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ROLE OF INULIN IN SHAPING THE QUALITY OF MEAT PRODUCTS

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Abstract. The effect of the substitution of pork fat with inulin and rape-seed oil added to batter on selected quality parameters of preserved meat products was studied. The chemical composition of the meat preserve was examined, the texture profile was characterized by instrumental and sensory methods and the sensory desirability of the products was evaluated. According to expectations, the fat content and energy values of the preserved meat products evaluated was significantly lower compared to the control variant. The inulin and vegetable oil introduced in place of the animal fat have generated a delicate structure as reflected in the characteristics of the texture, lower springiness, hardness 1 and chewiness, determined by instrumental methods and its lower consistency, springiness, hardness and lower impression of fatness as determined by the sensory methods. Inulin and vegetable oil, as added to the product instead of animal fat, "imitated" well the sensory impression of fat and the creamy taste as reflected in the taste desirability, similar to that of the control product. The cellulose preparation examined may be used as an animal fat substitute in meat products.

Keywords: inulin, fat substitute, meat product, texture profile, sensory quality

INTRODUCTION

Oligosaccharides have found a wider and wider application in food production. The basic favourable physiological consequences of the effect of oligosaccharides include low calorific value, stimulation of bifidobacterial growth in the intestine and a dietetic effect similar to that of cellulose. Oligosaccharides enable also the appropriate consistency and organoleptic properties of food to be obtained and they should be used in the manufacture of the greatest number of food products possible [21].

Oligosaccharides include inulin, which is present naturally in plants as a reserve material. It appears in many fruits and vegetables and it is obtained, on an industrial scale from root chicory. Inulin is used mainly as a filling and as a fat

substitute. It is commonly employed in the confectionery industry and in the manufacture of products with a low energy value. It is applied as an addition in products such as yogurt and others milk drinks, cheese, dessert milk, ice-creams margarine and chocolate. It is also used in high-cellulose products, supporting slimming diets. Inulin improves consistency and gives the impression of creaminess and the flavour of fat (informational materials of the Hotrimex Company). It is simultaneously a texture-forming substance. It is recommended as a sugar and fat substitute in the fat and meat industry in dietetic foods [8,21,22].

Apart from the favourable correction of the nutritive value of meat products, the addition of vegetable oils to these products may also act as a functional additive. The effects obtained are dependent, among other things, on the type of oil, the degree of its exchange in relation to the animal fat and the parameters of the technological processes. One important function of poly-unsaturated fatty acids (PUFA) in food is verified in favour of mono-unsaturated fatty acids (MUFA), more especially of oleic acid. A low-erucic rapeseed oil is a good source of oleic acid [7,9].

The aim of the work was to evaluate the effect of inulin, used as a pork fat substitute in model preserved meat products on the selected quality parameters.

MATERIAL AND METHODS

The studies were conducted on a model, finely ground preserved meat product. Instead of pork fat, inulin (5% and 10%) or inulin (5% and 10%) and refined rapeseed oil (10%), were introduced. Before introducing it to the batter, the preparation was hydrated, with the preservation of the preparation: water ratio equal to 1:3.5. The control sample contained exclusively pork fat from the foreshank muscles (variant K). The presentation of the raw materials used in the experiment and design of variants are given in table 1.

In the studies, the inulin preparation Frutafit HD from Sensus was used. The application of inulin in model meat products was aimed at lowering the fat level, using the preparation as a fat substitute as well as for enriching the meat product as a health-promoting substance, such as cellulose. In addition to inulin, 10-% of rapeseed oil was introduced instead of pork fat. The application of rapeseed oil instead of pork fat was aimed at improving the profile of fatty acids, and especially the enrichment of the product in oleic acid.

The raw materials used in the manufacture of model batter, at a temperature of 0-2°C, were processed in a grinder through a plate with 3 mm holes and then

chopped, and placed into the grinder along with the meat, ice, cellulose preparation, fat, refined rape oil and curing mixture. The duration of the chopping process was about 10 minutes. The final temperature of the batter, obtained in the process did not exceed 12°C. The batter was prepared in a Seydelmann, type 40 Ras, grinder with 6 knives and a capacity of 0.04 m^3. The technical parameters of the grinder were as follows: rotations of the grinder's vessel – 30 min^{-1}, rotations of knife shaft – 3600 min^{-1}, standard knives, EE type with slide coefficient λ = 1.5. The batter was filled in the cans of 400 g capacity and pasteurised in water bath at 75°C till the temperature in the can geometric centre reached 72°C; it lasted about 90 min. Then, the cans were cooled down with a running cold water. Cans were stored at temperature of 4-6°C in a refrigeration room until analysed.

Table 1. Scheme and denotation of the experimental variants

Components (%)	Variants				
	K	I-5	I-10	I-5-o	I-10-o
Pork meat from foreshank muscles	30	30	30	30	30
Beef meat	40	40	40	40	40
Pieces of fat tissue from hams	30	25	20	15	10
Inulin	–	5	10	5	10
Rapeseed oil	–	–	–	10	10
Water	40	40	40	40	40

In the block of preserved meat the following determinations were carried out: water content by the dryer method according to [13]; total protein content by the Kjeldahl method using a 1026 Kjeltec Analyser according to [16]; fat content by the Soxhlet method using an HT-6 Soxtec Fat Analyser according to [14]; the sodium chloride content according to [15] and the carbohydrate content according to [17]. Also, the energy value of the product, expressed in kJ/100g, was calculated.

The texture profile was characterised by instruments and the sensory method. Hardness 1 and hardness 2, springiness, gumminess, chewiness and cohesiveness were determined by the instrumental method TPA [4]. The parameters of the test were: deformation – 20% (hardness 1), deformation – 80% (hardness 2), rate of the test – 60 mm min^{-1}, thickness of the sample – 20 mm and diameter – 25.4 mm.

The sensory characteristics of the texture was determined by the scale method [18,19]. The texture profile was characterised using such determinants as hardness,

springiness and an impression of humidity, impression of fatness and an evaluation of the product's consistency. The intensity of the determinants was marked on a 10-centimetre graphic scale, with the respective extreme definitions:

- hardness: soft (low level) → hard (high level),
- springiness: plastic (lack of springiness) → elastic (low level),
- impression of humidity: dry (lack of humidity) → humid (high level),
- impression of fatness: little fat (low level) → fat (high level),
- consistency of the product: non-homogenous (low level) → homogenous (high level).

Also, the palatability, consistency and general desirability of the product was determined in hedonic categories. One cm on the graphical scale corresponded to one score of intensity of the determinant evaluated. The results were expressed in agreed units (a.u.). A team, consisting of 8 judges, trained at the Sensory Laboratory of the Research Institute for Meat and Fats conducted the evaluation which met the requirements of standard ISO 8589 [20] and used the ANALSENS computer-operated system.

The results obtained were subjected to variance analysis and regression analysis, using the 'Statgraphics for Windows' statistical package ver. 3.1.

DISCUSSION OF THE RESULTS

The mean values of the discriminating factors studied, characterising the basic chemical composition of the product and the calculated energy value of model preserved meat products, is given in table 2. As a consequence of the substitution of pork fat with inulin, the fat content, having been analytically determined, decreased according to expectations: from 26.2% in the control product to 21.2-22.2% in the products, containing the inulin preparation. The energy value of the meat preserve containing inulin was lower, decreasing by 14-17.8% in comparison to the control product. In the preserved products containing inulin, an increased water content was found: from 61.9% in the control product to 64.9-66.1% in the tested products. This rise was related to the hydration of inulin. Similar tendencies were observed during the application of other fat substitutes or with the addition of different levels of technological water to finely comminuted meat products which were presented, among other things, in the studies conducted, inter alia, by Makała and Olkiewicz [10], Dolata et al. [5,6] and Makała [11,12].

The characteristics of the texture parameters of the model meat preserves, as determined using instruments, are given in table 3. The inulin preparation employed which replaces part of the fat as well as the addition of vegetable oil instead of animal fat, did not have any significant effect on cohesiveness, hardness 2 or the gumminess of the products. The highest springiness and chewiness was found in the control variant while inulin and vegetable oil had a significant influence on their attenuation. The higher level of the replacement of the formulation of pork fat with the inulin preparation as well as the addition of vegetable oil caused a decrease in the springiness and chewiness of the meat preserve. The changes observed resulted from the weaker, more delicate structure produced in the experimental variants studied, containing inulin and vegetable oil.

Table 2. Chemical composition in the loaf of the preserved meat

Factor	Variants				
	K	I-5	I-10	I-5-o	I-10-o
Water content (%)	61.9^{a}	64.9^{ab}	66.1^{b}	65.1^{ab}	65.9^{ab}
Protein content (%)	10.0^{b}	9.2^{ab}	8.9^{a}	9.4^{ab}	9.1^{ab}
Fat content (%)	26.2^{b}	22.2^{a}	21.2^{a}	22.1^{a}	22.1^{a}
Carbohydrate (%)	0.46	0.89	1.03	0.75	0.84
Sodium chloride content (%)	1.57^{a}	1.84^{c}	1.76^{b}	1.82^{c}	1.73^{b}
Calorie content (kJ $(100g)^{-1}$)	1170.4^{b}	1005.3^{a}	961.8^{a}	1001.5^{a}	996.9^{a}

$^{a, b, c}$ – means in the same column marked with various letters differ significantly ($\alpha \leq 0.05$).

Table 3. Mean values of the measurement of texture using instruments

Factor	Variants				
	K	I-5	I-10	I-5-o	I-10-o
Springiness (mm)	4.28^{c}	3.41^{b}	2.86^{ab}	3.24^{ab}	2.46^{a}
Cohesiveness	0.13	0.13	0.13	0.13	0.14
Hardness 1 (N)	66.9^{ab}	67.9^{ab}	65.8^{a}	71.9^{ab}	72.7^{b}
Hardness 2 (N)	50.4	51.8	51.1	54.1	54.6
Gumminess (N)	8.93	8.61	8.63	9.29	9.65
Chewiness (N mm)	38.46^{b}	30.63^{ab}	24.70^{a}	30.19^{ab}	24.37^{a}

$^{a, b, c}$ – means in the same rows marked with various letters differ significantly ($\alpha \leq 0.05$).

Values for texture discriminating factors, being organoleptically evaluated are given in table 4. The presence of inulin as well as inulin and vegetable oil had a significant influence on the weakening of consistency, springiness, hardness of

the product and impression of fatness. A higher level of animal fat substitute enhanced the tendencies observed. An exception was the preserve in variant I-5-o, which was characterised by the highest sensory feeling of fatness. This feeling did not differ significantly from the impression of fatness which characterised the control variant. In the experiment conducted, tendencies to lower the sensory impression of humidity and increase the use of fat substitute and vegetable oil, were observed in spite of the analytically stated higher water content in these variants. This may be evidence of the very good functional properties of the substitute used and of the favourable functional role of the oil in affecting the structure of the product.

Table 4. Mean values of sensory measurement of texture (c.u.)

Factor	Variants				
	K	I-5	I-10	I-5-o	I-10-o
Consistency	4.29^{b}	3.56^{ab}	3.47^{ab}	3.40^{ab}	3.01^{a}
Springiness	3.82^{b}	2.87^{ab}	3.02^{ab}	3.18^{ab}	2.47^{a}
Hardness	4.30^{b}	3.67^{ab}	3.57^{ab}	3.59^{ab}	2.77^{a}
Fatness	4.04^{bc}	3.90^{ab}	3.83^{ab}	4.21^{c}	3.67^{a}
Wetness	4.55	4.41	3.73	4.07	3.47

$^{a, b, c}$ – means in the same column marked with various letters differ significantly ($\alpha \leq 0.05$).

The results of sensory desirability of the products examined are given in table 5. The level of the employed inulin as well as inulin and vegetable oil had no statistically significant effect on shaping the evaluated determinants of desirability, except for the desirability of taste. The desirability of taste of the model preserved meat products containing inulin preparation and oil, in variants I-5-o and I-10-o was evaluated on a level similar to that for the control product. Lower evaluation scores for the desirability of taste were found for products with the addition of an 'inulin only' preparation – variants I-5 and I-10. The desirability of colour and the general desirability of the products examined were lower than those for the control variant together with an increase in the level of substitution but these relationships were not statistically significant. Similar results were obtained in studies conducted by Makała [12] in respect of meat products containing inulin.

Based on the analysis of the physico-chemical discriminating factors, the characteristics of texture discriminants and the evaluation of sensory desirability, the replacement of pork fat with refined rapeseed oil had a significant effect on the lowering of the value of springiness and the tendency to increase gumminess,

in spite of the fact that this relationship was not statistically significant. The addition of oil affected the improvement of taste desirability and the improvement of the nutritive value of model preserved meat products which was confirmed by the studies conducted by Kowalski and Cepiak [9]. In the case of the 10-% fat substitution with inulin, the addition of vegetable oil had an influence on the attenuation of consistency, springiness (as determined by instruments and sensory methods), hardness and the impression of fatness as compared to the variants containing 5% of inulin as well as on the control variant.

Table 5. Overall hedonic rating of model meat products

Factor	Variants				
	K	I-5	I-10	I-5-o	I-10-o
Colour desirability	4.65	4.08	3.96	4.36	4.04
Taste desirability	4.85^{b}	4.08^{a}	4.12^{a}	$4.56a^{b}$	4.28^{ab}
Overall hedonic rating	4.96	4.32	4.08	4.12	4.20

$^{a, b, c}$ – means in the same column marked with various letters differ significantly ($\alpha \leq 0.05$)

Due to increasing consumer demand for low-calorie nutritious meat products containing soluble cellulose, further studies on the best ways to use fat substitutes in the meat industry and in dietetic foods, should be undertaken.

CONCLUSIONS

1. Inulin and the level at which it was substituted as well as the addition of vegetable oil had a significant effect on most of the chemical composition in the loaf of preserved meat and on texture discriminating factors which were determined by instruments as well as by sensory methods and also on taste desirability.
2. As a result of the substitution of pork fat with inulin, the fat content and energy value of meat preserves containing inulin, are lower according to expectations, in comparison to the control product.
3. Inulin and vegetable oil used instead of animal fat, have generated a delicate structure as reflected in the characteristics of the texture profile which was lower in springiness, hardness 1 and chewiness, when compared to the control variant and as determined using instruments and the lower consistency, springiness, hardness and lower impression of fatness as determined by sensory methods.

4. Inulin and vegetable oil, when added to the model product instead of animal fat, "imitated" well the sensory impression of the creamy taste of fat which was reflected in taste desirability similar to that in the control product.

5. The cellulose preparation examined may be used as a substitute for animal fat in meat products.

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ROLA PREPARATU INULINY W KSZTAŁTOWANIU JAKOŚCI MODELOWEGO PRODUKTU MIĘSNEGO

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Streszczenie. Badano wpływ substytucji tłuszczu wieprzowego preparatem inuliny oraz oleju rzepakowego do farszu na wybrane wyróżniki jakości modelowej konserwy mięsnej. Badano skład chemiczny bloku konserwy, charakteryzowano profil tekstury przy zastosowaniu metody instrumentalnej i sensorycznej oraz oceniano pożądalność sensoryczną wyrobów. Zgodnie z oczekiwaniem, istotnie obniżyła się zawartość tłuszczu i wartość energetyczna ocenianych konserw w stosunku do wariantu kontrolnego. Preparat inuliny i olej roślinny wprowadzone w miejsce tłuszczu zwierzęcego wytworzyły delikatną strukturę, co znalazło wyraz w charakterystyce profilu tekstury, niższej sprężystości, twardości i żujności, oznaczanych instrumentalnie, oraz niższej konsystencji, sprężystości, twardości i niższemu wrażeniu tłustości, oznaczanych sensorycznie. Preparat inuliny i olej roślinny, dodane do modelowego wyrobu w miejsce tłuszczu zwierzęcego, dobrze „naśladowały" sensoryczne wrażenie smaku tłustego, kremowego, co uwidoczniło się w zbliżonej do wyrobu kontrolnego pożądalności smaku. Badany preparat błonnika może być stosowany jako substytut tłuszczu zwierzęcego w wyrobach mięsnych.

Słowa kluczowe: inulina, zamiennik tłuszczu, produkt mięsny, profil tekstury, jakość sensoryczna