is found in numerous fruits and vegetables, primarily chicory, Jerusalem artichoke, artichoke, asparagus, and garlic, in which its content varied from 10 to 22% [1, 6].

The bifidogenic effect and the potential to reduce energy value of food are the main reasons for the growing interest in inulin [2, 5, 7, 9]. At present inulin is applied as an additive in the production of bread spreads with reduced calorie contents. It was also used as a fat replacement in meat products [7, 10, 12]. Thus the aim of the study was to assess the effect of the addition of inulin as a fat substitute in pork meatballs on their chemical composition, energy value and consumer acceptance in model experiments.

Material and methods

Experiments were conducted using a commercial preparation of inulin (Raftiline® HPX by Orafiti, Belgium), which from chicory (*Cichorium endivio*) are derived. Inulin in the form of rehydrated powder (4:1) was applied as a fat substitute at 10% (variant B - what gives 25% pork back fat replacement) and 20% (variant C - 50% pork back fat replacement). Control meatballs were produced with no inulin (variant A). Pork shoulder meat and pork back fat were purchased at a local market in Poznan, and next were ground twice in a grinder (mesh size of 10 and 5mm). Meatballs were prepared by mixing ingredients (table 1), forming 70g portions and steam-cooking in a Combi-Dampfer convection oven (Rational) at 100°C for 15 min. Meatballs after cooling were packed in vacuum polyamide/polyethylene (PA/PE 75 μ m) bags and stored for 14 days at +4°C. Samples were analyzed in terms of their basic chemical composition [11]. Consumer acceptance (by a panel of 30 assessors), were performed at the same intervals, after being heated meatballs to 50°C, in a microwave oven. The analysis was conducted by using an unstructured scale with anchoring points of undesirable (0 points) and desirable (10 points). The assessment consisted such traits as color at cross-section, consistency, juiciness, odor, taste and overall desirability.

Table 1

The recipe of meatballs (%)
Receptura pulpetów (%)

Ingredients	Variant		
	0% [A]	10% [B]	20% [C]
Pork shoulder	44.0	44.0	44.0
Pork back fat	40.0	30.0	20.0
Eggs	8.0	8.0	8.0
Breadcrumbs	5.0	5.0	5.0
Onion	2.0	2.0	2.0
Inulin	0.0	2.5	5.0
Water	0.0	7.5	15.0
Salt	1.0	1.0	1.0
Total	100.0	100.0	100.0

Energy value was calculated, based on assayed contents of fat, protein and water. It was assumed that 1g protein and 1g carbohydrates correspond to 4 kcal, 1g fat to 9 kcal and 1g inulin to 1.5 kcal, respectively.

Testing results constituting a mean of three replications performed in two series were subjected to statistical analysis using Statistica 7 software. Significance of differences at the level of 95% between values of testing results was determined based on a one-way analysis of variance.

Results and discussion

Results of assayed chemical composition of meatballs after production and their energy value are presented in table 2. Water content was typical for this type of products (51.5 – 56.2%). Analyses showed that assessed products, depending on the variant, differed in water content; however, only in sample C the differences were statistically significant ($p < 0.05$).

Protein content in the control (variant A) was highest, amounting to approx. 15%. The introduction of inulin as a pork fat substitute was connected with a decrease in protein content in meatballs. Analyzed meat products had varied fat contents, resulting from the application of inulin as a fat substitute. At a 25% pork back fat replacement, fat content was reduced by 21.5%, while in the sample, in which 50% pork back fat was replaced, fat content was reduced by 43.1%. This was also connected with a considerable decrease of energy value of the product - by 13% recorded for sample B and by 34% for sample C. No significant differences in contents of analyzed chemical components were found in samples after a 14-day cold storage of meatballs in PA/PE bags.

Table 2

Chemical composition and caloric value of meatballs
Skład chemiczny i wartość energetyczna pulpe

Variant Wariant	Water Woda [%]	Fat Tłuszcz [%]		Protein Białko [%]	Ash Popiół [%]	Caloric value Wartość energetyczna	
		Content Zawartość	Reduction Redukcja			Content Zawartość [Kcal]	Reduction Redukcja [%]
A	51.52 ^a ±0.89	37.02 ^a ±0.30	0.00	14.98 ^a ±0.46	1.90 ^a ±0.04	279.18 ^a ±1.26	0.00
B	51.78 ^a ±0.59	24.35 ^b ±0.24	21.50	14.14 ^{ab} ±0.41	1.72 ^{ab} ±0.07	219.15 ^b ±2.25	13.00
C	56.19 ^b ±0.38	17.64 ^c ±0.21	43.10	13.18 ^b ±0.69	1.59 ^b ±0.08	158.76 ^c ±0.98	34.30

Averages followed by different letter within the same column correspond to the type of test and are significantly different at $p < 0.05$

Wartości średnie oznaczone różnymi literami w kolumnach różnią się istotnie $p < 0,05$.

Results of consumer acceptance are presented on fig. 1.

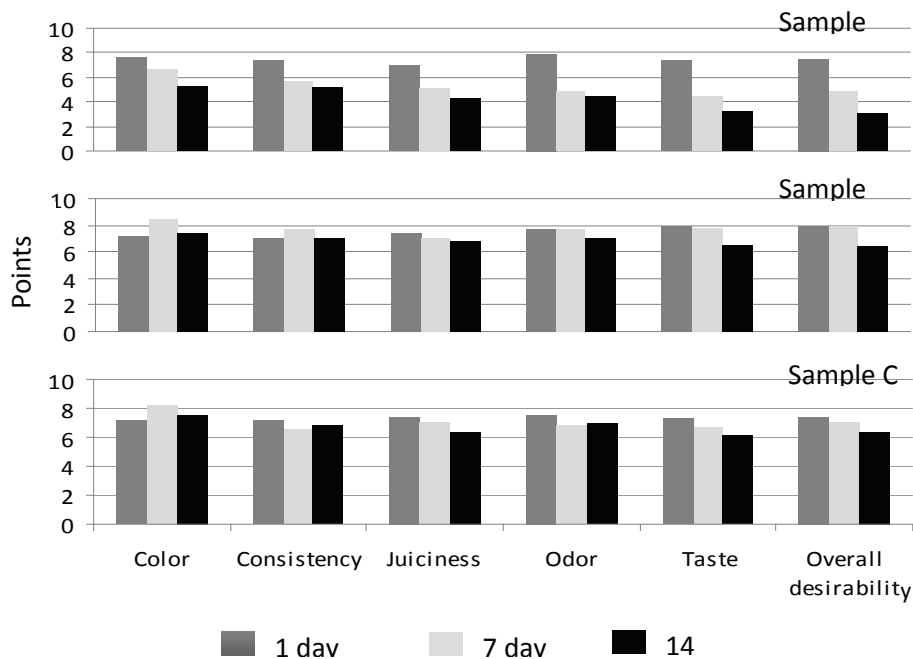


Fig. 1. Consumer acceptance of model meatballs fresh and after 7 and 14 days of cold storage
Rys. 1 Akceptacja konsumencka modelowych pulpetów świeżych po 7 i 14 dniach od zamrożenia

No significant differences in overall desirability of all meat products were found on the 1st day of analyses. It is very serious, because the replacement of pork back fat is on

a very high level. This means that such big replacement of pork back fat doesn't influenced on overall desirability. Also analyzed sensory attributes, i.e. color, consistency, juiciness as well as aroma and taste did not differ significantly in comparison to the control (variant A). It needs to be stressed that in terms of juiciness and taste samples of variant B received even higher scores. After 7- and 14-day cold storage, meatballs with inulin received higher scores for overall desirability than the control meatballs, with the simultaneous high notes for juiciness and adequate consistency.

Inulin is usually added to processed foodstuffs in the form of 20-25% water solutions, thus water content typically increased with an increase of inulin concentration in the product. This trend was also observed in this study. The experiments results confirm a study presented by Makala [12], conducted on a model canned meat product. The introduction of inulin as a substitute of fat in the level of 5% (dry matter), applied by the cited author, resulted in a lowering of fat content by 15.3%, and a decreasing of protein content. Applying the inulin to the meatballs on the level 2-10% gives similar results [10]. The using of inulin in a processed food product not only effectively reduces the level of fat and energy value, but it also improves consistency and affects juiciness. For this reason inulin may be added to meat products, confectionary and desserts, as well as yoghurts, in which it positively modifies rheological attributes [1]. The addition of inulin to low-fat bread spreads, light drinks and chocolate modified their structure. In cakes, especially low-fat cakes, inulin improved such desirable attributes as softness and tenderness [7-8]. Pagliarini and Beatrice [13] showed that inulin improved sensory attributes of low-fat mozzarella.

Results obtained in this study indicate a positive effect of inulin gel on the quality of meatballs, which results from their consumer acceptance. This is crucial in view of the large-scale commercial production of ready-to-eat and convenience food. Meatballs with added inulin gel, as a meat product with reduced calorie content, are likely to become a popular product.

Conclusions

1. Meatballs with inulin added as a fat substitute differed in their basic chemical composition in comparison to that of the control. The replacement of 25 and 50% pork back fat by inulin gel resulted in a reduction of fat content by approx. 21 and 43%, and energy value by 13 and 34%, respectively.
2. Overall desirability of meatballs immediately after production reflected in consumer traits was similar. Assessment results for the sample with 10% added inulin gel were even slightly higher, which was connected with higher scores for juiciness, aroma and taste. The introduction of inulin to meatballs inhibited the adverse effect of storage time on their sensory attributes.

Literature

- [1] Silva R.F.: Use of inulin as a natural texture modifier. *Cereal Foods World*, 1996, 41(10), 792-794.
- [2] Niness K.: Breakfast foods and the health benefits of inulin and oligofructose. *Cereal Foods World*, 1999, 44(2), 79-81.
- [3] Chrapkowska K., Górecka D.: Assessment of the inulin preparation usefulness to confectionery - the model research. *Food Sci. Technol.*, 2000, 4, 55-62.
- [4] Cieślak E., Filipiak-Florkiewicz A.: Topinambur (*Helianthus tuberosus* L) - możliwości wykorzystania do produkcji żywności funkcjonalnej. *Żywność. Nauka. Technologia. Jakość*, 2000, 1, 73-81.
- [5] Filipiak-Florkiewicz A., Cieślak E.: Poziom fruktanów w chlebie mieszanym. *Żywność. Nauka. Technologia. Jakość*, 2001, Supl. (3), 119-123.
- [6] Górecka D., Butka A., Korczak J.: Wpływ dodatku inuliny na jakość pieczywa cukierniczego. *Żywność. Nauka. Technologia. Jakość*, 2001, Supl. (3), 125-133.
- [7] Mendoza E. Garcia M.L. Casas C. Selgas M.D.: Inulin as fat substitute in low fat, dry fermented sausages. *Meat Sci.*, 2001, 57, 387-393.
- [8] Roberfroid M.B.: Functional foods: concepts and application to inulin and oligofructose. *Brit. J. Nutr.*, 2002, 87, Sup.(2), 139-143.
- [9] Florowska A., Krygier K.: Inulina jako zamiennik tłuszczu w produktach spożywczych. *Przem. Spoż.*, 2007, 5, 18-21.
- [10] Górecka D., Korczak J., Flaczyk E., Gryśka A.: Próba zastosowania inuliny do potraw mięsnych. *Bromat. Chem. Toksykol.*, 2004, 37, Supl (4), 169-175.
- [11] AOAC. Official Methods of Analysis. Association of Official Analytical Chemists. Washington. DC. 1990.
- [12] Makala H.: Effect of potato and wheat cellulose and inulin preparations on physicochemical characteristics and rheological properties of model meat preserves. *Food*, 2003, 10, 3(36), 21-31.
- [13] Pagliarini E. Beatrice N.: Sensory and rheological properties of low-fat filled „pasta filata” cheese. *J. Dairy Res.*, 1994, 61, 299-301.

WPLYW DODATKU INULINY JAKO ZAMIENNIKA TŁUSZCZU NA WARTOŚĆ ENERGETYCZNĄ I AKCEPTACJĘ KONSUMENCKĄ MODELOWYCH KLOPSÓW WIEPRZOWYCH

Streszczenie

Określono wpływ inuliny stosowanej jako zamiennik tłuszczu w pulpetach mięsnych na zawartość podstawowych składników chemicznych, ich wartość kaloryczną oraz akceptację konsumencką. Wykazano, że zastąpienie boczku wieprzowego inuliną w pulpetach mięsnych spowodowało obniżenie w nich zawartości tłuszczu i kaloryczności. Pulpety, w których zastąpiono boczec uwodnioną inuliną na poziomie 25 % cechowały się wyższą akceptacją konsumencką w porównaniu z próbą kontrolną w czasie 14 dni chłodniczego przechowywania pulpetów.

Słowa kluczowe: inulina, zawartość tłuszczu, pulpety, akceptacja konsumentów ☒