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APPLICABILITY OF ASPARAGUS (*ASPARAGUS OFFICINALIS* L.) AS A COMPONENT OF MEATLOAF

MOŻLIWOŚĆ ZASTOSOWANIA SZPARAGÓW (*ASPARAGUS OFFICINALIS* L.) JAKO SKŁADNIKA PIECZENI RZYMSKIEJ

Abstract

Background. Some of the factors determining the nutritive value of asparagus include its low energy value, high contents of dietary fibre, vitamins and minerals, as well as contents of antioxidants. Among polyphenols rutin, quercetin, isoquercetin and kaempferol predominate, while among phenolic acids large amounts of caffeic, chlorogenic, p-coumaric, cinnamic, ferulic and salicylic acids are found in asparagus. On the Polish market there is a limited number of products based on or containing some proportion of asparagus. In view of the dynamically developing market for products with programmed health-promoting properties and the small range of foodstuffs based on asparagus the aim of this study was to develop the technology for a novel meat product using freee-dried green asparagus.

Material and methods. Green asparagus cv. 'Grolim' was obtained from the plantations in Miedzichowo, the Nowy Tomyśl county (harvest of 2014). Cooked asparagus spears were comminuted and freee-dried. Meatloaf variants were prepared with a 1.5%, 2% and 3% asparagus addition. The chemical composition and total polyphenol contents were assayed. Antioxidant activity was determined in DPPH and ABTS tests. Chelating activity was recorded and sensory evaluation was performed.

Results. It was shown that the addition of asparagus had a positive effect on the antioxidant activity of the product. Meatloaf with the addition of asparagus had higher polyphenol contents and as a result – also higher scavenging capacity towards the DPPH radical and the ABTS cation radical, as well as chelating activity. Based on the results of sensory evaluation it was stated that a 1.5 and 2% addition of asparagus provides a product with desirable sensory attributes and high scores for taste, aroma and colour.

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Conclusions. The use of asparagus to produce meatloaf provides a novel meat product of high nutritive value, antioxidant activity and sensory attractiveness.

Keywords: antioxidants, asparagus, polyphenols, meat, meatloaf, chelating activity

Introduction

Within the last several years we have been observing increased interest in healthy diets. Food not only satisfies hunger, but also influences many bodily processes, which in turn affects our sense of well-being. Among major groups of food products a particularly important role is played by meat and its processed products. Meat is an essential element of a healthy human diet, providing quality protein, vitamins and minerals. In view of the considerable interest in food having a positive effect on the body functions, food producers and researchers have been striving to enhance nutritive value of these products (Flaczyk et al., 2014; Gramza-Michałowska et al., 2016; Kmiecik et al., 2015; Kobus et al., 2009; Kobus-Cisowska et al., 2014; Obuchowski et al., 2015). Asparagus belongs to the family Asparagaceae and is a herbaceous perennial, classified as a perennial vegetable. Asparagus is most commonly white, since these plants grow with no access to light. Under the influence of sunlight they first turn purple at the tip and then the colour changes to green. Asparagus has a high nutritive value and a rich chemical composition at a limited energy value (20 kcal w 100 g) (Guillén et al., 2008; Kulczyński et al., 2016). Asparagus contains saponins exhibiting anticancer and antiviral properties. A major factor determining the considerable nutritive value of asparagus is connected with its contents of antioxidant compounds. Spears contain such flavonoids as rutin, quercetin, isoquercetin and kaempferol. In turn, the most important phenolic acids found in asparagus include caffeic, chlorogenic, p-coumaric, cinnamic, ferulic and salicylic acids. Among the entire group of polyphenols rutin is present in largest amounts (Fuentes-Alventosa et al., 2013; Ha et al., 2013; Kulczyński et al., 2016).

On the Polish market there is a limited number of products either based or containing some proportion of asparagus. In view of the dynamically developing market for products with programmed health-promoting properties and the small range of foodstuffs produced using asparagus, the aim of his study was to develop a technology for a novel meat product using asparagus.

Material and methods

Asparagus

Green asparagus cv. ‘Grolim’ was obtained in 2014 from the plantations in Miedzichowo, the Nowy Tomyśl county (52°22'06.8"N 15°57'01.1"E). Comminuted and cooked vegetables were freeze-dried (CHRIST 1-4 LSC) at a pressure of 1.650 mbar for 48 h. Asparagus powder was sealed in a vacuum container and stored with no access to light.

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Reagents

Ingredients to be used to prepare meatloaf, having a minimum 3-day shelf life, were purchased at local shops. All solvents and reagents used in the analyses were analytically pure and they were purchased from Sigma-Aldrich (St. Louis, MO, USA), Merck (Darmstadt, Germany) and POCH (Gliwice, Poland).

Preparation of meatloaf

The formulation of the meatloaf was developed experimentally in a laboratory, with samples for analyses prepared following the formulation given in Table 1. The control (A) comprised meatloaf produced with no asparagus addition, while in samples B, C and D asparagus accounted for 1.5, 2.0 and 3.0 % of the formulation, respectively. Linseed was hydrated at 90°C for 5 min. Spices and freeze-dried asparagus were mixed in the dry form. Meat and eggs were blended and next spices and linseed were added. Meat batter was formed into a loaf and placed in a greased loaf pan covered with ground linseed. Samples were subjected to thermal treatment for 30 min at 190°C in a convection oven (Rational) with the fan-assisted setting.

Table 1. The composition of meatloaf with the addition of asparagus (g)

Component	Samples							
	A		B		C		D	
	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)
Pork shoulder	80.00	96.00	78.67	94.40	78.27	93.92	77.97	93.56
Eggs	12.17	14.60	12.00	14.40	11.90	14.28	11.20	13.44
Asparagus	0.00	0.00	1.50	1.80	2.00	2.40	3.00	3.60
Linseed	1.85	2.22	1.85	2.22	1.85	2.22	1.85	2.22
Water	4.80	5.76	4.80	5.76	4.80	5.76	4.80	5.76
Paprika	0.49	0.59	0.49	0.59	0.49	0.59	0.49	0.59
Pepper	0.16	0.19	0.16	0.19	0.16	0.19	0.16	0.19
Salt	0.53	0.64	0.53	0.64	0.53	0.64	0.53	0.64

Characteristics of the basic composition of meatloaf

All analyses were conducted in three replications according to the AOAC (Horwitz and Association of Official Analytical Chemists, 2000). Water content in samples was determined by drying at a temperature of 103 ±2°C to constant mass (AOAC method: 925.10). Protein content was determined according to Kjeldahl (N × 6.25) in a Kjeltec 2200 apparatus (Foss Tecator, Sweden) (AOAC method: 950.36). Fat content was determined in a Soxtec HT6 apparatus (Foss Tecator, Sweden) (AOAC method: 930.05). The energy value and carbohydrate content were calculated using results of instrumental analyses.

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Extraction

Comminuted, previously defatted meatloaf was extracted with deionised water at a proportion of 10 g comminuted sample per 100 ml water. Single extraction was conducted by shaking the entire sample at 90°C, followed by centrifugation (Eppendorf Centrifuge 5702R) for 15 min at 4500 rpm. Further stages of analyses were conducted using a clear supernatant, which was stored under nitrogen in dark containers at 4 ±1°C until analyses.

Total polyphenol contents and antioxidant activity

Contents of total polyphenols were assayed based on a method described by Cheung et al. (2003). Results are given as an equivalent of quercetin in milligrams per 1 g d.m. of the product and d.m. of the product. Antioxidant activity against the DPPH radical was assessed by the spectrophotometric method described by Tang et al. (2002). The activity against the ABTS cation radical was assessed based on the method described by Re et al. (1999). The DPPH and ABTS scavenging capacity (expressed for the product and d.m. of the product – TE) was calculated from the regression equation for the standard curve plotted for various trolox concentrations (2.0, 1.5, 1.0 and 0.5 mg/ml). Chelating activity was assayed following the method described by Tang et al. (2002). Chelating activity was measured at various extract concentrations and expressed as a percentage of formed chelates.

Sensory evaluation

Sensory evaluation of experimental meatloaf samples was conducted at a sensory laboratory meeting the requirements of the respective standard. The quantitative descriptive analysis, i.e. sensory profiling, involved a 20-person panel. Qualitative attributes of colour, aroma, taste and consistency were assessed. Intensity of each quality attribute was determined using a 10-cm structured end-anchored linear scale. Results were substituted with numerical values expressed as point scores.

Statistical analysis

Statistical analysis was conducted using the STATISTICA^{TM}PL software by StatSoft. Basic descriptive statistics were prepared for individual parameters. Means for tested attributes were compared using the analysis of variance for factorial designs with a varied number of observations and differences between groups were evaluated using Tukey's test ($p \leq 0.05$).

Results and discussion

Table 2 presents the nutritive value of tested meatloaf samples. The use of asparagus in the formulation resulted in a decrease of fat content, thus reducing the energy value. The control contained 19.2% fat and its energy value was 236.1 kcal per 100 g, while sample D with a 3% asparagus content contained 18.3% fat at the energy value of 226.5 kcal per 100 g.

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Table 2. Nutritional value of meatloaf with the addition of asparagus

Index	Samples							
	A		B		C		D	
	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)	in 100 g	in the portion (120 g)
Nutritional value (kcal)	236.1 ±7.3^{a}	283.2	231.6 ±8.6^{b}	277.92	229.6 ±20.2^{b}	275.47	226.5 ±15.2^{c}	271.8
Fat (g)	19.2 ±0.9^{a}	23.04	18.8 ±1.3^{b}	22.56	18.6 ±2.5^{b}	22.32	18.3 ±1.1^{c}	21.9
Protein (g)	14.9 ±1.2^{a}	17.88	14.5 ±0.3^{ab}	17.4	14.2 ±1.2^{b}	17.04	14.1 ±1.1^{b}	16.8
Carobohydrates (g)	0.92 ±0.1^{a}	1.104	1.1 ±0.1^{b}	1.32	1.34 ±0.2^{c}	1.60	1.45 ±0.2^{c}	1.74

Data represent the mean of three replications and the standard deviation. Mean values marked with different letters on the same line indicate the significance of differences ($p \leq 0.05$).

Table 3 presents antioxidant activity measured by tests with the DPPH radical, the ABTS cation radical as well as total polyphenol contents. It was shown that an addition of asparagus to meatloaf had a statistically significant effect on an increase in antioxidant activity. In the DPPH test antioxidant activity of the control was 0.30 mmol TE per

Table 3. Antioxidant potential and polyphenol content in meatloaf with the addition of asparagus

Index	Samples			
	A	B	C	D
DPPH				
mmol TE per 1 g product	0.30 ±0.00^{a}	0.49 ±0.00^{b}	0.57 ±0.01^{b}	0.73 ±0.01^{b}
mmol TE per 1 g d.m. product	0.85 ±0.01^{a}	1.44 ±0.01^{b}	1.68 ±0.01^{b}	2.53 ±0.02^{c}
% scavenged radicals	16.92 ±0.03^{a}	22.18 ±0.02^{b}	27.54 ±0.04^{b}	36.44 ±0.04^{c}
ABTS				
mmol TE per 1 g product	0.12 ±0.00^{a}	0.23 ±0.00^{b}	0.34 ±0.00^{c}	0.43 ±0.00^{b}
mmol TE per 1 g d.m. product	0.37 ±0.01^{a}	0.66 ±0.01^{b}	0.98 ±0.00^{c}	1.25 ±0.01^{d}
% scavenged radicals	14.87 ±0.02^{a}	16.30 ±0.02^{a}	18.55 ±0.01^{b}	29.45 ±0.03^{c}
Total polyphenols				
mg quercetin per 1 g product	0.21 ±0.00^{a}	0.23 ±0.00^{a}	0.26 ±0.00^{ab}	0.31 ±0.00^{b}
mg quercetin per 1 g d.m. product	0.61 ±0.01^{a}	0.67 ±0.02^{a}	0.75 ±0.02^{ab}	0.89 ±0.01^{b}

Data represent the mean of three replications and the standard deviation. Mean values marked with different letters on the same line indicate the significance of differences ($p \leq 0.05$).

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1 g product, while in meatloaves containing asparagus it amounted to 0.49, 0.57 and 0.73 mmol TE per 1 g product, respectively. Similarly, in the ABTS test the activity in relation to that of the control (0.12 mmol TE per 1 g product) was as much as 3.5-fold higher and amounted to 0.23, 0.34 and 0.43 mmol TE per 1 g product for meatloaves with asparagus added at 1.5, 2.0 and 3.0%, respectively. Antioxidant activity probably resulted from the high contents of polyphenols, which greatest level was assayed in sample D at 0.31 mg/g product. The antioxidant capacity of asparagus was investigated by Papoulias et al. (2009). They found no significant difference in the scavenging capacity of synthetic DPPH radicals between raw and cooked asparagus. Asparagus juice was also investigated by Wang et al. (2011). It was found that juices from fresh, green asparagus exhibit the capacity to scavenge DPPH radicals, which is dependent on the extract concentration. In a study by Kulczyński et al. (2016) it was shown that in comparison to white and purple varieties green asparagus has the highest antioxidant activity.

Within this study the capacity to chelate metals was measured, with the results given in Figure 1. Chelating activity increased with an increase of extract concentration. The highest activity was assayed in sample D, in which asparagus accounted for 3% meatloaf composition (ranging from 0.300 to 0.596). The control had the lowest activity to chelate metals, with an increase in the concentration of the reaction mixture to a slight extent resulting in its increase (0.122 for 200 ppm up to 0.215 for 2000 ppm, respectively). These results indicate that asparagus exhibits a chelating activity, probably resulting from the presence of such phytochemicals as polyphenols, including primarily rutin and derivatives of hydroxycinnamic acid (Kulczyński et al., 2016). Chen et al. (2015) showed that to the greatest degree the content of rutin is responsible for the antioxidant activity of asparagus juice, with the activity dependent on thermal treatment conditions.

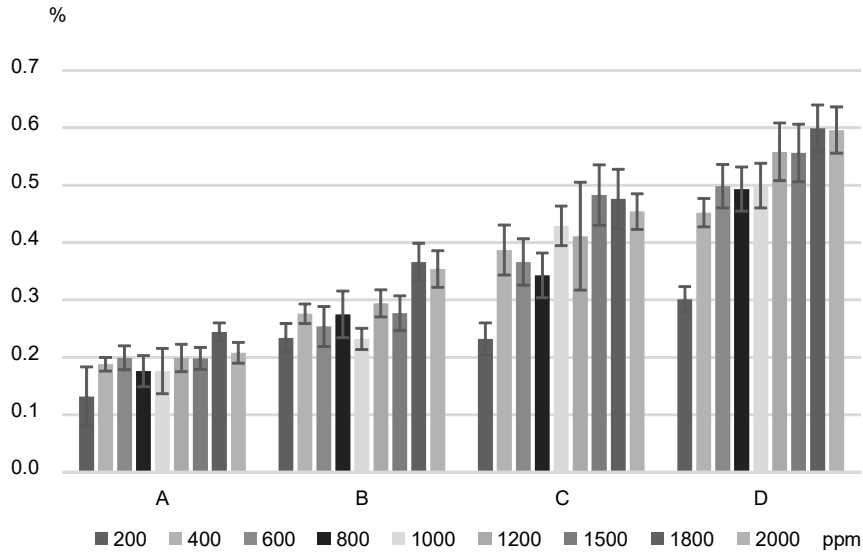

Fig. 1. Metal ion chelating activity of meatloaf with the addition of asparagus; data represent the mean of three replications and the standard deviation

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Sensory attractiveness is a major factor determining the commercial success of a novel product. For this reason when developing a new technology it is necessary to conduct sensory analysis. Since freeze-dried asparagus due to its green colour may influence meatloaf colour, while also altering the perception of taste and aroma as well as consistency and juiciness, meatloaf was subjected to the quantitative descriptive analysis (Fig. 2).

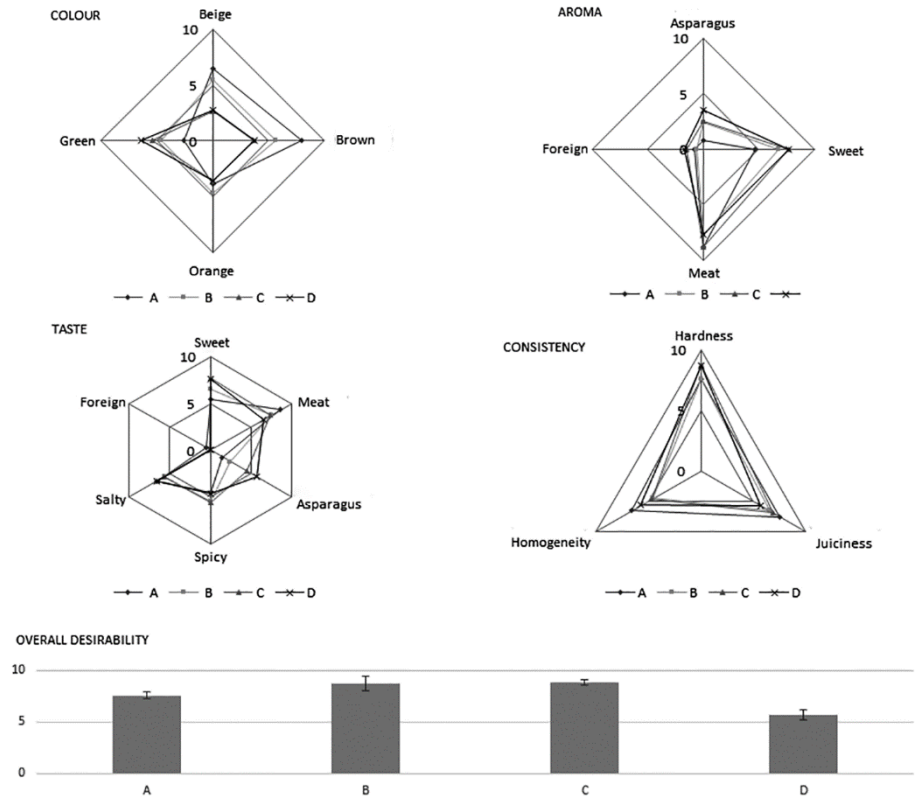

Fig. 2. Sensory evaluation of meatloaf with the addition of asparagus

It was found that colour of samples with an addition of asparagus differed statistically significantly from that of the control. In samples with the addition of asparagus the green colour was perceptible at the level from 4.5 to 6.4, while the control received the score of 2.5. Moreover, it was shown that increasing the percentage share of asparagus resulted in a reduced intensity of the beige and brown colours. In turn, the orange colour in all samples was perceptible at a similar level (3.5–4.6). The addition of asparagus influenced the aroma profile of meatloaf samples. In the samples containing an addition of asparagus the sweet aroma was statistically significantly more perceptible than in the control.

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In these samples to a limited degree the development of a foreign aroma was observed, classified as desirable, with its perceptibility increasing with an increase in the share of asparagus in the sample. Similar observations were also reported in relation to taste. Samples containing asparagus were sweeter and the taste of asparagus in meatloaf was more intensive. Irrespective of the level of asparagus addition, no effect of asparagus was found on the sensation of a meaty, salty and spicy taste. Samples containing asparagus were harder and less juicy. The highest overall scores were found for samples B and C, in which asparagus was added at 1.5 and 2%. Literature sources present no data on the use of asparagus as components of meat products. However, high nutritive value and contents of phytochemicals were also stressed (Kulczyński et al., 2016). In their study Ha et al. (2013) showed that asparagus extracts contain polyphenols and enzymes, which are proteases influencing meat tenderness and the perception of the sweet taste.

Conclusions

Meatloaf with an addition of asparagus was characterised by a lower fat content and lower energy value. Asparagus influenced antioxidant activity and total polyphenol contents in the meatloaf extract. The use of asparagus to produce meatloaf provides a novel meat product of high nutritive value, antioxidant activity and sensory attractiveness.

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MOŻLIWOŚĆ ZASTOSOWANIA SZPARAGÓW (*ASPARAGUS OFFICINALIS* L.) JAKO SKŁADNIKA PIECZENI RZYMSKIEJ

Abstrakt

Wstęp. Jednym z czynników decydujących o wartości żywieniowej szparagów jest ich mała wartość energetyczna, duża zawartość błonnika i witamin oraz składników mineralnych, a także zawartość związków o właściwościach przeciwutleniających. Wśród polifenoli obecnych w szparagach dominują: rutyna, kwercetyna, izokwercetyna i kempferol, a także fenolokwasy, takie jak: kwas kawowy, chlorogenowy, p-kumarowy, cynamonowy, ferulowy i salicylowy. Na rynku polskim mało jest produktów posiadających w swym składzie szparagi. Z uwagi na rozwijający się rynek produktów o zaprogramowanych właściwościach prozdrowotnych i mały asortyment żywności zawierającej szparagi przedmiotem niniejszej pracy było opracowanie technologii produkcji nowego produktu mięsnego z wykorzystaniem liofilizowanych zielonych szparagów.

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Materiał i metody. Zielone szparagi odmiany 'Grolim' pozyskano z upraw w miejscowości Miedzichowo w powiecie nowotomyskim w 2014 roku. Ugotowane szparagi rozdrobniono i wysuszono w procesie liofilizacji. Przygotowano pieczeń rzymską z dodatkiem 1,5%, 2%, oraz 3% szparagów. Oznaczono skład podstawowy oraz zawartość polifenoli ogółem. Potencjał przeciwutleniający oznaczono w testach z DPPH oraz ABTS. Oceniono również aktywność chelatującą oraz wykonano analizę sensoryczną.
Wyniki. Wykazano, że dodatek szparagów pozytywnie wpłynął na potencjał antyoksydacyjny produktu. Pieczeń z dodatkiem szparagów cechowała się większą zawartością polifenoli, a w związku z tym większą aktywnością zmiatania rodnika DPPH oraz kationorodnika ABTS, a także aktywnością chelatującą. Na podstawie wyników analizy sensorycznej stwierdzono, że dodatek szparagów na poziomie 1,5 oraz 2% pozwala na uzyskanie produktu pożądanego sensorycznie o bardzo dobrych notach charakteryzujących smak, zapach oraz barwę.
Wnioski. Wykorzystanie szparagów w produkcji pieczeni rzymskiej umożliwia uzyskanie nowego produktu mięsnego o bardzo dobrych walorach żywieniowych, dużym potencjale przeciwutleniającym i atrakcyjnego sensorycznie.

Słowa kluczowe: przeciwutleniacze, szparagi, polifenole, mięso, pieczeń rzymska, aktywność chelatująca

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