Risk-indicative or sustainable consumption? Consumers' risk perception on conventional and organic food products in Poland

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Abstract: The consumption of organic food is becoming increasingly popular and, to avoid numerous threats to human health and the natural environment, the issues devoted to it require greater attention from decision-makers, producers, and consumers. Consumer decisions have an impact on shaping food consumption patterns and recently the trend of the consumption of conventional versus organic food products has been widely discussed. This is especially true given the fact that the area of human health is strongly related to the consumption of food products produced under the challenges of environmental protection and sustainability. The study aimed to investigate if the perception of consumption among Polish respondents was risk-indicative or sustainable based on the animal, fruit, and vegetable products purchased from conventional or organic production. The results revealed that fruit and vegetable consumption was not identically related with socio-demographic features, but the income level equally affected consumer choices regarding the purchase of organic food products. Gender and marital status only influenced decisions regarding the purchase of organic fruit. The consumption of animal products regarding the frequency of their consumption did not reveal the features of sustainability. The metal accumulation index (MAI) for conventionally cultivated vegetables was not higher for all of the investigated vegetables, namely pumpkin, spring onion, cabbage, lettuce, spinach, and garlic. Our study contributes to addressing the knowledge gap on consumer choices about organic food products in Poland.

Keywords: fruit, vegetables, animal products, food risk, sustainable consumption, metal accumulation index (MAI), potentially harmful elements

INTRODUCTION

Consumer decisions about food have an impact on the environment. Investigations performed in the countries of the European Union as part of the Eurobarometer survey (European Food Safety Authority 2022) revealed that among the factors affecting the decision on food purchases were cost, taste, food safety, and the geographical origin of the food. Other factors were also nutrient content, the impact on the environment and climate, ethics, and beliefs. The Eurobarometer survey indicated a healthy diet as the most important factor affecting health and includes eating locally produced food, organic products, a plant-based diet, more fruits and vegetables, more fish, more fibre, more legumes, pulses, and nuts, less fat, fewer sugars and salt, less ultra-processed food, less meat and dairy (European Food Safety Authority 2022). Moreover, the main concerns raised in the Eurobarometer survey on food safety were pesticide residues, antibiotic, hormone or steroid residues in food, colours, preservatives or flavourings added to food, microplastics found in food, zoonosis, environmental pollutants in fish, meat, and dairy (European Food Safety Authority 2022).

Conventional farming was transformed into an intensive model to meet global food needs (Cristache et al. 2018). This was not only achieved by ensuring the appropriate crop yield (Alvarez 2022) but also by the intensity of soil use and industrialisation of agriculture, increased use of mineral fertilisers, manure, pesticides, and sewage sludge (Alengebawy et al. 2021). This allowed for easier and more efficient food production to be achieved regarding its quantity but led to unsustainable food production in terms of the environmental issues related to water, soil, and food products contamination, eutrophication, climate change, and the disruption of soil microbial communities (Głodowska & Krawczyk 2017). This is also considered to potentially affect consumers' health negatively. For example, while pesticides are considered efficient, economical, and effective against pests, their uncontrolled use caused their bioaccumulation in food chains (Alengebawy 2021). In agricultural processes, the primary sources of heavy metals are atmospheric deposition, livestock manure, irrigation with wastewater or polluted water, metallo-pesticides or herbicides, phosphate-based fertilizers, and sewage sludge-based amendments (Rai et al. 2019).

Safety in the food chain as part of the Farm to Fork Strategy has become one of the main issues of the European Union (EU), with considerable emphasis placed on providing safe food but also educating consumers in terms of making conscious choices on food, which is the basis of health. However, protecting human health must be in balance with animal health and welfare, plant health and the environment, under the One Health approach (European Food Safety Authority 2021). At the global level, the United Nations introduced an agenda based on 17 Sustainable Development Goals (SDGs) to be achieved by 2030 in areas crucial for humanity and the planet. At the EU level, the European Commission (EC) introduced the Farm to Fork Strategy, the aim of which is to achieve a fair, healthy and environmentally-friendly food system (European Commission 2020). The Farm to Fork Strategy, together with Biodiversity Strategy for 2030 and the Chemicals Strategy for Sustainability, are the key components of the European Green Deal, a set of provisions that aim to improve the well-being and health of citizens and future generations (European Commission 2019a). In addition, EAT – Lancet Committee in 2019 launched a universal healthy reference diet, called planetary health diet, or EAT-Lancet diet. This Great Food Transformation was proposed to optimize human health without exceeding the Earth's planetary boundaries and to achieve the Sustainable Development Goals and the Paris Agreement (Willet et al. 2019). The proposed reference diet consists mainly of vegetables, fruits, whole grains, legumes, nuts, and unsaturated oils, with low to moderate amounts of seafood and poultry, and with no to low quantities of red meat, processed meat, added sugar, refined grains, and starchy vegetables (Willet et al. 2019).

Therefore, the alternative in food production is organic farming. It offers a holistic production management system promoting agroecosystem health with biodiversity, biological cycles, and soil biological activity, and an efficient approach for sustainable agriculture by a circular and green economy (Fernández et al. 2022) and by eliminating the use of synthetic inputs such as synthetic fertilizers and pesticides, veterinary drugs, genetically modified seeds and varieties, preservatives, additives, and irradiation (Food and Agriculture Organization 1999). Since the introduction of organic production by the *Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and the labelling of organic products and repealing Regulation (EEC) No 2092/91* there has been a significant increase in the number of countries, organizations, and companies encouraging organic farming as a viable solution on the way to achieve the sustainable production and consumption (Cristache et al. 2018). Organic farming is becoming increasingly important not only in the agricultural sector but also in terms of consumption. Pereira et al. (2021) indicated that ecologically based farming allows food production of better nutritional and sanitary quality. An organic lifestyle is on the rise, especially among young adults in the West (Von Essen & Englander 2013). Ecolabelling indicates that the product has been produced using a specific production method (Food and Agriculture Organization 1999) – among others, the use of crop rotation and the absence of synthetic means of production. Organic food is a combination of traditional and innovative methods of food production, processing, and preservation together with marketing practices (Thøgersen & Crompton 2009, Mughal et al. 2021). This term is also used as a heuristic indicator of superiority – a powerful word associated by consumers with the terms healthier, safer, higher quality, more authentic, and natural than conventional food (Vega-Zamora et al. 2013) and more environmentally friendly (Fatha & Ayoubi 2021). Organic diets often eliminate consumer concerns about ordinary, conventional food (Gumber & Rana 2021); therefore, it is treated as non-conventional food.

Hence, the health risks associated with the consumption of food products have been an important scientific issue worldwide for years. The challenges related to problems such as hunger, malnutrition, and overall food insecurity continue to grow, highlighting the vulnerabilities of agri-food systems and inequalities resulting, among others, in the inhibition of growth, destruction of the body, and a deficiency of essential microelements, as well as overweight and obesity (Food and Agriculture Organization 2022). In terms of risk assessment, no single method was stated as the best because its selection depends on risk assessors, risk characteristics, and data availability (Van der Fels-Klerx et al. 2018). In addition, not all consumers' behaviours, considered as "green", always contribute to food safety (Kasza et al. 2022). Food risk issues do not only concern less economically developed countries, but also more developed ones, especially in terms of food waste issues (Jellil et al. 2018), the risks of obesity (Kozioł-Kozakowska et al. 2022), and chronical exposure to a mixture of pollutants, including those from food processes (Eskola et al. 2020). Pollution with heavy metals is one of the most severe aspects as these compounds originate from multiple sources and are resistant in the environment (Abd Elnabi et al. 2023). As plants may accumulate various pollutants simultaneously, the knowledge on the accumulation capability of the investigated plant is important (Chamba et al. 2016). Regarding pollution indices for heavy metals, the metal accumulation index (MAI) was applied in this research to evaluate the overall performance of the chosen edible plants that accumulate metals regarding the general belief that organic farming is more sustainable and environmentally friendly (Średnicka-Tober et al. 2016, Cristache et al. 2018). In our earlier studies (Gruszecka-Kosowska 2019a, 2019b, 2020, Gruszecka-Kosowska et al. 2019, 2020), the contents of heavy metals in arable soils and edible plants were investigated, as metals accumulate easily in the soil and then may migrate into the food chain through edible plants, posing a risk to consumer health.

The goal of this study was to investigate if the consumption among Polish customers was risk-indicative or sustainable based on the questionnaire surveys performed in reference to conventional and organic food products purchase, namely vegetables, fruits, and animal products. The detailed objectives were to investigate: (1) if socio-demographic features had an impact on buying certified organic vegetables and fruits by the consumer, (2) if the consumption of animal products revealed the sustainability features based on the frequency of the consumption of animal products, (3) which products, conventional or organic, indicated higher metal accumulation potential based on the MAI values. The article is a proverbial "brick" for activities that increase the level of consumer awareness and improve their quality of life and health. It refers to the declared behaviours within Polish households related to the consumption of animal products, fruit, and vegetables.

MATERIALS AND METHODS

Participants' recruitment and survey procedure

To determine the preferences of Poles regarding the purchase of food products, namely fruit, vegetables, and animal products, a questionnaire prepared by the authors was used in the study.

The questionnaire was divided into four sections. The first section was about determining the place of the actual purchase of food products, namely marketplaces, greengrocers, supermarkets, local stores, from own crops, in health food stores, and certified organic farming (this concerned only fruit and vegetables). In the second section, respondents were asked for the reasons of making their consumption decisions. If none of the proposed answers in the questionnaire suited the respondents, they could enter their own answer by choosing the category "other" and answering in their own words or they could simply select the response "I do not know". The third section of the questionnaire was about the amount of particular food types consumed. The study investigated the following products: fruit (in total, 32 types commonly grown and consumed in Poland), vegetables (36 types), as well as meat, fish, and eggs. Characteristic of the investigated fruits and vegetables according to their common and botanical name is presented in Table 1. Moreover, the following popular groups of animal products in Poland were investigated: unprocessed meat, namely beef, veal, pork, lamb, and poultry (chickens and roosters, turkeys, ducks, geese); processed meat, namely cold cuts, sausages, pates, canned meat, sea and freshwater fish (fresh, chilled, frozen, dried, smoked, salted), and chicken eggs. The fourth section contained questions on the socio-demographic characteristics of the respondents, namely gender, age, level of education, marital status, region (province) and area of residence, number of people in the household, and approximate net income. Moreover, those questions were asked in relation to particular groups of foods, namely fruit, vegetables, and animal products.

The chain-referral technique was used to distribute the survey among potential respondents due to the difficulty of recruiting people without any compensation for providing referrals and the highly likely situation that the respondents would be reluctant to be honest about their healthy or unhealthy eating habits. The exponential non-discriminative snowball sampling pattern was chosen to distribute the survey, in which the first respondent (authors) provided many respondents in the second wave, where subjects meeting the criteria were selected. The authors did not attempt reach any specified target group; the survey was more focused on performing the screening analysis since the survey topic is still quite innovative in Poland. Beside the above, the snowball method of sampling was also chosen due to its cost-effectiveness, easiness to find subjects, and discreetness in collecting responds and opinions (Dusek et al. 2015, Simkus 2020, Statistics Poland 2022).

The survey was prepared for completion electronically and was available for the participants between February and November 2017 via the Interankiety.pl website. Links to the survey were shared through research and social networks such as Research Gate, LinkedIn, and Facebook (Meta). At the beginning of the questionnaire, informed content was obtained and respondents reassured that the survey was anonymous, and its participants provided their answers voluntarily and free of charge. The respondent could only proceed with the survey after agreeing to the above conditions by clicking the "Agree" button. Bioethics committee approval was not required in the case of our studies. Regarding inclusion/exclusion criteria, only completely fulfilled questionnaires were considered for further evaluation in the study, questionnaires had to be completed by adults living in Poland, and by those responsible for supplying their households with the products analysed in the survey, namely vegetables, fruits, and animal products.

We obtained 74 questionnaires for the consumption of fruit, 108 for vegetables, and 67 for animal products. The survey results were only processed in the form of summary tables with no information how individual respondents replied to questions. Thus, the statistical analysis, including the normality of the distribution, were not investigated.

Table 1
Description of the fruit and vegetables investigated in this study

No.	Fruit		No.	Vegetables	
	Common name	**Botanical name**		**Common name**	**Botanical name**
1.	Apple	*Malus domestica*	1.	Arugula	*Eruca sativa*
2.	Apricot	*Prunus armeniaca*	2.	Asparagus	*Asparagus officinalis*
3.	Avocado	*Persea americana*	3.	Aubergine/ Eggplant	*Solanum melongena*
4.	Banana	*Musa x paradisiaca*	4.	Beans	*Phaseolus*
5.	Blackberry	*Rubus fruticosus*	5.	Beetroot	*Beta vulgaris*
6.	Black currant	*Ribes nigrum*	6.	Broccoli	*Brassica oleracea*
7.	Bluberry	*Vaccinium myrtillus*	7.	Broad beans	*Vicia faba*
8.	Cherry	*Prunus cerasus*	8.	Brussels	*Sprouts var. gemmifera*
9.	Chokeberry	*Aronia melanocarpa*	9.	Cauliflower	*Brassica oleracea var. botrytis*
10.	Gean	*Prunus avium*	10.	Cabbage	*Brassica oleracea var. botrytis*
11.	Gooseberry	*Ribes uva-crispa*	11.	Carrot	*Daucus carota*
12.	Grapefruit	*Citrus x paradisi*	12., 13.	Celery root/ Celery	*Apium graveolens var. rapaceum/ Apium graveolens*
13.	Grapes	*Vitis vinifera*	14.	Chives	*Allium schoenoprasum*
14.	Hawrthorn	*Crataegus oxyacantha*	15.	Corn	*Zea mays*
15.	Kiwi	*Actinidia*	16.	Cucumber	*Cucumis sativus*
16.	Lemon	*Citrus limon*	17.	Garlic	*Allium sativum*
17.	Mango	*Mangifera indica*	18.	Horseradish	*Armoracia rusticana*
18.	Nectarine	*Prunus persica var. nucipersica*	19.	Kohlrabi	*Brassica oleracea var. gongylodes*
19.	Orange	*Citrus x sinensis*	20.	Leek	*Allium porrum*
20.	Papaya	*Carica papaya*	21.	Lettuce	*Lactuca sativa*
21.	Peach	*Prunus persica*	22.	Lovage	*Armoracia rusticana*
22.	Pear	*Pyrus communis*	23.	Onion	*Allium cepa*
23.	Pineapple	*Ananas comosus*	24., 25.	Parsley tops/ Parsley root	*Petroselinum hortense*
24.	Plum	*Prunus domestica*	26.	Pea	*Pisum sativum*
25.	Raspberry	*Rubus idaeus*	27.	Potato	*Solanum tuberosum*
26.	Red currant	*Ribes rubrum*	28.	Pumpkin	*Cucurbita pepo*
27.	Rosehip	*Rosa canina*	29.	Radish	*Raphanus sativus var. sativus*
28.	Strawberry	*Fragaraia x ananassa Duchesne*	30.	Rhubarb	*Rheum rhaponticum*
29.	Tangerine	*Citrus reticulata*	31.	Spinach	*Brassica oleracea*
30.	Walnut	*Juglans regia*	32.–34.	Sweet pepper/ Ground pepper/ Hot pepper	*Capsicum annuum/ Piper nigrum/ Capsicum frutescens*
31.	Watermelon	*Citrullus lanatus*	35.	Tomato	*Lycopersicon esculentum*
32.	Wild strawberry	*Fragaria vesca*	36.	Zucchini/ Squash	*Cucurbita pepo convar. giromontiina greb*

Objective, hypothesis, and research procedures

The main objective of this study was to investigate the correlation between the socio-demographic parameters of the respondents and the consumer decisions on choosing organic fruit and vegetables. To analyse this correlation, a general hypothesis was formulated as follows:

H1. It is expected that socio-demographic features like gender, marital status, level of education, and income have an impact on choosing certified organic products namely fruit and vegetables.

From this hypothesis, four specific hypotheses were stated based on those socio-demographic features for which in particular questions response groups were not equal to 0.

H1.1. More female consumers compared to males choose certified organic fruit and vegetables.

H1.2. More married/ in relation consumers compared to single/ divorced/ widowed choose certified organic fruit and vegetables.

H1.3. More consumers with higher indicative net income compared to those with lower indicative net income choose certified organic fruit and vegetables.

H1.4. More consumers with higher educational level compared to those with lower educational level choose certified organic fruit and vegetables.

As we obtained qualitative results in our survey to investigate the validity of the stated hypotheses, the chi-squared test was applied using Excel software (Microsoft 365). In the case when calculated p-values were >0.05, it confirmed the validity of the hypothesis, while p-values were <0.05 it confirmed the validity of the alternative hypothesis.

As a primary risk-indicative trend in the consumption of fruit and vegetables, the aspect of avoiding the choice of purchasing food in places selling certified organic food was assumed. For this purpose, the respondents' choices regarding the purchase of fruit, vegetables and animal products were compared, and then the chi-squared test was performed for the results related to certified organic farming of fruit and vegetables, according to their socio-demographic characteristics.

Metal accumulation index (MAI)

In this study we only calculated MAI index for vegetables since heavy metal concentrations were investigated in our previous study in 2017 in the Małopolskie region in vegetables cultivated in both a traditional and organic manner. The vegetables that were used for the MAI index investigations are presented in Table 2. Based on the calculated MAI index values, we analysed the accumulation from individual and total heavy metals (As, Cd, Co, Cu, Hg, Pb, Ni, Sb, Tl, and Zn) for conventionally and organically cultivated vegetables.

Table 2
The types of vegetables cultivated both conventionally and organically used for the MAI index value calculations in the study

Plant part	Vegetable cultivated both conventionally and organic
Leaf	beetroot, spring onion, cabbage, parsley, lettuce, chive, spinach, rhubarb
Fruit	zucchini, pumpkin, cucumber,
Legume	green bean
Root	beetroot, radish, celery
Tuber	garlic, potato
Seed	broad bean, pea, pumpkin seed

Values of the MAI index were calculated according to the following equations (Liu et al. 2007):

$$\mathrm{MAI} = \frac{1}{N} \cdot \sum_{j=1}^{N} Ij \tag{1}$$

$$Ij = \frac{x}{\delta x} \tag{2}$$

where:
MAI – metal accumulation index,
N – total number of investigated metals (10 in our studies),
Ij – sub-index for metal j,
x – mean value of each metal,
δx – each metal standard deviation.

The higher the MAI value, the higher overall ability for metal accumulation for the plant species.

RESULTS

Descriptive statistics of survey responses

The descriptive socio-demographic characteristics of the respondents considering three food product types, namely fruit, vegetables, and animal products are presented in Table 3. The survey results for all types of products indictated that the majority of responses were given by females (74% for fruit, 73% for vegetables, and 76% for animal products). In terms of age, the most replies were obtained from the 31 to 40 years old age group from (35% for fruit, 41% for vegetables, and 34% for animal products). Regarding educational level, the majority of responses was obtained from respondents with a higher level of education (67% for fruit, 68% for vegetables, and 67% for animal products). Furthermore, the majority of responses were received from married/in relationship respondents (55% for fruit, 59% for vegetables, and 57% for animal products). Most of the responses came from two of the 16 provinces in Poland, namely the Małopolskie (34% for fruit, 22% for vegetables, and 36% for animal products) and Opolskie voivodeships (23% for fruit, 25% for vegetables, and 25% for animal products). The majority of the responses came from large cities of between 751,000 and 1,000,000 inhabitants (26% for fruit, 22% for vegetables, and 27% for animal products). Regarding the number of people in households, the majority of respondents indicated 2 persons (41% for fruit, 44% for vegetables, and 40% for animal products). Considering the declared net income, most of the respondents indicated a value between PLN 1001–3000 (US$ 251.7–754.5) (45% for fruit, 52% for vegetables, and 45% for animal products).

Table 3
The socio-demographic characteristics of Polish respondents divided into sections: fruit, vegetables, and animal products

Demographic factor	Fruit		Vegetables		Animal products	
	Frequency (*n* = 74)	Percentage [%]	Frequency (*n* = 108)	Percentage [%]	Frequency (*n* = 67)	Percentage [%]
Gender						
Male	19	26	29	27	16	24
Female	55	74	79	73	51	76
Refusal to answer	0	0	0	0	0	0
Age						
18–20 years	3	2	2	2	0	0
21–30 years	16	22	24	22	14	21
31–40 years	26	35	44	41	23	34
41–50 years	11	15	13	12	10	15
51–60 years	5	7	9	8	6	9
61–70 years	7	9	10	9	6	9
Over 70 years	5	7	6	6	5	7
Refusal to answer	1	1	0	0	3	3
Educational level						
Secondary education	5	7	7	2	4	6
Secondary vocational	3	4	2	2	2	3
Post-secondary	7	10	9	8	6	9
Higher vocational	3	4	4	4	2	5
Bachelor's degree	4	5	9	8	4	6
Master's degree	49	67	73	68	44	67
Other	0	0	3	3	0	0
Refusal to answer	0	0	2	2	4	4

***Table 3** cont.*

Demographic factor	Fruit		Vegetables		Animal products	
	Frequency (n = 74)	Percentage [%]	Frequency (n = 108)	Percentage [%]	Frequency (n = 67)	Percentage [%]
Marital status						
Single	24	32	31	29	21	31
Married/in a relationship	41	55	64	59	38	57
Separation/after divorce	2	3	4	4	2	3
Widowed	4	5	5	5	4	6
Refusal to answer	2	3	4	3	2	3
Region of Poland (voivodeship/ province)						
Dolnośląskie	12	16	14	13	10	15
Kujawsko-Pomorskie	1	1	1	1	1	1
Lubuskie	0	0	2	2	0	0
Łódzkie	2	3	20	19	2	3
Małopolskie	25	34	24	22	24	36
Opolskie	17	23	27	25	17	25
Podkarpackie	2	3	1	1	2	3
Pomorskie	1	1	1	1	0	0
Śląskie	4	5	5	5	2	3
Warmińsko-Mazurskie	1	1	4	4	0	0
Wielkopolskie	3	4	3	3	3	4
Zachodniopomorskie	1	1	4	4	0	0
Refusal to answer	1	1	0	0	3	4
Area of residence (number of inhabitants)						
Countryside, agricultural area	8	11	9	8	9	13
Countryside, industrialized area	0	0	3	3	0	0
City, up to 20,000	1	1	5	5	1	1
City, 21,000–100,000	8	11	8	7	4	6
City, 101,000–250,000	14	19	20	19	16	24
City, 251,000–500,000	5	7	10	9	3	4
City, 501,000–750,000	7	9	9	8	4	6
City, 751,000–1,000,000	19	26	24	22	18	27
City, over 1,000,000	9	12	16	15	9	13
Refusal to answer	3	4	4	4	3	4
Number of people in the household						
1	16	12	16	15	10	15
2	30	41	47	44	27	40
3	13	18	15	14	10	15
4	11	15	19	18	11	16
5	5	7	5	5	5	8
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	0	0	1	1	0	0
Refusal to answer	1	1	3	3	2	3
Indicative net income PLN [USD]						
Up to PLN 1000 [US$ 251.5]	4	5	3	3	3	4
PLN 1001–3000 [US$ 251.7–754.5]	33	45	56	52	30	45
PLN 3001–5000 [US$ 754.8–1257.6]	12	16	16	15	11	16
PLN 5001–7000 [US$ 1257.8–1760.6]	11	15	13	12	7	10
PLN 7001–9000 [US$ 1760.8–2263.6]	1	1	3	3	0	0
Over PLN 9000 [US$ 2263.6]	2	3	2	2	3	4
Refusal to answer	11	15	15	14	13	19

Risk-indicative trends in the food consumption

Places specializing in the sale of organic food were not popular places for the purchasing of food by the surveyed group of Poles (Fig. 1). Respondents more often chose a different place to buy food, such as supermarkets and local shops. As part of the more balanced choices of the respondents, eggs were most often purchased from farmers (45% of responses), meat – from a butcher (27%), while fruit and vegetables were from one's own crops (22% each). In the question of the purchasing of food products from certified organic crops, most answers also indicated the lack of the interest of respondents in obtaining certified products as 77% of negative answers on fruit certified products and 70% of negative answers on fruit certified products (Fig. 2).

The choices related to the decision as to whether to supply one's household with fruit and vegetables from certified organic farms were related to the for and against arguments articulated by the respondents. In the group indicating the reasons for purchasing certified organic products, the respondents' answers mainly indicated a positive impact on health (Fig. 3), namely the desire for healthy eating (fruit 32% of the answers, vegetables 30%) and perceived by respondents as healthier than those purchased elsewhere (fruit 20% of the answers, vegetables 28%).

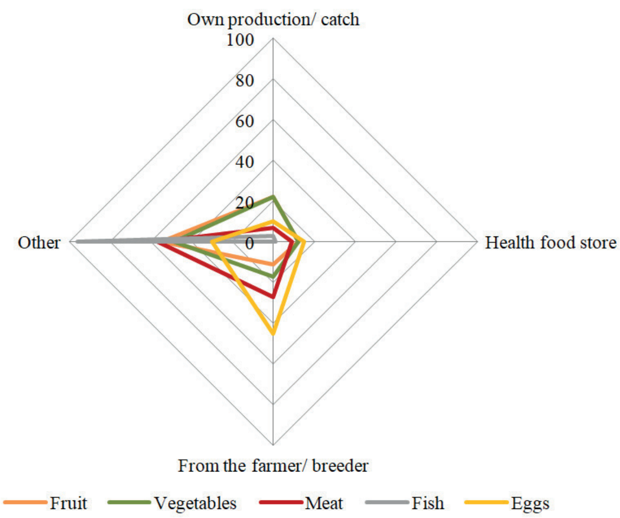

***Fig. 1.** Food products' supply places [%], regarding to the respondents*

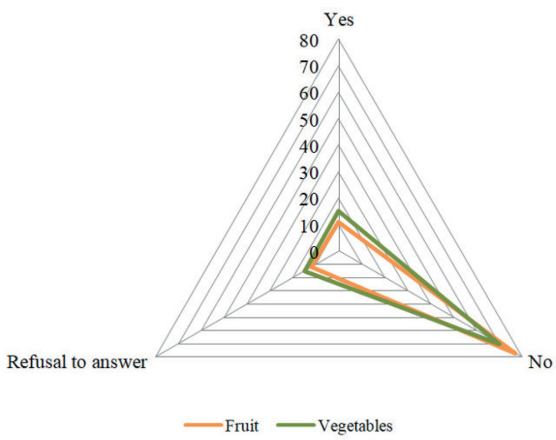

***Fig. 2.** Declaration of purchasing food products from certified organic farming [%], according to the respondents*

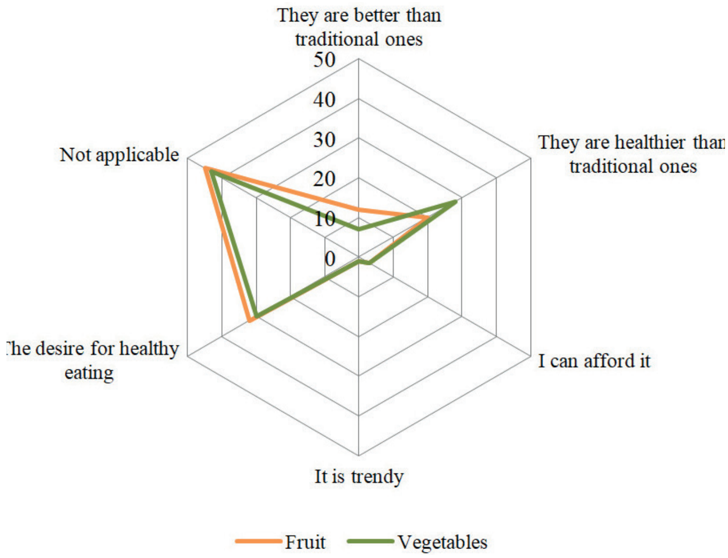

***Fig. 3.** Reasons for purchasing fruit and vegetables from certified organic farming [%]*

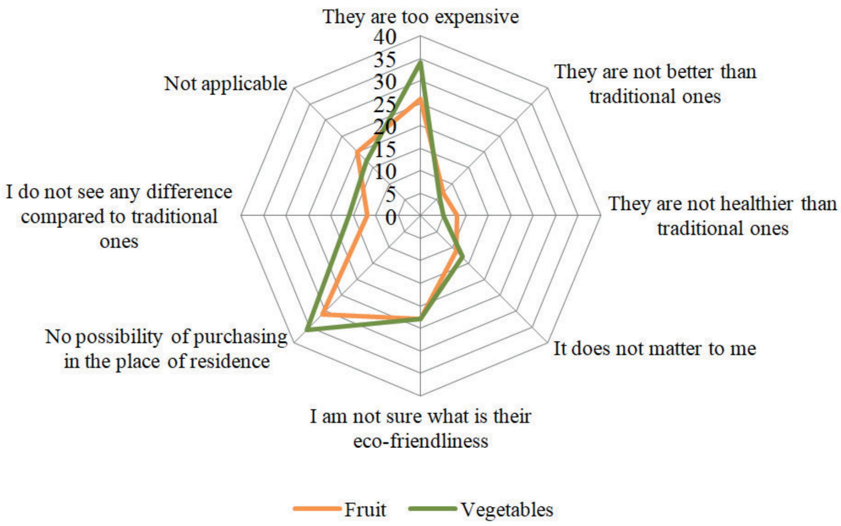

***Fig. 4.** Reasons for not purchasing fruit and vegetables from certified organic farming [%]*

In the group of statements against choosing certified organic products, the most frequent arguments were related mainly to (Fig. 4): the distant location of certified organic food sales points (fruit 31% of the answers, vegetables 36%), higher prices (fruit 26% of the answers, vegetables 34%), and the lack of certainty regarding their genuine environmental friendliness (fruit 23%, vegetables 23%).

An additional established risk-indicative trend in the consumption of animal products was the aspect of the excessive frequency of consumption, especially in processed form. The conducted research allowed for the emergence of the observation that within the surveyed group of respondents, chicken was most often consumed, followed by pork, turkey, duck, beef, veal, and lamb (Fig. 5A, B). Very regular, i.e., weekly consumption (covering the range from 1 to 6 times a week) mainly concerned eggs (79%), processed meat (58%), and unprocessed meat – pork (49%). The consumption of fish (38%) and beef and chicken (24% each) was also observed. In terms of frequency, the least consumed animal products were unprocessed goose, duck, mutton, and lamb.

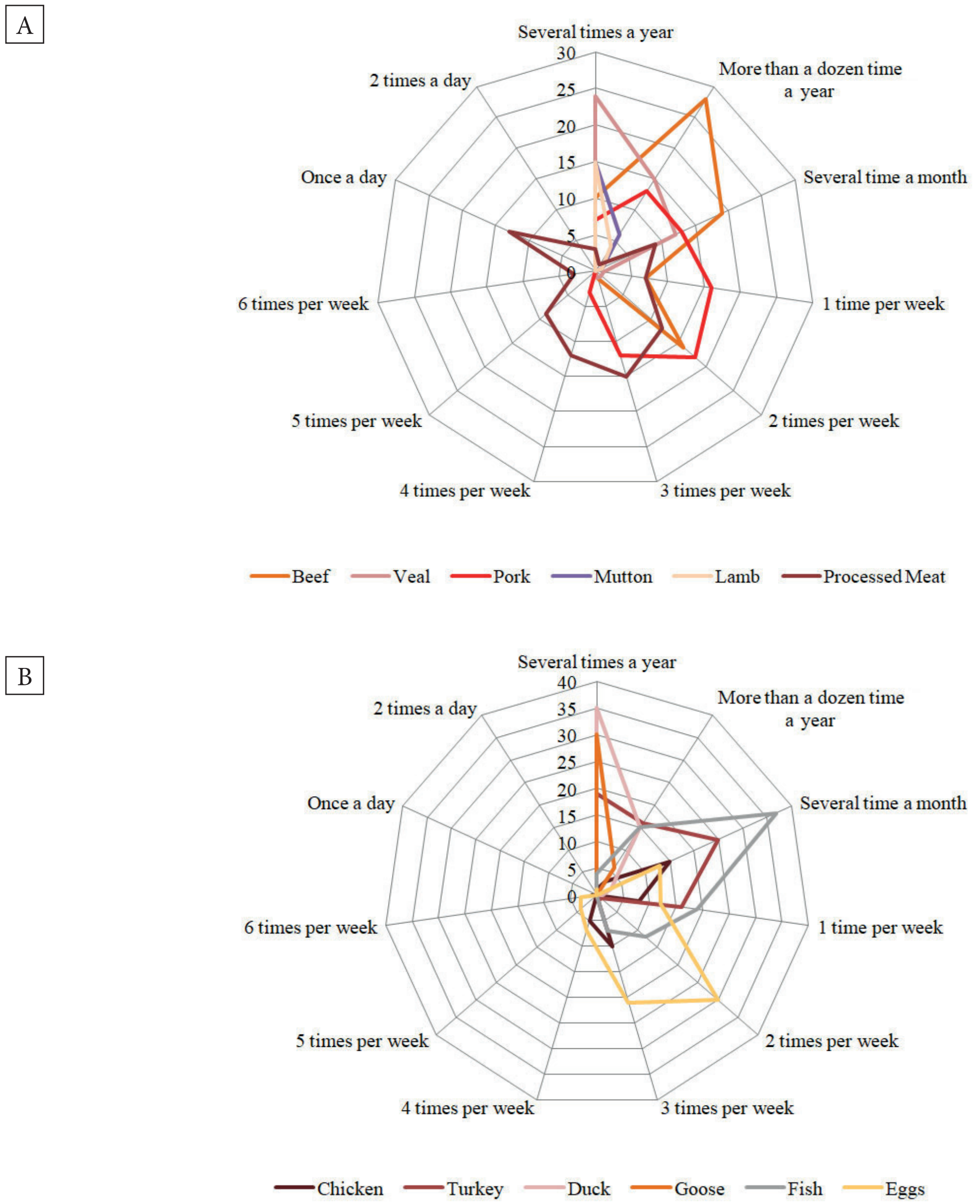

Fig. 5. *The frequency of animal products' consumption [%] among respondents: A) beef, veal, pork, mutton, lamb, processed meat; B) chicken, turkey, duck, goose, fish, eggs*

Socio-demographic variables and certified organic food purchase

To analyse whether the socio-demographic featured declared by the respondents were correlated with the purchase of certified food products, the chi-squared tests were performed. The first specific hypothesis *H1.1. More female consumers compared to males choose certified organic fruit and vegetables* was not supported by the results for fruits (Table 4) but was supported for vegetables (Table 5) indicating that buying certified organic vegetables was statistically significant for females. The second specific hypothesis *H1.2. More married/in relation consumers compared to single/divorced/widowed choose certified organic fruit and vegetables* was not supported by the results for fruits (Table 6) and was supported for vegetables (Table 7), showing that purchasing certified organic vegetables was statistically significant for married respondents and those in relationships. The third specific hypothesis

H1.3. More consumers with higher indicative net income compared to those with lower indicative net income choose certified organic fruit and vegetables was not supported by the results for both fruits (Table 8) and vegetables (Table 9), revealing that declared net income was not a statistically significant factor for purchasing organic food products among respondents. The fourth specific hypothesis *H1.4. More consumers with higher educational level compared to those with lower educational level choose certified organic fruit and vegetables* was supported by the results for both fruits (Table 10) and vegetables (Table 11), indicating that the educational level of respondents was statistically significant in decisions on purchasing certified organic products.

Table 4
The purchasing of fruit from certified organic farms, according to the gender of the respondents

Respondent's answer	Observed		Expected		*p*-value
	Male	Female	Male	Female	
Yes	7	1	5.9459	2.0541	0.2973
No	43	14	42.3649	14.6351	
I do not know	5	4	6.6892	2.3108	
Decision	Reject the H1.1				

Table 5
The purchasing of vegetables from certified organic farms, according to the gender of the respondents

Respondent's answer	Observed		Expected		*p*-value
	Male	Female	Male	Female	
Yes	13	2	10.9722	4.0278	0.0018
No	60	17	56.3241	20.6759	
I do not know	6	10	11.7037	4.2963	
Decision	Retain the H1.1				

Table 6
The purchasing of fruit from certified organic farms, according to the marital status of the respondents

Respondent's answer	Observed				Expected				*p*-value
	Single	Married/ in relation	Separation/ after divorce	Widowed	Single	Married/ in relation	Separation/ after divorce	Widowed	
Yes	2	4	0	2	2.5946	4.4324	0.2162	0.4324	0.0702
No	17	34	1	2	18.1622	31.0270	0.2703	3.0270	
I do not know	5	3	1	0	3.2432	5.5405	0.2703	0.4054	
Decision	Reject the H1.2								

Table 7
The purchasing of vegetables from certified organic farms, according to the marital status of the respondents

Respondent's answer	Observed				Expected				*p*-value
	Single	Married/ in relation	Separation/ after divorce	Widowed	Single	Married/ in relation	Separation/ after divorce	Widowed	
Yes	3	10	0	1	5.1667	10.5000	0.5000	0.8333	0.0073
No	23	46	1	4	21.5278	43.7500	2.0833	3.4722	
I do not know	5	7	2	0	4.3056	8.7500	0.4167	0.6944	
Decision	Retain the H1.2								

Table 8
The purchasing of fruit from certified organic farms, according to the indicative net income [PLN] of the respondents

Respondent's answer	Observed							Expected							p-value
	Up to PLN 1000	PLN 1001–3000	PLN 3001–5000	PLN 5001–7000	PLN 7001–9000	Over PLN 9000	Refusal to answer	Up to PLN 1000	PLN 1001–3000	PLN 3001–5000	PLN 5001–7000	PLN 7001–9000	Over PLN 9000	Refusal to answer	
Yes	0	3	1	3	0	1	0	0.4324	3.5676	1.2973	1.1892	0.1081	0.2162	1.1892	0.1165
No	4	25	10	8	0	1	9	3.0811	25.4189	9.2432	8.4730	0.7703	1.5405	8.4730	
I do not know	0	5	1	0	1	0	2	0.4865	4.0135	1.4595	1.3378	0.1216	0.2432	1.3378	
Decision	Reject the H1.3														

Table 9
The purchasing of vegetables from certified organic farms, according to the indicative net income [PLN] of the respondents

Respondent's answer	Observed							Expected							p-value
	Up to PLN 1000	PLN 1001–3000	PLN 3001–5000	PLN 5001–7000	PLN 7001–9000	Over PLN 9000	Refusal to answer	Up to PLN 1000	PLN 1001–3000	PLN 3001–5000	PLN 5001–7000	PLN 7001–9000	Over PLN 9000	Refusal to answer	
Yes	0	7	0	3	0	1	6	0.3148	8.8148	2.3611	2.0463	0.4722	0.3148	2.6759	0.1345
No	2	42	13	10	2	1	7	1.4259	39.9259	10.6944	9.2685	2.1389	1.4259	12.1204	
I do not know	0	7	2	0	1	0	4	0.2593	7.2593	1.9444	1.6852	0.3889	0.2593	2.2037	
Decision	Rejects the H1.3														

Table 10
The purchasing of fruit from certified organic farms, according to the educational level of the respondents

Respondent's answer	Observed						Expected						p-value
	Secondary education	Secondary vocational	Post-secondary	Higher vocational	Bachelor's degree	Master's degree	Secondary education	Secondary vocational	Post-secondary	Higher vocational	Bachelor's degree	Master's degree	
Yes	2	0	1	1	0	4	0.5405	0.3243	0.7568	0.4324	0.4324	5.5135	0.0169
No	1	1	5	2	3	44	3.7838	2.2703	5.2973	3.0270	3.0270	38.5946	
I do not know	2	2	1	1	1	3	0.6757	0.4054	0.9459	0.5405	0.5405	6.8919	
Decision	Retain the H1.4												

Table 11
The purchasing of vegetables from certified organic farms, according to the educational level of the respondents

Respondent's answer	Observed							Expected							p-value
	Secondary education	Secondary vocational	Post-secondary	Higher vocational	Bachelor's degree	Master's degree	Refusal to answer	Secondary education	Secondary vocational	Post-secondary	Higher vocational	Bachelor's degree	Master's degree	Refusal to answer	
Yes	0	0	4	1	1	8	2	0.4444	0.8889	1.3333	0.5926	1.3333	10.5185	0.8889	0.0032
No	1	5	4	2	4	58	2	2.1111	4.2222	6.3333	2.8148	6.3333	49.9630	4.2222	
I do not know	2	1	1	1	4	5	2	0.4444	0.8889	1.3333	0.5926	1.3333	10.5185	0.8889	
Decision	Retain the H1.4														

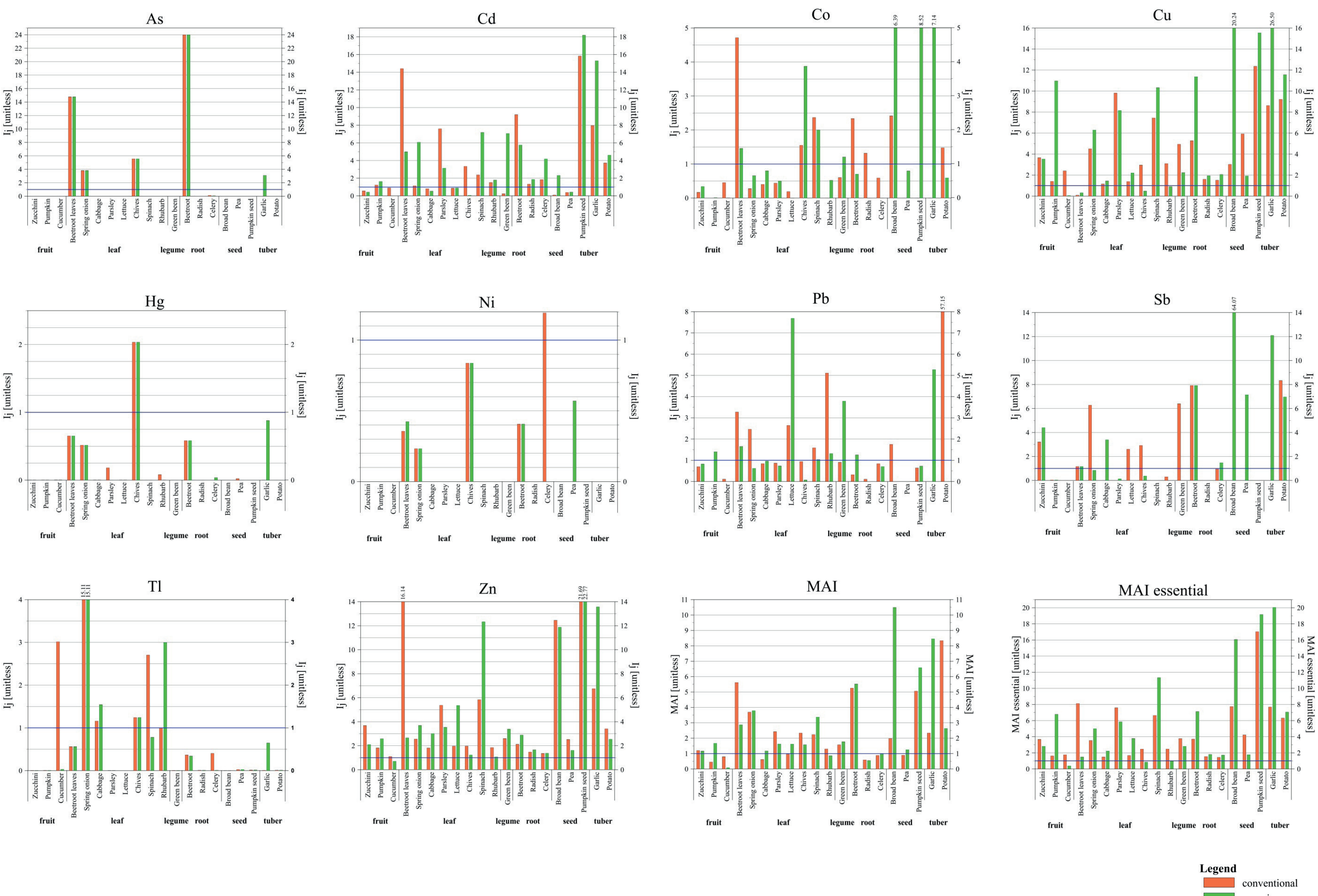

Fig. 6. Metal accumulation in vegetables cultivated conventionally and organically based on the MAI index values

Heavy metal accumulation in conventionally and organically cultivated vegetables

The results of the calculated MAI index values are presented in Figure 6. Considering the mean values of the MAI index, metal accumulation was higher for conventionally cultivated vegetables in the following plant parts: fruits (except for pumpkin), leaves (except for spring onion, cabbage, lettuce, and spinach), and tubers (except for garlic). Regarding the highest share in the MAI index values ($I > 1$) in edible parts of investigated vegetables the decreasing order of heavy metals was as follows: fruit: Cu > Zn > Sb > Tl; leaf: Zn > Cd > Cu > As > Tl > Pb > Co; legume: Sb > Cu > Zn; root: As > Cd > Sb > Cu > Zn; seed: Zn > Cu > Cd; tuber: Pb > Cu > Cd > Zn. For the total MAI index, its mean values in the conventionally investigated groups of vegetables were decreasingly ordered as follows: tuber > seed > leaf > root > legume > fruit. Considering two essential elements, the decreasing order of MAI index values for Cu and Zn in investigated conventionally cultivated vegetables were as follows: seed > tuber > leaf > legume > fruit > root. For vegetables cultivated conventionally, the total MAI values were observed in the following decreasing order: tuber (2.33–8.33, mean 5.33); seed (0.89–5.05, 2.64); leaf (0.62–5.61, 2.40); root (0.58–5.25, 2.24); legume (1.57); fruit (0.45–1.20, 0.82). For individual parts of vegetables, the mean I values for individual heavy metals were ordered decreasingly as follows: fruits: Cu > Zn > Sb > Tl > Cd > Pb > Co > Hg > As > Ni; leaf: Zn > Cd > Cu > As > Tl > Pb > Sb > Co > Hg > Ni; root: As > Cd > Sb > Cu > Zn > Co > Ni > Pb > Tl > Hg; seed: Zn > Cu > Cd > Co > Pb > Tl > Hg > As > Sb > Ni; tuber: Pb > Cu > Cd > Zn > Sb > Co > Tl > As > Hg > Ni.

In the organically cultivated groups of vegetables, the mean values of the total MAI index were decreasingly ordered as follows: seed > tuber > root > leaf > legume > fruit. Considering two essential elements, the decreasing order of MAI index values for Cu and Zn in investigated organically cultivated vegetables were as follows: tuber > seed > leaf > root > fruit > legume. In the organically cultivated vegetables, the total MAI index values were higher for following plant parts: legume (except for green beans), root (except for radish), and seed. Regarding the highest share of the particular metals in the MAI index ($I > 1$) among groups of investigated edible plants was following: fruit: Cu > Zn > Sb; leaf: Zn > Cu > Cd > As > Tl > Pb; legume: Cd > Pb > Zn > Cu > Co; root: As > Cu > Cd > Sb > Zn; seed: Sb > Cu > Zn > Cd > Co; tuber: Cu > Cd > Sb > Zn > Co > Pb > As. For organically cultivated vegetables, the decreasing order of the total MAI values was stated: seed (1.25–10.5, mean 6.10); tuber (2.63–8.45, 5.54); root (0.55–5.52, 2.35); leaf (0.86–3.78, 2.11); legume (1.77); fruit (0.08–1.66, 0.97). For individual parts of vegetables, decreasing order of the I value in the total MAI value was as follows: fruit: Cu > Zn > Sb > Pb > Cd > Co > Tl > Hg > As > Ni; leaf: Zn > Cu > Cd > As > Tl > Pb > Co > Sb > Hg > Ni; root: As > Cu > Cd > Sb > Zn > Pb > Co > Hg > Ni > Tl; seed: Sb > Cu > Zn > Cd > Co > Pb > Ni > Tl > As > Hg; tuber: Cu > Cd> Sb > Zn > Co > Pb > As > Hg > Tl > Ni.

DISCUSSION

The results of our research showed an unfavourable trend in the consumption of food products for all investigated food groups. The Poles surveyed were reluctant and/or quite rarely bought food in health food stores and organic food from certified farms. Respondents most often bought food products in places not too far from their place of residence, e.g., in convenience stores or supermarkets. In our research, among such food products as fruit, vegetables, meat, fish, and eggs, the latter were most often purchased directly from the farmer, indicating the most pro-sustainable solutions for purchasing products. As the second, the cultivation of one's own fruit and vegetable crops was mentioned. Our research made it possible to specify a group of factors that attract consumers to purchase organic food, mainly those related to health, treating organic food as healthier than conventional food, and the desire to pay more attention to one's own health, especially in the area of food product consumption. Research conducted in Hungary emphasized, among other features, that self-interest prevailed over socially responsible behaviour when making decisions about food consumption (Bauerné Gáthy et al. 2022).

Consumers' risk perception towards conventional and organic food consumption behaviour in Poland has also been investigated by Woś et al. (2022) and Dudziak & Kocira (2022). However, both surveys had a limited range of respondents: the first study focused on mothers of children up to 6 years of age (Woś et al. 2022) and the second on the inhabitants of one province in Poland – Lublin Province (Dudziak & Kocira 2022). The relationship between a low-quality diet and selected metabolic diseases in Poland was investigated by Gajda et al. (2023). Similarly, the impact of a pro-inflammatory diet on cardiovascular risk factors in Poland was investigated by Szypowska et al. (2023).

Of course, these two factors were not the only ones that shape consumer behaviour since much depends on the type of perspective adopted. Li & Jaharuddin (2022) proposed dividing the perspectives of Chinese consumers into three background factors: individual – regarding the purchasing attitude and health awareness, social – e.g., ecological and information – related to labelling, health awareness, self-perception of vegetarianism, and information in social media. These researchers also noted the important moderating role of oral communication face-to-face or through social networks (referred to by them as Word-of-Mouth) to reinforce purchasing decisions (Li & Jaharuddin 2022). Other factors included elements related to the organizational culture of the producer. For example, research conducted in Thailand by Hengboriboon et al. (2022) showed that both the product image and the company's reputation were key factors influencing the prospects and purchasing intentions of consumers.

Our research also found that factors that pushed consumers away from buying organic food included: the distance between where they live and where they buy organic food, the higher price, and the lack of certainty about the aspect of their real environmental friendliness. The first of these factors was confirmed in the results of research conducted in Central Texas by the team of Janda et al. (2022) that noted, among others, that geographical access to food was directly related to the consumption of fresh products. The second of these factors was also confirmed in the EFSA report. It showed that, among others, the cost of food, taste, safety (the existence of risk associated with consumption), and origin, primarily affected decisions related to food within the European Union. Other factors mentioned by EU consumers were also nutrient content, the impact on the environment and climate, ethics, and beliefs. In the case of Poland, it was also the cost and taste that determined purchasing decisions – such answers were indicated by more than half of the respondents (European Food Safety Authority 2022). Arguments for not consuming organic food also indicated low consumer confidence in such food. Consumers of organic food can be also divided into segments, e.g., incognizant consumers, unconcerned consumers, critical consumers, conservative consumers, and congruent consumers (Gumber & Rana 2021). By comparing the above information, we could see differences between health and environmental values. The first group predominated in our group of respondents. Vega-Zamora et al. (2013) defined them more bluntly, dividing them into egoistic (health-related) and altruistic (environmental) values. They also noted that the consumption of organic food was perceived as a means – a way to achieve health, and not as an expression of environmental values. The purchase and consumption of organic food was not a goal, but an intermediary.

However, much of the previous research indicated that high prices are a major barrier to the consumption of organic food products (Hansmann et al. 2020, Kociszewski et al. 2023). Apart from monetary value, other barriers and drivers of the low consumption of organic food products were: limited variety and availability, low visibility in the shop, inadequate information and convenience on the higher quality of the organic food product, the extra time involved in buying organic food, perception and trust in labelling and certification of the organic products, tradition in buying food product based on the sensory experiences, shorter expiration date of the organic products, habit and satisfaction with the conventional product, confusion or lack of knowledge on organic food, scepticism or lack of trust the quality of organic food available in the market, or low production efficiency (Kushwah et al. 2019).

Conducting the chi-squared test allowed us to check how socio-demographic characteristics influence the selection of certified organic products when purchasing fruit and vegetables. They indicated certain trends that are not always identical in the area of fruit and vegetable consumption. Whether the consumer is a woman or a man (women more often decided to buy organic food) and what is their marital status – running a household independently or co-running it (singles decided to buy organic food more often), determined the purchase of organic fruit, but it did not affect the consumption of organic vegetables. The common feature that determined the decision to purchase organic food (for fruit and vegetable consumption) is the respondents' income level, which translates into the price argument that determines the decision to purchase organic food. On the other hand, the characteristics that had no influence included educational level (for fruit and vegetables). These results were in accordance with previous research on organic foods. The gender feature was indicated in the previously mentioned study on awareness – women were more aware than men, as well younger people being more aware than older people (Fatha & Ayoubi 2021). However, in the study conducted in Italy by Bimbo et al. (2022) people interested in organic food were consumers e.g., middle-aged, with high professional status and well-educated. Regarding the age of the consumers, there are studies that showed that younger people are more optimistic about consuming organic food (Annunziata et al. 2019). However, there are also studies that have indicated that, despite being more favorable towards organic food and declaring that they bought it more often, this was not supported by the numbers since younger consumers often could not afford to buy organic products due to their lower salaries and adults were the most abundant group that bought organic food products (Thanki et al. 2022, Yilmaz 2023).

The last of the features mentioned, however, was not confirmed by other studies. For example, the frequency of online organic food purchases in the Czech Republic increased with the level of education. The same applied to the respondents' income (Zámková et al. 2022). However, unlike our research, the studies conducted in the Czech Republic were not directly related to the purchase of food, but through online channels. In contrast, a study in Romania on the characteristics of organic products showed that consumers, regardless of their socio-demographic background, paid attention to more or less the same inherent characteristics of organic products. The characteristics related to the level of education and income in the decision-making process influenced the choice of organic products, with given external characteristics related to their price, brand, and labels (Brata et al. 2022).

The second aspect related to sustainable choices concerned the consumption of animal products. Our research showed that in this space, consumers most often chose red meat – above all pork, followed by beef, veal, and lamb. Among red meat, pork (the most frequently consumed) and mutton, along with lamb (the least consumed) were in the extreme positions. Among the white meat, chicken was most often consumed and goose meat the least. More than half of the respondents consumed processed meat from 1 to 5 times a week. However, fish was not often chosen by our respondents. Most often, fish was eaten several times a month (about 1/4 of the answers), once a week (about 1/5), and several times a year (over 1/10). The above indicated a trend of a slight orientation towards sustainability in the consumption of meat and fish by respondents from Poland. The study's findings were also consistent with other studies regarding the popularity of diets containing meat in Poland (Kuczuk & Widera 2021), the growing popularity of chicken around the world (Whitton et al. 2021), as well as the high consumption of red meat (pork and beef) and processed meat (e.g., cold cuts, sausages, bacon) (Stoś et al. 2022). On the other hand, the unsatisfactory consumption of fish in Poland was also emphasized in other studies, e.g., Kosicka-Gębska & Ładecka (2012), and Rejman et al. (2015).

In terms of egg consumption, the results were more satisfactory in the context of sustainable choices than in the case of meat and fish. Most often, in the study group, 1–3 eggs were eaten a week. From our results, it can be concluded that more than half of the respondents consumed eggs in a moderate way, i.e., between 2–5 eggs a week. Moderate egg consumption was in the safe zone, especially in the light of research conducted in China by Xia et al. (2020) indicating that both low and high egg consumption might be associated with the occurrence of cardiovascular disease. This is also confirmed by the results of Korean research conducted by Park et al. (2018) recommending, among others eating 4–7 eggs a week to lower the risk of metabolic syndrome.

Regarding the potential of the investigated vegetables to accumulate metals, the study of Intawongse & Dean (2006) revealed that certain crops such as spinach, lettuce, carrot, radish, and courgette can accumulate heavy metals in their tissues, e.g., Cd, Cu, Mn, Pb and Zn. The general trend was observed that the uptake increased in plants that were grown in areas characterised by higher soil contamination, and Cd and Zn are fairly mobile and readily absorbed by plants (Intawongse & Dean 2006). On the other hand, Cu and Pb were strongly adsorbed into soil particles, reducing their availability to plants as they are bound to organic matter and being absorbed by carbonate minerals and hydrous iron and manganese oxides (Intawongse & Dean 2006). The above showed that regarding the production of conventional and organic food, apart from natural factors like geochemistry, soil properties, environmental pollution in the region of cultivation, the amount and circulation rate of the plant protection product should also be considered when analysing accumulation patterns.

As synthetic fertilizer may contain more heavy metals than is expected, the content of metals should be lower in the products from organic farming. However, organic agriculture highly relies on organic fertilizers, animal manure, and copper-based fungicides, which could result in a considerable level of metals in organic agriculture (Abeywickrama & Wansapala 2019). The research of Xavier et al. (2020) performed in the Mysore region, Karnataka, Southern India on heavy metal contents among conventional, organic, and protected vegetables revealed that Pb and Cd were only present in conventionally grown vegetable samples, exceeding the safe limit of Pb (0.3 ppm) in fenugreek leaves, cauliflower, amaranthus coriander, palak, brinjal (aubergine), horse gram, and Bengal gram and Cd (0.2 ppm) in brinjal, horse gram. In organically grown and protected cultivated crops, no metal contents were found and the nutrient contents were higher than compared with the conventionally cultivated vegetables. As Cd, Pb Cu, and Zn are the main metals present in the commonly used fertilizers (Alengebawy et al. 2021), their elevated contents in edible plants might be related to their introduction with plant protection products in the food chain during the cultivation process.

The research of Hadayat et al. (2018) on metal concentrations in the five most-consumed vegetables grown conventionally and organically in the United States, namely potato, lettuce, tomato, carrot, and onion, indicated that metal contents in organic vegetables were lower than in conventional vegetables, especially for Cd and Pb. Similar results were also obtained in research performed in Greece (Karavoltsos et al. 2008), France (Malmauret et al. 2002), and Italy (Ghidini et al. 2005). In the studies of Hoefkens et al. (2009), Liñero et al. (2015), and Cámara-Martos et al. (2021), similar contents of metals were reported between organically and conventionally grown vegetables. The studies of Krejčová et al. (2016) in Czech Republic and Arslanbas & Baydan (2013) in Turkey on the metal content in carrots reported no difference in As, Cd, Pb, and Cr and Cd and Pb levels between organic and conventional cultivation.

Our calculations of the MAI index showing the ability of the overall heavy metal accumulation in plants revealed that the metal accumulation was higher for the majority of the conventionally cultivated vegetables investigated than in the case of those cultivated organically. This could indicate the presence of heavy metals in products used during the vegetable cultivation as well as the pollution of the environment. Higher MAI values in organically cultivated vegetables were stated for pumpkin (vegetable part fruit), spring onion, cabbage, lettuce, and spinach (vegetable part leaf) and garlic (plant part tuber). For organically cultivated vegetables, possible reasons are the pollution of the environment where vegetables are cultivated and/or food fraud in the form of using forbidden products in certified organic plant cultivation. Research on the metal content in vegetables collected from conventional and organic farms in Poland (Głodowska & Krawczyk 2017) revealed significant differences between vegetables cultivated in these two growing systems, however conventionally grown vegetables tend to contain higher concentrations of some elements and celery and parsley leaves assimilated more heavy metals in comparison to other vegetables. Studies on the level of metal in fruits and leaves of organic, conventional, and wild raspberries performed in Poland by Kotuła et al. (2022) indicated that fruit from organic farming contained more Cd, Zn, Mn, and V compared to conventional cultivation and wild-growing raspberry fruits had higher contents of Cd, Zn, Co, and Mn compared to other crops. Wild-growing raspberry leaves contained more Cd, Pb, Zn, Mn, and Tl than leaves from other cultivation systems. Furthermore, the raspberry leaves from organic cultivation had more Cr, Cd, and Pb compared to leaves from conventional cultivation.

The other issue was also related to the possibility of the occurrence of so-called 'food fraud', meaning that a producer might claim that they possessed organic farming certificates for food products (Lightsey 2021). The phrases "ecological" or "environmentally friendly" are an important feature while buying products, apart from the price and taste (European Institute of Technology 2021). It might be the case that consumers feel an especially high level of pressure in relation to this ecological aspect because of the current state of the world and this leads them to believe sellers without checking or thinking. This seems to be especially true if the price of the given organic food is lower than it should be for the same organic products in other shops given the current realities of organic food production.

Implications of the study

The organic food sector is still developing in Poland and thus a result of our study would be that it can help to understand the current situation among Polish consumers. It also highlights the health benefits and may accordingly raise interest in organic food among consumers. Since our respondents most often purchased food products in stores closest to their place of residence, the findings can also have implications for food suppliers, owners, and managers in neighborhood stores and local markets to expand their range of eco-labelled food. This research can have also important implications for the development of the organic food industry and the product distribution channels chosen by this sector.

Limitations of the study

The main limitation of the study was the choice of the method of selection for the study, resulting in a relatively small number of participants in our surveys. Access to the study was limited since some people, especially the elderly, do have not the requisite skills to use online surveys, the fact that some locations, such as villages, do not have good access to Internet, and that the survey was distributed via severely limited circles, for example through Facebook. We are thus aware that the results obtained are not representative of the entire population of Poland or even to the two main voivodships in the surveys. Moreover, most of our respondents were people with a higher level of education and had higher income rates than people with lower educational levels. On the other hand, based on the group of respondents questioned, it could be stated that the result for respondents with lower educational levels and income status will be lower as much depends on ecological consciousness and financial ability. Moreover, most of the results were from two out of 16 regions in Poland and one age category dominated the responses obtained. Both factors might be related with the characteristic of the first respondent (authors) providing choices in the second wave.

Regarding the MAI index, we also investigated some types of vegetables which are only cultivated in the Małopolskie region. The reason was related to the fact that vegetables were bought in the fresh food markets, from vendors declaring that they were selling certified organic food products. In this study, it could be considered as a randomly taken sample with the suggestion of involving more regions and types of vegetables in further studies to expand research on the differences between metal accumulation in edible plants from conventional and organic samples.

CONCLUSIONS

Organic food markets are developing around the world in response to the demands of consumers. The current study contributed to addressing the knowledge gap on organic food products, especially fruit, vegetables, and animal products in Poland about consumer choices. The presented results could be valuable for decision-makers, producers related to food marketing, and health policymakers, as well as others interested in organic food consumption. This study found that the consumption of products of plant origin (fruit and vegetables) were not identically dependent on socio-demographic characteristics. Nevertheless, the characteristics of income level equally affected consumer choices regarding the purchase of organic fruit and vegetables. On the other hand, gender and marital status only influenced decisions regarding the purchase of organic fruit. The consumption of animal products, especially in the area of meat and fish, did not reveal the features of sustainability resulting from the frequency of their consumption. However, the frequency of egg consumption in the study group shed a more positive light on sustainability issues by their moderate consumption. The calculated MAI index values indicated that in general metal accumulation was higher in conventionally cultivated vegetables, but higher for organically farmed pumpkin, spring onion, cabbage, lettuce, spinach, and garlic. Since many factors affect the accumulation of metals, this issue should be constantly monitored during consumption. Therefore, it seems necessary to develop healthier attitudes and activities further in the areas of consumption that encourage sustainable choices in Poland.

Author contributions. *Conceptualization: K.M.-W.; methodology: K.M.-W. and A.G.-K.; software: K.M.-W.; validation: K.M.-W.; formal analysis: K.M.-W. and A.G.-K.; investigation: K.M.-W. and A.G.-K.; resources: K.M.-W. and A.G.-K.; data curation: K.M.-W. and A.G.-K.; writing – original draft preparation: K.M.-W. and A.G.-K.; writing – review and editing: K.M.-W. and A.G.-K.; visualization: K.M.-W. and A.W.; supervision: K.M.-W.; project administration: K.M.-W.; funding acquisition: K.M.-W. and A.G.-K. All authors have read and agreed to the published version of the manuscript.*

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