The assessment of allergenicity risk of selected strawberry cultivars on the guinea pig model.

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Abstract

The aim of the presented study was to assess the risk of any allergic reaction or food hypersensitivity resulting from topical application and chronic oral administration of fruit of selected strawberry cultivars – 'Elsanta' and 'Honeoye', coming from farms located in Central Poland. Plantations were managed according to organic (OR) or integrated production (IFP) systems. The experiments were performed on outbred young, adult, white albinotic guinea pigs (Dankin Hartley). Fruit characteristics included: the total soluble solids content (TSS), titratable acidity (TA), sugar content (sucrose, glucose, fructose, and sorbitol), polyphenols content (chlorogenic acid, p-coumaric acid, quercetin, kaempferol, procyanidins, anthocyanins, ellagic acid), and macro and micro nutrients (P, K, Mg, Ca, B, Cu, Fe, Mn, Zn, and S). Moreover in the tested fruits pesticide residues, heavy metals contamination, nitrate and nitrites content and microbiological contamination (fungi & bacteria) were also analyzed.

The observations of skin reactions resulting from topical application of 'Honeoye' strawberry fruit extracts according to Guinea-Pig Maximization Test (GPMT,) coming from plantation managed according to integrated or organic production, showed no significant changes in guinea pigs skin. Topical exposition to 'Elsanta' strawberry from plantation managed according to organic practice showed some changes (i.e. discrete, moderate or intense erythema and swelling), as compared to animals being exposed to 'Elsanta' from plantation managed according to integrated fruit production. Chronic oral administration of selected fruit extracts did not cause any skin reactions in groups receiving 'Elsanta' or 'Honeoye' from organic or integrated productions. Skin prick test did not show any immediate skin reactions as compared to exposure to 1% histamine hydrochloride solution. No impact of terms of production (organic vs integrated) on allergenicity risk was observed. The influence of any agronomical practices and environmental conditions on allergenicity risk from 'Elsanta' strawberry needs further investigations.

The quality of fruits depended not only on cultivars but also on production system.

Keywords: strawberry, allergy, fruit quality, organic, integrated fruit production

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Introduction

Fruits from the Rosaceae family (e.g. peach, almond, cherry, apple and strawberry) are widely consumed and have been increasingly reported as causes of allergic reactions. Strawberry has a reputation among the general population of being an allergenic fruit. Hypersensitivity to strawberry is commonly reported but poorly documented. Considering the growing interest in organic cultivation, assessment of hypo(hyper-) allergenic potential of these products requires further research, as well.

The aim of the study was to assess the risk of any allergic reaction or food hypersensitivity resulting from topical application and chronic oral administration of selected strawberry cultivars – 'Elsanta' and 'Honeoye', coming from organic or integrated plantations.

Material and Methods

The strawberry fruits of 'Elsanta' and 'Honeoye' cvs were harvested at plantations located in Central Poland, managed according to organic or integrated fruit production systems. The assessment of the risk of any allergic reaction was performed on young, adult, white albinotic guinea pigs (Dankin Hartley). The performed procedures included: I. Guinea-Pig Maximization Test (GPMT) - OECD 406; II. chronic oral administration of selected fruit extracts; III. skin prick (Dreborg) test (Dreborg et al, 1989) and IV. Determination of total IgE antibodies (commercial Guinea Pig Immunoglobulin E, IgE ELISA Kit). Fruit characteristics included: the total soluble solids content (TSS), titratable acidity (TA), sugar content (sucrose, glucose, fructose, and sorbitol), polyphenols content (chlorogenic acid, p-coumaric acid, quercetin, kaempferol, procyanidins, anthocyanins, ellagic acid), macro and micro nutrients (P, K, Mg, Ca, B, Cu, Fe, Mn, Zn, and S). In the tested fruits pesticides residues, heavy metals contamination, nitrate and nitrites content and microbiological contamination (fungi and bacteria incl. Escherichia coli) were also analyzed. Pesticides residues in fruits were analyzed according QuEChERS method using gas chromatography with mass detector (GC/MS) and liquid chromatography tandem mass spectrometry (LC/MS-MS) for 170 pesticides.

Extraction and determination of nitrites from plant material were conducted according to method described in PN-EN 12014-2: „Foodstuffs – Determination of nitrate and/or nitrite content – Part 2: HPLC/IC method for the determination of nitrate content of vegetable and vegetable products".

Content of calcium, phosphorus, potassium, magnesium, boron, copper, iron, manganese, zinc and sulphur, was determined after drying fresh plant material and microwave mineralization using inductively coupled plasma optical emission spectrometry (ICP-OES). Soluble solids were determined by indirect refractometric method using ATAGO PR-101 refractometer (ATAGO, Japan). Titratable acidity was determined by standard titration methods with DL 50 Graphix titrator (Mettler Toledo, Switzerland), by titration with 0.1N NaOH to the end point at pH=8.1. The sugar and polyphenols content were determined using the HPLC methods.

Results and Discussion

The validation process of Magnusson-Kligmann test, which was performed with the use of benzocaine – substance with mild-to-moderate skin sensitization properties – has confirmed the sensitivity and reliability of the above experimental technique. The observations of skin reactions resulting from topical tests according to Guinea-Pig Maximization Test (GPMT) showed no significant changes in guinea pigs being exposed to extracts from 'Honeoye' strawberry coming from integrated or organic production. Topical exposition to 'Elsanta' strawberry from plantation managed according to organic practice

showed some changes (i.e. discrete, moderate or intense erythema and swelling), as compared to animals being exposed to ‘Elsanta’ from plantation managed according to integrated production. Chronic oral administration of selected fruit extracts did not cause any skin reactions in groups receiving ‘Elsanta’ or ‘Honeoye’ from organic or integrated productions. Skin prick test did not show any immediate skin reactions as compared to exposure to 1% histamine hydrochloride solution. Data presented in Table 1 show that regardless of the production system ‘Honeoye’ fruits characterized by higher titratable acidity compared to ‘Elsanta’. For both strawberry cultivars fruits from organic plantation had higher total soluble solids content and lower titratable acidity compared to those from integrated production. However, the quality parameters of fruits more often depend on the season than crop management practise (Peck *et al.*, 2006).

Regardless of cultivar, higher content of Ca, B, and S were found in fruits from plantation cultivated according to organic farming than from plantation cultivated according to IFP. In contrast K, Mg and Mn content were higher in fruits from IFP than from OR. Reganold et al (2010) also showed lower potassium content in strawberries produced under organic practice. The sugar and polyphenols content depended both on cultivars and production system. Fruits from organic farming contained higher amount of ellagic acid. It confirms data obtained by Hakkinen and Torronen (2000).

All fruits (except ‘Elsanta’ from IFP) were free from pesticide residues. For ‘Elsanta’ two pesticides (boscalid and cyprodinil) were detected, but at very low concentrations: 0.08 mg*kg-1 and 0.02 mg*kg-1 respectively. The MRL values are 10 mg*kg-1 for boscalid and 5 mg*kg-1 for cyprodinil. There were no microbiological contaminations (fungi, bacteria including Escherichia coli) in the tested fruits.

Conclusion

No impact of terms of production (organic vs integrated) on allergenicity risk was observed for ‘Honeoye’ cv. The influence of any agronomical practices and environmental conditions on allergenicity risk from ‘Elsanta’ strawberry needs further investigations. The quality of fruits depends on cultivars but also production system.

Table 1: The influence of production system on total soluble solid content and fruit acidity of ‘Elsanta’ and ‘Honeoye’ strawberry cultivars.

Cultivars	Production system	Total soluble solid - TSS (%)	Titratable acidity - TA (%)	TSS / TA ratio
‘Elsanta’	OR	9.6	0.63	15,2
	IFP	8.7	0.79	11,0
‘Honeoye’	OR	10.3	0.95	10,9
	IFP	7.7	1.02	7,5

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