

## CONSUMER AWARENESS OF ADDITIVES USED ON THE FOOD MARKET

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### ABSTRACT

The aim of the study was to assess the knowledge of additives used in food in a random group of Polish consumers. It was based on the results of a consumer survey addressed to the inhabitants of Poland via the Internet. The questions in the survey concerned the knowledge and behaviour of respondents regarding food additives. The analysis showed that the respondents pay attention to additives used in food to a large extent, but their general knowledge on this subject is at an average level. Pro-health attitudes regarding the purchase of food without additives were most often shown by females and younger people and those with higher education and living in urban agglomerations. Since the survey did not confirm the respondents' opinion about their extensive knowledge of additives used in food production, it should be assumed that this largely reflects the state of awareness in this area in a large part of society. Actions should be taken to educate the public about the use of additives in the food industry to raise awareness about the safety and scale of consumption of food additives.

**Key words:** food safety, pro-health attitudes, food additives, consumer

### INTRODUCTION

The diet of an average consumer in developed countries consists of approx. 70% of industrially processed food containing various additives. This term refers to substances that are not normally consumed as food and are not used as a characteristic food ingredient [EU 2008, Wu et al. 2022]. They constitute a wide group of substances marked with the E symbol, which comprises natural, nature identical, and artificial additives [Mierzejewska 2017, Zyska et al. 2018]. In terms of their technological functions, these substances are divided into different groups [Rutkowski et al. 2003, Ratusz and Maszewska 2012, Pałczyński and Kuna 2015, Cygan-Szczegieliński et al. 2016, Świerczek et al. 2016]. The use of these food components is expected to increase the efficiency of the production process (e.g. thickeners, stabilisers, emulsifiers), prevent unfavourable changes in food taste, colour, and odour, extend food shelf life, increase the nutritional value and attractiveness of the product, and help to design new products, e.g. “light” type foods [Kilara and Desai

2002, Mahungu and Artz 2002, Laganà et al. 2017, Zyska et al. 2018].

In many countries, the use of additives in the food industry is regulated by law due to the increasing role of such substances in food production and the dynamic increase in their quantity as well as the necessity to ensure food safety [Ptasińska 2005, Drożdżewski 2017]. The basic act on the use of additives in the food industry in force in Poland and on the European market is Regulation (EC) No. 1333/2008 of the European Parliament and of the Council of December 16, 2008 on food additives [EU 2008]. It specifies general criteria and principles for the use of food additives and provides a list of all additives [Mierzejewska 2017, Zhong et al. 2018]. The Commission Regulation (EU) No. 1129/2011 of November 11, 2011 amending Annex II to Regulation (EC) No. 1333/2008 of the European Parliament and of the Council entered into force on June 1, 2013 [EU 2011], Part A, contains a list of foodstuffs in which the presence of an additive may not be permitted by virtue of the carry-over principle and a list of foods in which the presence

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of a food colour may not be permitted by virtue of the carry-over principle. Part B contains a list of food additives (names and E numbers) approved for use. A change in the labelling of products is that the regulation provides only general names of groups of some compounds [Gajda-Wyrębek et al. 2013].

It has been found [Wilson and Bahna 2005, Randhawa and Bahna 2009, Wasilewska and Małgorzewicz 2015] that the consumption of excessive amounts of synthetic food additives may exert many adverse effects. The most important indicator in the assessment of the degree of risk to consumer health is the ADI (Acceptable Daily Intake), i.e. the maximum allowable level of daily consumption of a given substance by humans [Tymoszek and Szpakowska 2012, Drożdżewski 2017, Gruchelski and Niemczyk 2019]. Consumption of additive-containing food may also have positive aspects. Additives have great potential to reduce or eliminate the effects of numerous nutritional errors encountered among modern consumers. They contribute to an increase in the content of unsaturated fats, vitamins, or fibre in the diet and limitation of the consumption of refined sugar and table salt. Additives that prevent food spoilage also ensure the consumption of microbiologically safe food products [Sunmer and Eifert 2002, Ptasńska 2005, Rutkowski et al. 2003]. These aspects are usually highly important in affluent societies [Sunmer and Eifert 2002].

Currently, over 2500 different additives are deliberately added to food products to achieve the desired effect. Their use is well accepted, but not without controversy [Branen and Haggerty 2002, Pałczyński and Kuna 2015, Świerczek et al. 2016]. Since the introduction in the food industry, this important group of substances used sensibly has largely contributed to enhancement of the nutritional and aesthetic values of food, food quality, and safety of storage and distribution [Tymoszek and Szpakowska 2012, Kaptan and Kayisoglu 2015, Wu et al. 2022].

The aim of the study was to assess the knowledge of food additives among a random group of Polish consumers through analysis of the results of an online survey.

## MATERIAL AND METHODS

The analysis was based on an online survey conducted in the electronic form on forums and nutrition and health blogs. The survey was constructed and conducted as in Babbie [2019]. The original questionnaire (not included here but available from the corresponding author due to the editorial limitations of the volume of the paper) consisted of 20 questions (including 4 questions on personal data). The survey was constructed mostly as a sequence of questions with one or several ready-made answers to be indicated by the respondents. There were also two open questions. One of the questions contained statements about food additives, and the respondents indicated

their attitude to the statements. In this question, a 5-point Likert scale was used [Gamst et al. 2008], where “1” and “5” denoted the lowest and highest degree of agreement, respectively. To carry out the statistical analysis and compile a table, the statements were marked with symbols from S1 to S11 (Table 4) in accordance with the following scheme:

- S1 – All additives approved for use are safe for humans, as shown by the current knowledge.
- S2 – The use of food additives may have a negative effect on the functioning of the organism.
- S3 – The level of consumption of some food additives in the diet determines their safety or harmfulness.
- S4 – The use of additives may cause serious diseases in humans.
- S5 – Some food additives may cause allergies in humans.
- S6 – The use of food additives is regulated by law sufficiently.
- S7 – Food manufacturers use food additives too often.
- S8 – The provisions of food law in force in EU countries contain information on products or groups of products that can be supplemented with additives and specify their quantities.
- S9 – There is a legitimate technological requirement for the use of food additives that cannot be met in any other economically and technologically acceptable way.
- S10 – The use of food additives must not mislead consumers.
- S11 – Food additives must not be used to adulterate food.

The survey was conducted in February–May 2021. The responses were compiled in a spreadsheet. The results were presented as the number and percentage of respondents who chose a given answer/answers or provided their answer in the open questions. In the case of the question where the Likert scale was used, the mean, standard deviation, and coefficient of variation were calculated in addition to the number and percentage of respondents who indicated their attitude to the statements on the 1–5 scale. The data were analysed statistically in Statistica ver. 13.0 with the use of  $\chi^2$  tests (open questions) and ANOVA with Duncan’s test (Likert scale question).  $P \leq 0.01$  and  $P \leq 0.05$  were assumed as statistically significant.

## RESULTS AND DISCUSSION

Females constituted the majority of the 141 respondents (78.0%). In terms of age, respondents aged <30 years were the largest group (62.4%), whereas those aged >40 years accounted for the smallest percentage (10.6%). The majority of the respondents declared higher education

(58.2%), whereas the others had secondary or lower education. Rural residents represented 40.4% of the respondents, while the others (59.6%) were residents of different-size cities.

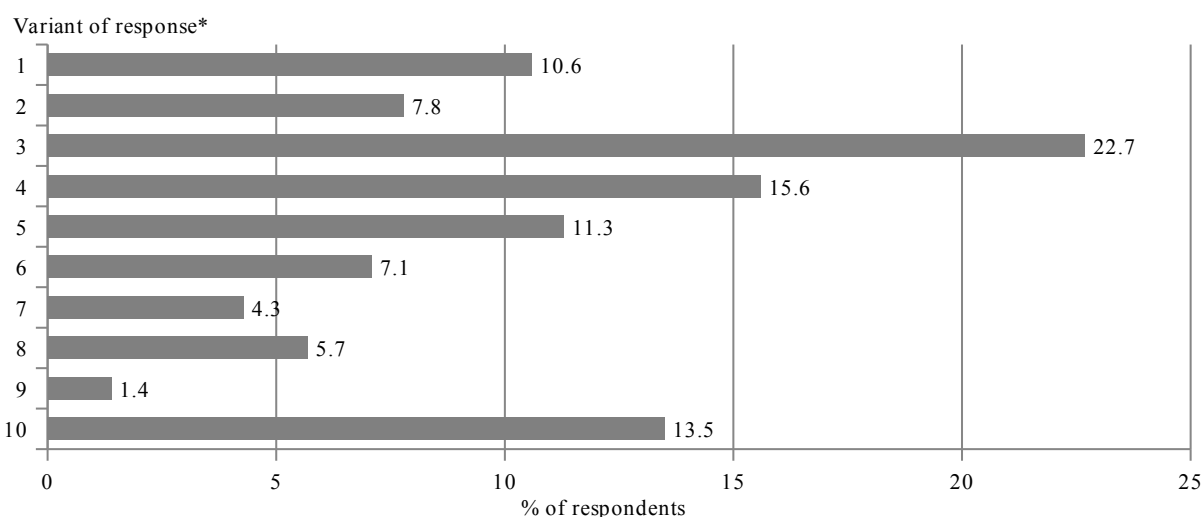
In the self-assessment, more than half of the respondents (50.4%) evaluated their knowledge of food additives as moderate, and 20.5% of the respondents evaluated their knowledge with the highest marks (“high” and “very high”) (Table 1). Almost 1/3 of the survey respondents (29.1%) declared that their knowledge was “negligible” or “non-existent”. In the survey groups, the females, respondents aged < 30 years, those with higher education, and residents of cities declared a higher

level of knowledge. However, a significant relationship ( $P \leq 0.05$ ) was found only in the case of education. A similar survey conducted among Hungarian consumers demonstrated that females rated their knowledge in this area higher than males, which was explained by the authors by the greater health awareness and more frequent involvement in shopping tasks of females rather than males [Tarnavölygi and Molnár 2004]. As reported by Bayram and Ozturkcan [2023] in their consumer survey, females and respondents with higher education had greater knowledge of food additives ( $P \leq 0.05$ ), but as many as 40% of respondents declared that they rarely read food labels.

**Table 1.** Results of respondents’ self-assessment of their knowledge of food additives

Respondent group		Self-assessment of knowledge of food additives – number (%) of respondents					Value of the $\chi^2$ test
		very high	high	moderate	negligible	non-existent	
Gender	- female	4 (3.6)	19 (17.3)	57 (51.8)	27 (24.6)	3 (2.7)	1.97
	- male	– (–)	6 (19.4)	14 (45.2)	10 (32.2)	1 (3.2)	
Age	- < 30 years	4 (4.6)	12 (13.6)	48 (54.5)	22 (25.0)	2 (2.3)	7.13
	- 31–40 years	– (–)	9 (23.7)	18 (47.4)	10 (26.3)	1 (2.6)	
	- > 40 years	– (–)	4 (26.7)	5 (33.3)	5 (33.3)	1 (6.7)	
Education	- secondary or lower	3 (5.1)	7 (11.9)	27 (45.8)	22 (37.3)	– (–)	11.80*
	- higher	1 (1.2)	18 (22.0)	44 (53.6)	15 (18.3)	4 (4.9)	
Place of residence	- rural area	1 (1.8)	8 (14.0)	27 (47.4)	20 (35.1)	1 (1.7)	4.55
	- urban area	3 (3.6)	17 (20.2)	44 (52.4)	17 (20.2)	3 (3.6)	
Total		4 (2.8)	25 (17.7)	71 (50.4)	37 (26.3)	4 (2.8)	×

\* – value significant at  $P \leq 0.05$ .



**Fig. 1.** Distribution of answers about the knowledge of food additives

\* – Notes: 1 – Natural or synthetic substances added to food to achieve a specific technological effect (e.g. extension of shelf life, improvement of the colour, flavour, and texture of the product); 2 – Substances intended to improve the taste/appearance/nutritional value/texture of the product; 3 – Substances intended to preserve the product and improve its flavour, appearance, odour, and texture; 4 – Preservatives and flavourings added to food; 5 – Preservatives and substances extending the freshness of the product; 6 – Substances expected to improve the flavour of the product; 7 – All types of enhancers; 8 – Usually artificial chemical substances; 9 – Substances marked as E; 10 – Other.

It was found that, despite the high scores in their self-assessment, the respondents had a serious problem with the correct definition of the term “food additives” (Fig. 1). Only 10.6% of the survey participants were able to provide a definition that was the closest to the correct one. In response to this question, 1.4% of the respondents gave a very simple answer that “all E” are food additives, which is correct but does not specify the nature of these substances or the purpose of their use. The other answers more or less focused on the effect of the use of additives. There were also general statements (classified in the figure as “others”), e.g. “chemistry”, “poison”, “unnecessary substances”, “fillers”, and “unhealthy substances”. As shown by Lee et al. [2014], consumers derive their knowledge of food additives mainly from social media (26.3%) and the Internet (22.5%), which do not always provide reliable knowledge and are not a reliable source of information.

A large group of the respondents (34.7%) found it difficult to specify the number of additives approved for use in the EU or admitted that they were unable to give the number (Table 2). The correct range of the number of food additives (100–500) was indicated by only 24.1% of the respondents. The statistical analysis showed that the distribution of the responses was correlated with the gender ( $P \leq 0.01$ ) and place of residence ( $P \leq 0.05$ ). More females (29.1%) gave the correct answer to this question than males (6.4%). As a rule, the males chose too high values (>1000), whereas the females significantly underestimated the number (<100) more often than the males. Noteworthy, the male respondents chose the answer “I do not know/it is hard to say” less frequently (by 7.4 p.p.). In the case of the rural residents, the answer “I do not know/it is hard to say” was the dominant statement (47.4%). In the group of the urban residents, 1/3 of the respondents gave the correct answer, while “>2000”

**Table 2.** Number of food additives currently approved for use in the EU according to the respondents

Respondent group	Number of additives					I do not know/it is hard to say	Value of the $\chi^2$ test	
	< 100	100–500	501–1000	1001–2000	> 2000			
Gender	- female	14 (12.7)	32 (29.1)	10 (9.1)	10 (9.1)	4 (3.6)	40 (36.4)	18.13**
	- male	3 (9.7)	2 (6.4)	4 (12.9)	7 (22.6)	6 (19.4)	9 (29.0)	
Age	- < 30 years	11 (12.5)	21 (23.9)	6 (6.8)	13 (14.8)	3 (3.4)	34 (38.6)	14.58
	- 31–40 years	4 (10.5)	10 (26.3)	4 (10.5)	2 (5.3)	6 (15.8)	12 (31.6)	
	- > 40 years	2 (13.3)	3 (20.0)	4 (26.7)	2 (13.3)	1 (6.7)	3 (20.0)	
Education	- secondary or lower	8 (13.5)	12 (20.3)	8 (13.6)	8 (13.6)	3 (5.1)	20 (33.9)	2.92
	- higher	9 (11.0)	22 (26.8)	6 (7.3)	9 (11.0)	7 (8.5)	29 (35.4)	
Place of residence	- rural area	6 (10.5)	6 (10.5)	4 (7.0)	9 (15.8)	5 (8.8)	27 (47.4)	14.20*
	- urban area	11 (13.1)	28 (33.3)	10 (11.9)	8 (9.5)	5 (6.0)	22 (26.2)	
Total		17 (12.1)	34 (24.1)	14 (9.9)	17 (12.1)	10 (7.1)	49 (34.7)	×

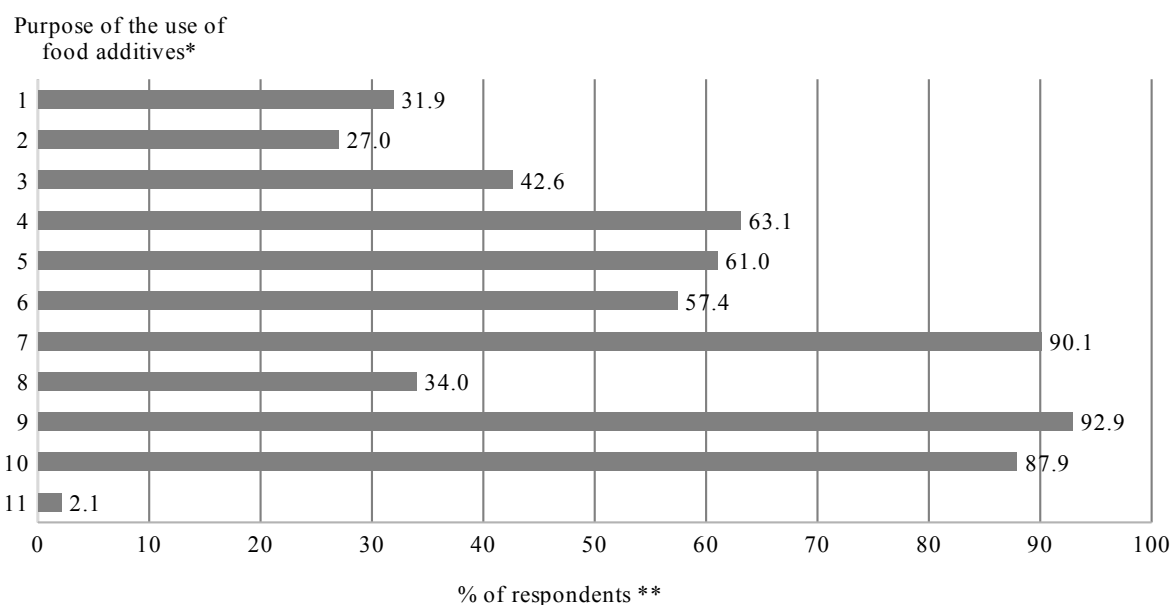
\* – value significant at  $P \leq 0.05$ .

\*\* – value significant at  $P \leq 0.01$ .

**Table 3.** Do you think food additives are synthetic substances?

Respondent group	Responses – number (%) of respondents				Value of the $\chi^2$ test	
	all are synthetic	they may be synthetic or natural	all are natural	I do not know/it is hard to say		
Gender	- female	11 (10.0)	81 (73.7)	4 (3.6)	14 (12.7)	3.19
	- male	1 (3.2)	27 (87.1)	– (–)	3 (9.7)	
Age	- < 30 years	6 (6.8)	64 (72.7)	4 (4.6)	14 (15.9)	19.91*
	- 31–40 years	1 (2.6)	35 (92.1)	– (–)	2 (5.3)	
	- > 40 years	5 (33.3)	9 (60.0)	– (–)	1 (6.7)	
Education	- secondary or lower	8 (13.6)	37 (62.7)	4 (6.8)	10 (16.9)	13.16*
	- higher	4 (4.9)	71 (86.6)	– (–)	7 (8.5)	
Place of residence	- rural area	8 (14.0)	36 (63.2)	1 (1.8)	12 (21.0)	12.50*
	- urban area	4 (4.8)	72 (85.7)	3 (3.6)	5 (5.9)	
Total		12 (8.5)	108 (76.6)	4 (2.8)	17 (12.1)	×

\*\* – value significant at  $P \leq 0.01$ .



**Fig. 2.** Distribution of respondents' answers to the question about the purpose of using food additives

\* – Notes: 1 – Easier packaging and transport; 2 – Preservation of nutrients and ingredients determining food nutritional value; 3 – Enhancement of production efficiency; 4 – Reduction of production costs; 5 – Stimulation of positive palatability; 6 – Maintenance of proper humidity; 7 – Improvement of structure/texture; 8 – Introduction of desired ingredients; 9 – Extension of durability/shelf life; 10 – Improvement of the flavour/smell/colour of products; 11 – I do not know/it is hard to say.

\*\* – Note: the results do not add up to 100%, as the respondents were allowed to choose more than one answer.

was the least popular answer. However, there was no significant relationship of the age and education with the knowledge of the number of food additives approved for use in the EU.

The data shown in Table 3 indicate that ¾ of the respondents were aware that food additives may be synthetic or natural. As reported by Gokce et al. [2018], only 22.6% of students surveyed in Turkey are aware that food additives can be synthetic or natural; therefore, the group surveyed in the present study should be assessed definitely positively in this respect. The values of the  $\chi^2$  test for each experimental factor indicate that the distribution of answers to this question depended on the age, education, and place of residence (value significant at  $P \leq 0.01$ ).

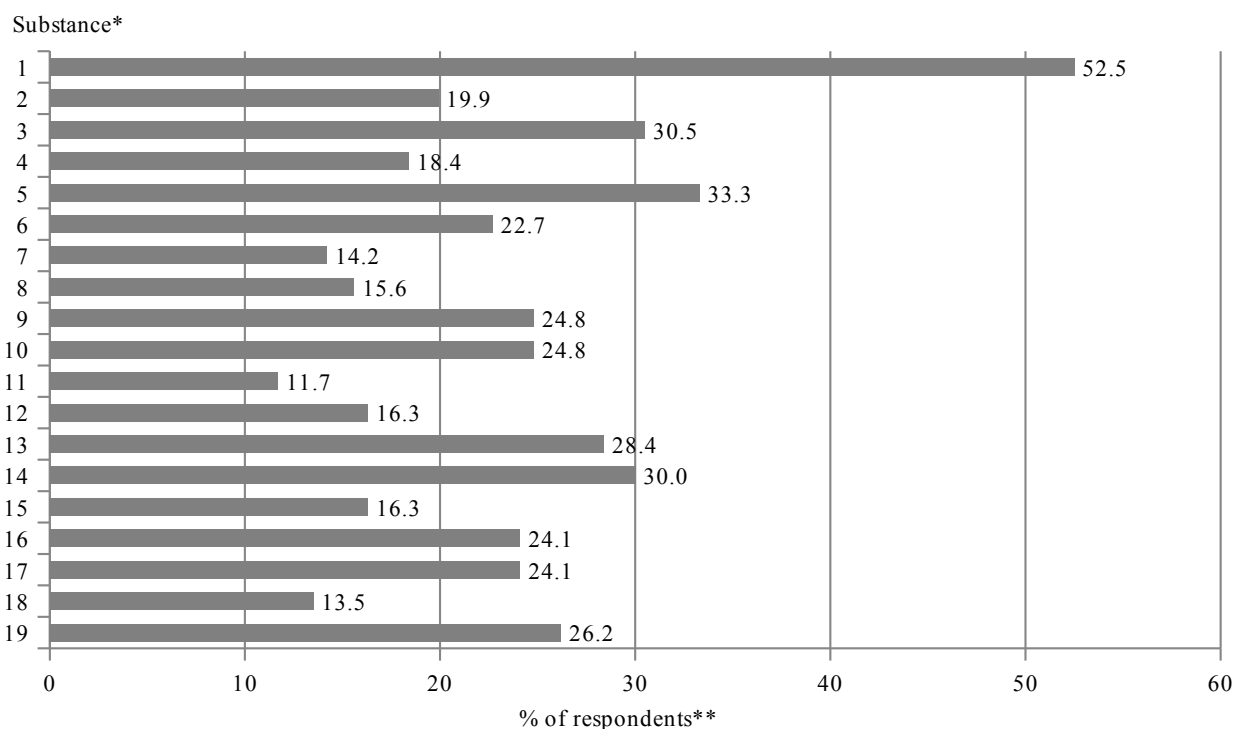
The functions of food additives can be divided into four main areas: food preservation (antimicrobials and antioxidants), colourants (enhancement or recovery of natural colours and production of special colours), replacement of sugar (intense sweeteners), and structure and technology (thickeners, gelling agents, stabilisers) [Laganà et al. 2017]. The respondents' knowledge of this issue was assessed by asking a question about the purpose of the use of additives in food production (Fig. 2).

Extension of durability/shelf life (92.9%), improvement of the structure/texture (90.1%), and improvement

of the flavour/smell/colour of products (87.9%) were the most frequently indicated purposes of using food additives (Fig. 2). The purposes of preservation of nutrients and ingredients determining food nutritional value (27.0%), easier packaging and transport (31.9%), and introduction of desired ingredients (34.0%) were mentioned the least frequently. A similarly high percentage of respondents (90.7%) indicating extension of food durability/shelf life as the purpose of using additives was reported by Ingaldi and Dziuba [2017]. As shown in a study conducted by Tarnavölygi and Molnár [2004], Hungarian consumers largely believe that there are some products that can be manufactured without the use of additives.

There was also a task in the survey to indicate substances that are not food additives (Fig. 3). Water was the most frequently indicated product (52.5%). As indicated by 1/3 of the respondents, edible gelatine, blood plasma, and table salt are not food additives. A slightly lower percent, i.e. 25% of the respondents, did not regard fishmeal, amino acids and their salts, monosaccharides, disaccharides, and oligosaccharides used for their sweetening properties, and formic acid as food additives.

Unexpectedly, nearly 1/4 of the respondents indicated that monosodium glutamate, sodium benzoate, and agar are not classified as food additives. In contrast, as reported by Kaptan and Kayisoglu [2015], there is



**Fig. 3.** Respondents’ answers to the question about substances that are not food additives

\* – Notes: 1 – water; 2 – gum base; 3 – edible gelatine; 4 – cochineal red; 5 – blood plasma; 6 – fishmeal; 7 – casein; 8 – inulin; 9 – monosodium glutamate; 10 – amino acids and their salts; 11 – ammonium chloride; 12 – liquid pectin; 13 – monosaccharides, disaccharides, and oligosaccharides used for their sweetening properties; 14 – table salt; 15 – white or yellow dextrin; 16 – sodium benzoate; 17 – agar; 18 – sodium citrate; 19 – formic acid.

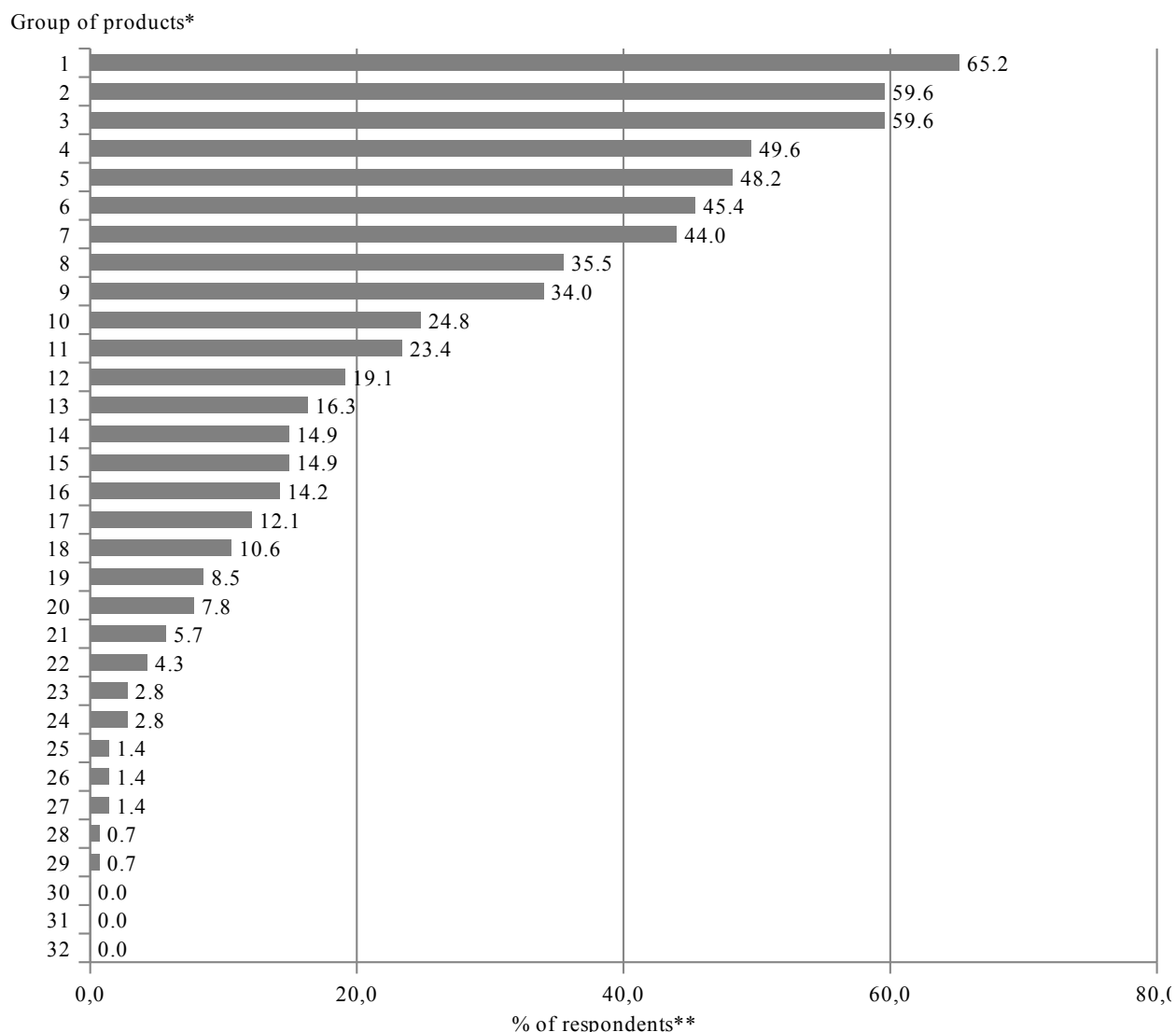
\*\* – Note: the results do not add up to 100%, as the respondents were allowed to choose more than one answer.

widespread knowledge of the common use of these substances not only in the food industry and their safety is widely commented on.

Due to the availability of a wide spectrum of various additives on the market and their multi-directional applications, there are many food products supplemented with these substances [Devcich et al. 2007, Eun-Jung et al. 2007]. Therefore, the respondents were asked to indicate no more than five food products that contain the largest amounts of additives (Fig. 4). Processed meat (pâtés, luncheon meats) was indicated by the respondents most frequently (65.2%) as a product with the highest amounts of additives. Instant soups and sauces (59.6%) as well as candies, bars, and other sweets (59.6%) were indicated equally often. A slightly lower but still high frequency was noted in the case of cold cuts (49.6%), savoury snacks (48.2%), tinned fish and meat (45.4%), and sweetened drinks (44.0%). Fruit yoghurts (19.1%) and meat (16.3%) were indicated quite frequently. Surprisingly, a small percentage of respondents (14.2%) indicated bakery products. Rice, fresh/raw fruit and vegetables, and butter were not indicated by any of the respondents. Groats and fresh/raw fish were selected by very few par-

ticipants of the survey (0.7% each). In general, these results should be assessed positively, although the opinion that groats and flour contain food additives seems surprising, as these unprocessed products do not require the use of such substances. In a study conducted by Dziubanek and Zużalek [2008], the vast majority of respondents (70%) indicated sweetened beverages as products containing food additives, and deli foods (including cold cuts) were indicated by 13% of respondents.

The respondents’ knowledge of food additives was also verified based on their attitude to various statements about these substances. The statements and assigned symbols are presented in the MATERIAL AND METHODS section, and the results are summarised in Table 4. Statement S5 received the highest level of acceptance, as the responses “I rather agree” and “I strongly agree” accounted for 91.5% of all the responses to this statement. Consequently, the mean level of respondents’ agreement with this statement was 4.51. This value was statistically different from the means calculated for the other statements. The greatest disagreement was observed in the case of statement S6, as negative answers accounted for 39.7% of all indications. The responses



**Fig. 4.** Respondents' answers on groups of food products containing the largest amounts of food additives

\* – Notes: 1 – processed meat (pâtés, luncheon meats); 2 – instant soups and sauces; 3 – candies, bars, and other sweets; 4 – cold cuts; 5 – savoury snacks (sticks, crackers, chips, etc.); 6 – tinned meat and fish; 7 – sweetened drinks; 8 – ketchups, mustards, dressings; 9 – deli foods; 10 – tinned/jarred vegetables and ready-made vegetable salads; 11 – milk desserts; 12 – fruit yogurts; 13 – meat; 14 – ready-made products for babies and children (soups, purees, nutrient mixes, etc.); 15 – flavoured mineral waters; 16 – bakery products; 17 – margarine; 18 – smoked fish and meats; 19 – fruit and vegetable juices; 20 – alcohols; 21 – milk; 22 – cheeses; 23 – dried fruits and vegetables; 24 – frozen vegetables and fruits; 25 – flour; 26 – cheeses and curds; 27 – natural yoghurts; 28 – groats (various types); 29 – fresh/raw fish; 30 – rice (various types); 31 – fresh/raw fruit and vegetables; 32 – butter.

\*\* – Note: the results do not add up to 100%, as the respondents were allowed to choose more than one answer.

to statement S1 highly varied, which was indicated by the high value of the coefficient of variation (36.8%). It was one of the statements that obtained the largest number of “I strongly disagree” and “I rather disagree” responses. The respondents agreed with statements S2 and S3 with a similar frequency (41.1% and 49.7%, respectively). These statements did not receive any “I strongly disagree” responses. The responses to statement S4 were quite varied, with the dominance of respondents' agree-

ment (in total 68.1%). In total,  $\frac{3}{4}$  of the respondents agreed with statement S7, and only 2.8% had a different opinion. The other survey participants (18.5%) had no opinion in this field. Statements S8 and S9 received the greatest number of “I have no opinion” answers. The highest number of the “I strongly agree” answers, i.e. 63.1%, was achieved by statement S11. Statements with an average score exceeding 4 points in the survey (S2, S3, S5, S7, S10, and S11) suggest that the majority of

**Table 4.** Respondents' attitude to statements on the use of additives in food production

Symbol of statement*	Evaluation on a 5-point scale			Evaluation – number (%) of answers				
	$\bar{x}$	SD	coefficient of variation [V%]	I strongly disagree	I rather disagree	I have no opinion	I rather agree	I strongly agree
S1	3.00 <sup>Aa</sup>	1.11	36.8	11 (7.8)	37 (26.2)	48 (34.1)	30 (21.3)	15 (10.6)
S2	4.21 <sup>ABb</sup>	0.80	19.0	– (–)	5 (3.5)	18 (12.8)	60 (42.6)	58 (41.1)
S3	4.33 <sup>ACc</sup>	0.79	18.2	– (–)	4 (2.8)	16 (11.3)	51 (36.2)	70 (49.7)
S4	3.30 <sup>AD</sup>	1.05	26.8	1 (0.7)	17 (12.1)	27 (19.1)	45 (31.9)	51 (36.2)
S5	4.51 <sup>AE<sub>d</sub></sup>	0.71	15.8	– (–)	3 (2.1)	9 (6.4)	42 (29.8)	87 (61.7)
S6	2.80 <sup>BCDEF</sup>	1.14	40.7	20 (14.2)	36 (25.5)	49 (34.8)	24 (17.0)	12 (8.5)
S7	4.20 <sup>AFGe</sup>	0.91	21.7	3 (2.1)	1 (0.7)	26 (18.5)	45 (31.9)	66 (46.8)
S8	3.51 <sup>Eabedef</sup>	0.89	25.4	2 (1.4)	13 (9.2)	56 (39.7)	51 (36.2)	19 (13.5)
S9	3.45 <sup>GHc</sup>	0.87	25.1	3 (2.1)	9 (6.4)	67 (47.5)	45 (31.9)	17 (12.1)
S10	4.20 <sup>AF</sup>	0.95	22.6	1 (0.7)	8 (5.7)	22 (15.6)	41 (29.1)	69 (48.9)
S11	4.41 <sup>ADHFf</sup>	0.90	20.5	1 (0.7)	6 (4.3)	16 (11.3)	29 (20.6)	89 (63.1)

Means marked with the same capital letters differ statistically at  $P \leq 0.01$ .

Means marked with the same lowercase letters differ statistically at  $P \leq 0.05$ .

\* The “S” symbols are explained in the Material and methods section.

**Table 5.** Do you ever resign from buying products containing food additives?

Respondent group	Answers – number (%) of respondents			Value of the $\chi^2$ test	
	never or very rarely	rarely	quite often/often or always		
Gender	- female	32 (29.1)	33 (30.0)	45 (40.9)	1.04
	- male	9 (29.0)	12 (38.7)	10 (32.3)	
Age	- < 30 years	31 (35.2)	25 (28.4)	32 (36.4)	11.18*
	- 31–40 years	7 (18.4)	18 (47.4)	13 (34.2)	
	- > 40 years	3 (20.0)	2 (13.3)	10 (66.7)	
Education	- secondary or lower	24 (40.7)	18 (30.5)	17 (28.8)	7.46*
	- higher	17 (20.7)	27 (32.9)	38 (46.4)	
Place of residence	- rural area	20 (35.1)	22 (38.6)	15 (26.3)	6.48*
	- urban area	21 (25.0)	23 (27.4)	40 (47.6)	
Total		41 (29.1)	45 (31.9)	55 (39.0)	×

\*\* – value significant at  $P \leq 0.05$ .

the respondents believe that the use of food additives is not entirely safe and may have an impact on the organism by causing such diseases as allergies, and food manufacturers use additives too often to mislead consumers and adulterate food. In this question, the respondents suggested that the legal regulations for the use of food additives in EU countries are insufficient, and economic and technological reasons cannot justify the application of these substances. As demonstrated by the results of surveys conducted among food experts, the distrust in E-additives expressed by consumers is caused by the negative communication in traditional media, social media, and books. The experts have highlighted the importance of reliable sources and credibility of information about E-

additives and the need for a clear and honest explanation of the rationale behind the use E-additives by food companies. It has also been underlined that organisations disseminating information about nutrition and governments are adequate institutions to take action in this field, as consumers generally do not trust the food industry [van Gunst and Roodenburg 2019]. A study conducted by the Netherlands Food and Product Safety Authority [NVWA 2018] revealed that excessive amounts of sugar and salt in food products, followed by pesticides and food additives were the main health risks mentioned by consumers.

The next question in the present survey (Table 5) showed that the presence of food additives is never or very rarely a reason for resigning from purchasing prod-



**Table 6.** Which food additives raise the greatest concern?

Group of additives/name of substance		Number of responses	% of responses
All E		9	6.4
Pigments	- pigments (unspecified)	5	3.5
	- curcumin	3	2.1
	- cochineal red	2	1.4
	- annato	2	1.4
Preservatives	- preservatives (unspecified)	11	7.8
	- sodium benzoate	13	9.2
	- potassium sorbate	1	0.7
	- nitrates and nitrites	5	3.5
Emulsifiers	- locust bean gum	1	0.7
	- agar	2	1.4
Sweeteners	- sweeteners (unspecified)	22	15.6
	- acesulfame	1	0.7
	- aspartame	3	2.1
	- sugars	2	1.4
	- sugar	13	9.2
	- glucose-fructose syrup	4	2.8
Flavour enhancers	- flavour enhancers (unspecified)	3	2.1
	- monosodium glutamate	29	20.6
Thickeners	- gums as thickeners	2	1.4
	- guar gum	3	2.1
	- gum Arabic	1	0.7
None		8	5.7
I do not know/it is hard to say		21	14.9
Other (not classified into any of the aforementioned groups)		21	14.9

ucts for 29.1% of the respondents, and 31.9% of the survey participants declared that the content of food additives rarely affects their decision to resign from the purchase. Most frequently (39%), the respondents declared that they often or always give up buying additive-containing food products. A greater number of respondents (66.7%) declared avoidance of products containing preservatives in a study conducted by Ingaldi and Dziuba [2017]. In turn, Kościółek et al. [2012] conducted a survey in a population of post-secondary students and showed that only 14% of the respondents declared that they always give up buying products with food additives, 32% sometimes resign from the purchase, and 54% never resign from buying additive-containing food.

The statistical analysis showed that the distribution of the answers to this question depended on the age, education, and place of residence. Respondents aged <30 years most often chose the answer “never or very rarely” (35.2%), those aged 31–40 years indicated the answer “rarely” (47.4%), and the option “quite often/often or always” was most frequently indicated in the group of respondents aged >40 years (66.7%). In the group of participants with secondary or lower education, the answer that they never or very rarely resign from buying additive-containing food was selected with a 20 p.p. higher fre-

quency. In terms of the place of living, the residents of rural areas resigned from buying such food more frequently (by 10.1 p.p.) than the respondents from cities. As reported by Wu et al. [2013], the elderly in China were more cautious about food additives and declared a lower frequency of buying additive-containing food. Noteworthy, as in the study conducted by Dziubanek and Zużalek [2008], females’ decisions on the purchase of food were guided by the presence of E substances more frequently than in the male group.

Table 6 shows a summary of respondents’ answers to the question of food additives that arouse their greatest concerns. Sweeteners were found to be the most frequently indicated group of additives, as 45 respondents (31.9%) declared their concern about these agents, but the majority in this group (22 participants) did not mention any specific substance. The presence of flavour enhancers (22.7%) and preservatives (21.2%) was slightly less disturbing to the respondents. As many as 29 and 13 respondents declared their concern about monosodium glutamate (flavour enhancer) and sodium benzoate (preservative), respectively, and 11 survey participants did not specify any disturbing preservative agent. Pigments (8.4%), thickeners (4.2%), and emulsifiers (2.1%) were found to arouse much less concern. Nine respondents

(6.4%) indicated all substances marked with the E symbol, whereas eight participants (5.7%) declared no concern about any of the additives. As many as 21 respondents (14.9%) were unable to indicate food additives that may be a cause for concern. Ozimek et al. [2004] reported that 23.6% and 30.7% of respondents expressed very high and high concerns related to the consumption of additive-containing food, respectively, whereas 3.6% did not perceive any risk. Similar to this study, their results indicate that additives raise concerns in a significant percentage of society, despite the binding legal regulations for the types of additives permitted for use in food production, the precise rules of their use, and the establishment of their acceptable levels in food products. In turn, surveys conducted in Belgium and Romania by Petrescu et al. [2020] showed that consumers attached great importance to the quality of food, and their assessment of food quality was guided by freshness, flavour, and appearance. This suggests that consumers may continue to accept the use of various types of additives improving food quality. As suggested by our results, this attitude does not always coincide with profound knowledge of these substances.

Many authors have reported important common findings: consumers have poor knowledge of additives [Varela and Fiszman 2013], but they are aware of this fact and find it difficult to understand the issue of food additives [Aoki et al. 2010, Shim et al. 2011]. Other studies have revealed that consumers are concerned about additives [Shim et al. 2011, Varela and Fiszman 2013] and chemicals present in their diet [Dickson-Spillmann et al. 2011], and this has an impact on the conscious perception of additives in terms of food safety [Aoki et al. 2010, Shim et al. 2011, Mitterer-Daltoé et al. 2021]. As suggested by Bayram and Ozturkcan [2023], consumers should have knowledge of food additives and should be educated by appropriate experts. This is important, as food additives will still be widely used. As shown by Bolek [2020], this is associated with the fact that food safety is a key public health problem worldwide. Food-borne diseases, which impose a huge economic and social burden on communities and health systems, are mainly associated with the inadequate knowledge of food safety and unsafe food handling practices. Consumer behaviour with respect to food safety should be considered in the preventive measures to eliminate potential risks.

## CONCLUSIONS

The surveyed group has exhibited a moderate level of knowledge of food additives, although the respondents often claim that they are much better informed. However, their incorrect or “I do not know/it is hard to say” answers contradict their claims. Their superficial and fragmentary knowledge often arouses distrust and scepticism towards food additives and determines their purchasing decisions.

The socio-demographic groups of females, younger respondents, participants with higher education, and those living in urban agglomerations surveyed in this study exhibited a higher level of pro-health attitudes and awareness of the benefits and problems associated with the use of additives in the food industry.

Since the survey did not confirm the respondents' opinion about their extensive knowledge of additives used in food production, it seems reasonable to undertake various educational activities in this field. As a long-term effect, both the perception of food additives and the consumer awareness of the safety and scale of consumption of additives in the daily diet may improve.

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## ŚWIADOMOŚĆ KONSUMENTÓW NA TEMAT SUBSTANCJI DODATKOWYCH STOSOWANYCH NA RYNKU ŻYWNOSCI

### STRESZCZENIE

Celem pracy była ocena wiedzy losowej grupy polskich konsumentów na temat dodatków stosowanych w żywności. Oparto ją na wynikach ankiety konsumenckiej skierowanej drogą internetową do mieszkańców Polski. Pytania ankiety dotyczyły wiedzy i zachowań respondentów w odnośnieniu do dodatków do żywności. Analiza ta wykazała, że ankietowani w dużym stopniu zwracają uwagę na dodatki stosowane w żywności, jednak ich ogólna wiedza na ten temat jest na średnim poziomie. Prozdrowotnymi postawami w odnośnieniu do nabywania żywności bez dodatków wykazywały się najczęściej kobiety oraz osoby młodsze, z wyższym wykształceniem i mieszkające w aglomeracjach miejskich. Z uwagi na fakt, że przeprowadzone badania nie potwierdziły opinii samych ankietowanych o ich dużej wiedzy na temat substancji dodatkowych stosowanych w produkcji żywności, należy przypuszczać, że w znacznym stopniu odzwierciedla to stan świadomości w tym zakresie znacznej części społeczeństwa. Należy podjąć działania edukacyjne społeczeństwa dotyczące stosowania substancji dodatkowych w przemyśle spożywczym, aby zwiększyć świadomość odnośnie bezpieczeństwa i skali spożycia substancji dodatkowych w diecie.

**Słowa kluczowe:** bezpieczeństwo żywności, postawy prozdrowotne, dodatki do żywności, konsument