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Acceptance of Food Technologies, Perceived Values and Consumers' Expectations towards Bread. A Survey among Polish Sample

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Abstract: The aims of the study were to identify the perceptions about the technologies that are used to increase the nutritional value of cereal products, and to evaluate relations between consumers' perceptions of them, expected changes to bread, and the perceived values. Quantitative data was collected through computer-assisted personal interviews (CAPI) within a sample of 1000 Polish adults. Clustering method was used to identify homogeneous groups based on opinions on the technologies used in the production of cereals and cereal products. Neutral attitudes towards technologies were presented in the sample with relatively greater acceptance of traditional crossbreeding of varieties and enrichment processes. Nevertheless, three homogeneous clusters were identified: technological sceptics (33.6%), technological traditionalists (15.0%) and technological enthusiasts (51.4%). Technological traditionalists appreciated the naturalness of food, tradition, natural environment, quality of life and health more than the other clusters. Perceiving themselves as a person valuing tradition and quality of life was associated with belonging to the technological sceptics. Both sceptics and traditionalists declared greater fears resulting from the application of new technologies in food production, including threats to the environment, health, naturalness of food and quality of life. Technological enthusiasts were anticipating more changes in bread. The differences among the clusters, including perceived values, require communication that is adapted to the profile of the consumers. The results can be useful for bread manufacturers to predict the demand and deliver against it and for marketers who are responsible for the process of effective product labelling and communication in order to meet the consumer needs.

Keywords: technologies; acceptance; cereals; bread; consumers; Poland

1. Introduction

Global warming and environmental contamination threaten not only the survival of the human race but also the ecosystem, resulting in an increase in activities focused on the protection of the environment and nature [1–6]. Many companies consider the impact that their products have on the natural environment during the product development process, as well as engage in green marketing activities related to sustainable consumption [7,8]. Such trends can also be observed in consumer behaviour, with consumers tending to buy and use more eco-friendly goods and services in order to protect the environment [9–12]. However, consumers' behaviours are primarily conditioned by their

concern for health, which is confirmed by the results of numerous studies [13–15]. There is a growing interest in healthy foods with various improvements in the negative attributes (e.g., food lower in sodium), as well as the addition of beneficial ingredients (e.g., pro- and prebiotics). Simultaneously, to promote more healthy food choices and dietary patterns, nutrition labelling is widely used by producers [16]. In addition to the concern for the environment and people's health, food choices are also largely conditioned by other factors. The consumers' opinions on food products and the technologies used in agriculture and food production play an important role in explaining their decisions relating to food [14,17,18]. Perception of food, including cereal products, has already been examined quite profoundly. Consumers' decisions concerning food products are determined mainly by sensory attributes and physicochemical properties of these products, including freshness, formulation modifications, taste, colour and texture [15,19–22]. However, the price [20] and the impact on health [15,21] are considered important when choosing food. Moreover, studies revealed that some people tend to reject unfamiliar food products. A consumer's tendency to refuse or avoid unfamiliar food products is defined as food neophobia [22,23]. Thus, the factors conditioning the food choice, including the selection of cereal products, are widely recognised in the literature. In the majority of studies, the products available on the market are evaluated by taking into account different assessment criteria. However, to the best of our knowledge, little is known about consumer expectations in relation to specific products, including bread. There is, therefore, a need to confirm whether a tendency to look for healthy food products exists in the case of bread or whether other expectations regarding this product are more important for consumers.

Food producers are heavily involved in the development of new products, which are nutrient-enriched or produced with the use of new technologies, in order to meet consumer needs and demands and to be competitive in the market [24,25]. Cereal products are also intensively modified in the production process in order to obtain products with higher health values while preserving their sensory acceptance [14,26–29]. Changes in cereal products, e.g., the addition of fibre to white bread, are mostly accepted by consumers [19], although the level of acceptance depends on the product to which the fibre is added [30,31]. On the other hand, the need to preserve the naturalness of products is commonly emphasized by consumers [32].

Simultaneously, the resurgent interest in re-discovering ancient varieties as functional foods is currently noticed. This is expressed, e.g., by people who have to avoid all gluten in their diet [33]. Moreover, ancient crop species help provide new food products with health-promoting ingredients while increasing crop and food diversity [34]. The increasing interest in ancient wheat cultivars is based on their characteristic nature, and inter alia "perceived" higher nutritional value of their flour, in respect to modern wheat. The research conducted on ancient wheat varieties is currently scarce but available information raises interesting considerations that necessitate discussion, including conclusions on health benefits [35].

The use of different modern technologies in food production allows increased health properties to be achieved but also other benefits, including longer shelf life and higher convenience of use. However, the consumers' acceptance of the technologies used in the production of food differs [23,36–38], with some consumers inducing strong opposition, e.g., for the use of genetic modification [39], and thereby resulting in consumers rejecting such products. Moreover, consumers are afraid that in some situations innovations can damage the traditional character of food [40]. In the case of Polish consumers, highly processed and genetically modified food tends to be assessed as having low quality. This approach reflects consumers' fears towards food additives and new controversial technologies applied in food production [41]. More positive opinions concern the use of new technologies as a way of producing food that allows a more balanced diet and that controls the selection of food rather than achieving the safety associated with the consumption [42]. However, studies have shown that the majority of consumers has relatively little knowledge about the technologies used in food production [18], which may significantly affect their opinions on the use of these technologies [36,43], as well as their opinions on the impact that such innovations would have on the environment. The abovementioned

technologies, and especially the modern ones, have been the subject of many studies in which consumers' knowledge about the technologies [18], the health risks associated with them [23,36,38,42] and neophobic attitudes towards them have been evaluated [23,36,44]. However, there is a lack of research on the relationship between consumer acceptance of technologies used in food production and consumer expectations for food products.

Some authors suggest that sociodemographic variables are becoming less important in the differentiation of the attitudes and behaviours of consumers and underline the greater importance of variables that reflect consumer lifestyle, including values [45,46]. However, differences in consumers' opinions on various aspects of the technologies used in food production have been observed after taking into account sociodemographic characteristics [19]. Therefore, in this study, both sociodemographic features and perceived values were taken into account as variables differentiating acceptance of technologies used in food production. This will enable determining their importance in conditioning attitudes towards technologies used in food production, including cereals and cereal products.

To be able to develop products that respond better to consumers' expectations, food manufacturers need to know what technology-related attributes can possibly have a negative impact on the product's image, and thus act as barriers to acceptance. Since food products compete on the market, it is important to understand how expectations towards them correlate with the consumers' views on technologies employed in food production. Such information would provide cues for using and developing technologies that are more acceptable and for elaborating effective marketing strategies. Hence, the following research questions were formulated: (1) Are there differences in consumers' perceptions of individual technologies used in the production of cereals and cereal products and, if so, can these differences be the basis for distinguishing homogeneous groups of consumers? (2) What changes are expected by consumers in the bread that is available on the market? (3) How do consumers perceive modern technologies used in food production and how do they perceive values, with particular emphasis on health and the environment? (4) Are differences in the acceptance of the technologies that are used in the production of cereals and cereal products reflected in the acceptance of modern technologies used in food production, recognised values and expectations towards bread?

Therefore, the aim of this study was (1) to identify the perception of different technologies used in the production of cereals and cereal products in order to increase the food's nutritional value; (2) to evaluate the relations between the consumers' perception of the technologies used in the production of cereals, the changes expected in breads offered on the market, and the values important to the respondents. Sociodemographic characteristics were used as variables determining respondents' opinions.

2. Materials and Methods

2.1. The Survey

Quantitative data were collected within the project 'Bioproducts, innovative technologies of pro-health bakery products and pasta with reduced caloric value' aimed at increasing the innovativeness of the Polish agro-food sector through the development of bakery products providing functional and nutritional benefits. The paper presents only some of the findings from this vast study.

The sample (n = 1000) was drawn from the social security addresses database and is representative of the population of Poland aged 18 and above. The quota selection was applied. The quotas were selected adequately for gender, education, size of the place of residence, and region. The sample design was a multi-stage, random one. A number of sampling points were drawn with a probability proportional to the population size for the total area of the country and to the population density. The sampling points were drawn systematically from each of the administrative units after stratification by individual unit and type of area. In each of the selected sampling points, a starting address was drawn at random. Further addresses were selected by standard random route procedures from the

initial address [47]. Only the respondents who met the recruitment criteria, i.e., being responsible for food purchases or making cooperative food purchases within the household, participated in the study. The interviews were conducted face-to-face in the respondent's home with the use of a computer (computer-assisted personal interview (CAPI)) by the professional market research agency respecting ESOMAR (European Society for Opinion and Marketing Research) code. The detailed characteristics of the sample are provided in Table 1.

2.2. Description of the Questionnaire

The expected changes in bread offered on the market were measured using the following question: *What kind of changes in bread offered on the market do you expect?* A list of expected changes was created based on the analysis of the results of previous studies [20,48–50] and on a group discussion that took place prior to the preparation of the research tool used in the quantitative survey. Focus Group Interview (FGI) research was carried out according to the author's moderation scenario in a group of 30 consumers (3 groups of respondents, each with 5 women and 5 men). Each respondent's responsibility in the household for food purchases and food preparation was assumed as the inclusion criterion for group discussion. Among the changes expected in breads included in the quantitative study were the following: a longer shelf life; an improvement in bread characteristics such as taste, texture, freshness; an increase in the bread's nutritional value by its enrichment with various components; selling bread in individual packages with information about the product; selling frozen bread to be baked at home. The participants' opinions were measured using a seven-point scale: strongly not expected (1), not expected (2), rather not expected (3), neither expected nor unexpected (4), rather expected (5), expected (6), strongly expected (7).

Participants' opinions on new food technologies were measured using four statements derived from the food technology neophobia scale (FTNS)—a measure of attitudes towards new technologies used in the food industry [38]. The question was as follows: How much do you agree with the following statement (1) "New food technologies decrease the natural quality of food"; (2) Society should not depend heavily on technologies to solve its food problems; (3) New food technologies may have long-term negative environmental effects; (4) New food technologies may have long-term negative health effects. A seven-point scale was used to measure participants' opinions: strongly disagree (1), disagree (2), rather disagree (3), neither agree nor disagree (4), rather agree (5), agree (6), strongly agree (7).

The respondents presented their opinions on the six technologies used to enhance the nutritional qualities of cereals and/or cereal products, including: (1) traditional crossbreeding of different varieties; (2) modern breeding with the use of genetic modification; (3) the use of bacteria or yeast to improve the texture, flavour and nutritional value; (4) the use of enzymes to improve the texture; (5) removal of the seed coat in the process of mechanical fractionation; (6) enrichment processes, for example, with vitamin B, calcium, fibre [19]. Opinions were expressed on a seven-point scale: very negative (1), negative (2), rather negative (3), neither negative nor positive (4), rather positive (5), positive (6), very positive (7).

In this study, self-perception with respect to values was measured in order to describe the value-based motivational background of respondents. Items were selected to reflect those orientations that could be regarded as relevant to the acceptance of food technologies. Respondents' own evaluations of their values were assessed with five statements: 'I believe that I am a person (1) who values the naturalness of food; (2) who values tradition; (3) who values good quality of life; (4) who has high environmental awareness, and (5) who cares about health'. The respondents' opinions were expressed on a seven-point scale: strongly disagree (1), disagree (2), rather disagree (3), neither agree nor disagree (4), rather agree (5), agree (6), strongly agree (7) [15].

The sociodemographic characteristics of the respondents included gender, age, education, place of residence and the subjective opinion on income.

2.3. Data Analysis

Opinions on the technologies used to enhance the nutritional value of cereals or cereal products, as well as the changes expected in bread, are presented as the mean value and standard deviation score. Ward's hierarchical clustering method was used to identify three homogeneous clusters based on the opinions on the six technologies used in the production of cereals and cereal products. The clusters were named according to the level of acceptance of technologies used to increase the nutritional value of cereals and cereal products. Cluster I was named as technological sceptics (Tech-Scep) because it presented the most negative opinions on all technologies, with the exception of the opinion on the use of genetic modification (GM). Cluster II was described as technological traditionalists (Tech-Trad) because of the most positive opinions on traditional crossbreeding and bacteria and/or yeast addition that improves texture, flavour and nutritional value, and the most negative opinion on the use of GM. In cluster III, named as technological enthusiasts (Tech-Enth), respondents expressed more positive opinions on all technologies including genetic modification.

To determine the differences between the opinions on the technologies and clusters affiliation the ANOVA and Tukey's post hoc test were used. To profile the respondents' clusters, sociodemographic variables and self-perception regarding values, as well as opinions on new food technologies and expected changes in the bread market, were used. The clusters were tested for significant differences with the one-way ANOVA method, with cluster analysis serving as a fixed source of variation. Data analysis was performed with the use of IBM SPSS Statistics 24PL (IBM Corp. in Armonk, NY, USA).

3. Results

3.1. Sociodemographic Profile of the Sample

Regarding the sociodemographic characteristics of the respondents, the sample consisted of more female than male participants. More than 1/3 of the respondents lived in rural areas. Almost 2/5 of the sample was represented by respondents with education lower than secondary. Respondents' financial status was relatively good since 16.6% declared that they were able to "afford all needs" and 3.6% of the sample declared even to be able to "afford all needs and save something". Almost half of the respondents declared that they can "afford some needs but not all of them". The detailed description of the sample, including sociodemographic characteristics, is provided in Table 1.

Table 1. Sociodemographic profile of the total sample and the clusters identified [%].

Variables	Total Sample (n = 1000)	Tech-Scep [1] (33.6%)	Tech-Trad [1] (15.0%)	Tech-Enth [1] (51.4%)	Sig.
Gender					0.006
Female	54.5	36.9	16.3	46.8	
Male	45.5	29.7	13.4	56.9	
Place of residence					0.025
Rural area	37.8	33.3	14.0	52.7	
Town with less than 100,000 citizens	33.5	28.7	14.9	56.4	
Town with more than 100,000 citizens	28.7	39.7	16.4	43.9	
Education					<0.001
Lower than secondary	39.8	29.9	9.3	60.8	
Secondary	37.0	35.2	15.9	48.9	
Higher	23.2	37.5	23.3	39.2	
Age					0.312 *
<25 years old	12.3	29.3	14.6	56.1	
26–35 years old	17.5	34.9	20.0	45.1	
36–45 years old	16.6	30.7	15.7	53.6	
41–55 years old	28.3	35.3	11.3	53.4	
>55 years old	25.3	37.1	15.2	47.7	

Table 1. *Cont.*

Variables	Total Sample (n = 1000)	Tech-Scep [1] (33.6%)	Tech-Trad [1] (15.0%)	Tech-Enth [1] (51.4%)	Sig.
Opinions on income					0.171 *
It is absolutely insufficient	8.0	33.7	6.3	60.0	
It allows fulfilling of only basic needs	24.6	34.1	15.0	50.9	
We can afford some needs but not all of them	47.2	34.5	17.6	47.9	
We can afford all needs	16.6	30.1	12.1	57.8	
We can afford all needs and save something	3.6	33.3	13.9	52.8	

[1] Tech-Scep—technological sceptics; Tech-Trad—technological traditionalists; Tech-Enth—technological enthusiasts; * Differences between groups not significant (p-value > 0.05).

3.2. Respondents' Opinions Regarding Values, Technology Acceptance and Expectations towards Bread

The respondents' perceptions of themselves concerning values, their opinions on new food technologies and on methods used in the production of cereals and cereal products, as well as the expected changes in bread available on the market, are presented in Table 2.

Table 2. Profile of the sample according to perceived values, expected changes in bread and opinions on food technologies.

Items	Scope [1]	Modal	Dominant	Mean Value	Standard Deviation
Self-perception with respect to values					
A person who values naturalness of food	1–7	5	4	4.67	1.35
A person who values tradition	1–7	5	5	5.08	1.30
A person with high environmental awareness	1–7	4	4	4.39	1.38
A person who values quality of life	1–7	5	5	5.07	1.19
A person who cares about health	1–7	5	5	5.01	1.23
Opinions on new food technologies					
New food technologies decrease the natural quality of food	1–7	5	5	4.66	1.56
Society should not depend heavily on technologies to solve its food problems	1–7	5	4	4.72	1.52
New food technologies may have long-term negative environmental effects	1–7	5	5	4.64	1.51
New food technologies may have long-term negative health effects	1–7	5	4	3.98	1.62
Opinions on technologies used in cereal and cereal production to enhance their nutritional value					
Traditional crossbreeding	1–7	4	4	4.39	1.42
Modern breeding using genetic modification	1–7	3	4	3.24	1.55
Bacteria and/or yeast added to improve texture, flavour and nutritional value	1–7	4	4	4.06	1.43
Enzymes used to improve texture	1–7	4	4	3.55	1.42
Mechanical fractioning process to remove outer layers	1–7	4	4	3.64	1.39
Enrichment processes, i.e., with B vitamins, calcium, fibre	1–7	4	4	4.28	1.36
Expected changes in bread available on the market					
Longer shelf life	1–7	5	5	4.29	1.94
Improvement in bread characteristics such as taste, texture, freshness	1–7	5	5	4.90	1.68
Nutritional value of bread increased by the enrichment of various components	1–7	5	4	4.69	1.72
Sale of bread in individual packages with information about the product	1–7	5	5	4.59	1.76
Sale of frozen bread to be baked at home	1–7	4	4	3.90	1.86

[1] A seven-point scale: 1—strongly disagree/very negative/strongly not expected; 4—neither . . . nor . . . ; 7—strongly agree/very positive/strongly expected.

The respondents usually perceived themselves as individuals who value tradition, good quality of life and health rather than as people who care for the environment. However, they were more

convinced about the likelihood of long-term negative consequences of using new food technologies for the environment than for health. Traditional crossbreeding and enrichment processes were indicated as most useful methods for increasing the nutritional value of cereals and cereal products. Participants' expectations regarding the changes in bread were related primarily to the improvement of its sensory characteristics (such as flavour, texture and freshness), the increase of its nutritional values, the introduction of bread sold in individual packs with information about the product, followed by a longer shelf life. The least expected change turned out to be the introduction to the market of frozen bread that would be baked at home (Table 2).

3.3. Profile of the Clusters Identified

Resulting from this study, three clusters were identified and their characteristics are presented in Table 3.

Table 3. Profile of the identified clusters (mean value, standard deviation).

Technologies	Total Sample	Cluster [1]		
		Tech-Scep [2]	Tech-Trad [2]	Tech-Enth [2]
Traditional crossbreeding	4.38 ± 1.42	3.16 [a] ± 1.13	6.03 [b] ± 0.94	4.72 [c] ± 0.97
Modern breeding using genetic modification	3.24 ± 1.55	2.16 [a] ± 1.01	1.64 [b] ± 0.85	4.42 [c] ± 0.95
Bacteria and/or yeast added to improve texture, flavour and nutritional value	4.06 ± 1.43	2.87 [a] ± 1.01	5.08 [b] ± 1.46	4.55 [c] ± 0.99
Enzymes used to improve texture	3.55 ± 1.42	2.46 [a] ± 0.93	2.70 [a] ± 1.41	4.50 [b] ± 0.95
Mechanical fractioning process to remove outer layers	3.64 ± 1.39	2.55 [a] ± 1.04	3.33 [b] ± 1.42	4.45 [c] ± 0.99
Enrichment processes, i.e., with B vitamins, calcium, fibre	4.28 ± 1.36	3.40 [a] ± 1.32	4.92 [b] ± 1.49	4.67 [b] ± 1.01

[1] Mean value based on a seven-point scale: 1—very negative; 4—neither negative nor positive; 7—very positive; [2] Tech-Scep—technological sceptics; Tech-Trad—technological traditionalists; Tech-Enth—technological enthusiasts; [a–c] Means within a row with different superscripts differ significantly (ANOVA, $p \leq 0.05$).

The respondents from cluster I presented the most negative opinions on all technologies, with the exception of the opinion on the use of genetic modification (GM). In the case of GM, they showed significantly more positive opinions than those representing cluster II, but significantly more negative opinions than those from cluster III. The most positive opinions on traditional crossbreeding and bacteria and/or yeast addition to improving texture, flavour and nutritional value were observed in Tech-Scep while in cluster III, the respondents expressed more positive opinions on other technologies including genetic modification. There were no statistically significant differences between cluster II and cluster III concerning opinions on the enrichment process (Table 3).

More than 1/3 of the population (33.6%) was allocated to the Tech-Scep, 15.0% to the Tech-Trad and 51.4% of participants to the Tech-Enth (Table 4). The identified clusters differed significantly in terms of gender, education and place of residence of the respondents. More men than women were positively oriented towards the technologies that are used to increase the nutritional value of cereals and/or cereal products (Tech-Enth). Accordingly, in Tech-Scep and Tech-Trad, there were more women than men. Among Tech-Enth, there were more respondents with education lower than secondary compared to others. The Tech-Enth cluster was represented by the smallest number of people with higher education while the majority of these people were allocated to the Tech-Trad. Among the Tech-Scep and Tech-Trad, there were more people from large cities, while among Tech-Enth there were significantly more people from smaller towns and rural areas. Age and opinions on financial status did not differ in the sample (Table 1).

Self-perception regarding values significantly differentiated the clusters. Technological traditionalists perceived themselves as health- and environmentally-conscious individuals, paying attention to the naturalness of food, valuing tradition and good quality of life. The other two clusters did not differ in terms of values regarding the naturalness of food and environment and health

consciousness. On the other hand, technological sceptics perceived themselves as people who value tradition and quality of life to a higher extent than technological enthusiasts (Table 4).

Table 4. Profile of identified clusters according to self-perception with respect to values, expected changes and opinions on new food technologies (mean value, standard deviation).

	Cluster [1]		
	Tech-Scep [2]	**Tech-Trad** [2]	**Tech-Enth** [2]
Self-perception with respect to values			
A person who values food naturalness	4.59 [a] ± 1.30	5.41 [b] ± 1.61	4.51 [a] ±1.23
A person who appreciates tradition	5.23 [a] ± 1.26	5.68 [b] ± 1.41	4.81 [c] ± 1.22
An environmentally-conscious person	4.34 [a] ± 1.23	4.85 [b] ± 1.66	4.30 [a] ± 1.30
A person who values life quality	5.24 [a] ± 1.12	5.56 [b] ± 1.23	4.81 [c] ± 1.15
A health-conscious person	4.88 [a] ± 1.23	5.45 [b] ± 1.29	4.97 [a] ± 1.19
Expected changes on bread market			
Longer shelf life of bread	4.10 [a] ± 2.07	3.15 [b] ± 2.17	4.75 [c] ± 1.60
Improvement in bread characteristics such as taste, texture, freshness	4.98 [a] ± 1.78	4.93 [a] ± 2.06	4.83 [a] ± 1.49
Nutritional value of bread increased by the enrichment of various components	4.74 [a] ± 1.74	4.91 [a] ± 2.09	4.59 [a] ± 1.59
Sale of bread in individual packages with information about the product	4.70 [a] ± 1.85	4.69 [a] ± 2.21	4.49 [a] ± 1.55
Sale of frozen bread for baking it at home	3.82 [a] ± 1.99	3.21 [b] ± 2.06	4.15 [c] ± 1.66
Opinions on new food technologies			
New food technologies decrease the natural quality of food	4.91 [a] ± 1.61	5.00 [a] ± 1.69	4.39 [b] ± 1.44
Society should not depend heavily on technologies to solve its food problems	4.88 [a] ± 1.53	5.17 [a] ± 1.55	4.47 [b] ± 1.46
New food technologies may have long-term negative environmental effects	4.91 [a] ± 1.51	4.79 [a] ± 1.63	4.42 [b] ± 1.43
New food technologies may have long-term negative health effects	4.91 [a] ± 1.58	4.97 [a] ± 1.61	4.49 [b] ± 1.42

[1] Means based on a seven-point scale (1—strongly disagree/strongly not expected; 4—neither ... nor ... ; 7—strongly agree/strongly expected); [2] Tech-Scep—technological sceptics; Tech-Trad—technological traditionalists; Tech-Enth—technological enthusiasts. [a–c] Means within a row with different superscripts differ significantly (ANOVA, $p \leq 0.05$)

The most expected changes regarding bread among technological enthusiasts involved an extension of the shelf life and an introduction to the market of frozen bread that would be baked at home, while such changes were the least expected by technological traditionalists and technological sceptics (Table 4).

There were no differences in the opinions of technological sceptics and traditionalists concerning new food technologies. On the other hand, technological enthusiasts, to a smaller extent, agreed with statements regarding long-term negative effects of their application on the environment, health, natural quality of food and dependence of society on technologies. Therefore, these opinions confirm the positive attitudes of Tech-Enth towards the different methods used in the production of cereals and cereal products to enhance the nutritional qualities (Table 4).

4. Discussion

As far as processing methods are concerned, traditional crossbreeding has been preferred to all the other methods, both in the Polish population and in other countries [19]. As expected, genetic modification was the least accepted method of cereal production of those that were presented in our research. The lack of support for genetic modification confirmed the findings from other studies [19,39]. The perception of risk was the dominating association with the 'genetically modified' attribute [51]. Newly introduced food technologies might be perceived as risky due to their names, the media debate about them or because of the formation of a strong social opposition [52]. Genetic technology

tends to evoke strong negative attitudes, while consumers appear to have positive attitudes towards conventional technologies [53]. However, GM foods are more likely to be accepted when their benefits are concrete, tangible and personally relevant [54].

Aside from genetic modifications, lower acceptance was also revealed in our study of the technologies of mechanical fractionation and the use of enzymes. In the case of mechanical fractionation, the obtained results could result from the lack of familiarity with the term "fractionation". Refining of the grain in order to obtain the energy-dense endosperm for use as human food has been used for a long time [55]. Hence, this method, as one traditionally used for the production of white flour, should not raise consumers' fears, especially in a situation of widespread consumption of white bread within the Polish population. However, the lack of familiarity with this concept may be the cause of the perception of risk [41]. These assumptions are confirmed by results from other research showing that consumers know relatively little about the methods of bread production [20] and also about other technologies used in the production of food [18]. Despite the fact that consumers' fears of novel food technologies and the risks related to them are well documented in other studies [23,25,36,44], our study indicated that a commonly known technology, which is the mechanical fractionation and the use of enzymes, was also negatively evaluated by consumers. This assessment may result from the lack of acceptance of white flour that is deprived of many valuable components, as well as from a lack of knowledge about technology. Therefore, monitoring consumers' opinions on technologies should not be limited to only innovative technologies, especially when the technology assessment has a significant impact on a product's acceptance.

It is well documented that sociodemographic characteristics significantly determined consumers' behaviours, attitudes and beliefs [15,19,21,56,57]. However, researchers underline that these variables determine the choice of food in developed countries to a smaller and smaller extent [45]. In our study, sociodemographic characteristics significantly determined the acceptance of technologies used to improve the nutritional value of cereal products. Men, participants with lower education and those from smaller towns and rural areas were more enthusiastic about using technologies to improve the nutritional value of food (Tech-Enth). Women, well-educated participants and those living in larger cities were more sceptical about such use of technology (Tech-Scep). Other studies have also indicated that gender is a variable affecting the perception of technologies used for food production [19,56,57]. As in other studies on the acceptance of technologies used in the production of food [19,36], men were more positively oriented towards technologies used in the production of cereal products to increase nutritional value. The study carried out by Fell et al. [58] has shown that women are more concerned, less positive and more likely to perceive fewer benefits of novel food technologies than men. In contrast to our study, Dean et al. [19] indicated that participants with a rural identity and people with a lower education level were more sceptical about the production of functional foods. The rural consumers were also more conservative about innovations in traditional foods, while urban consumers were more willing to accept innovations [40]. These results have not been confirmed in our study and indeed a reversed situation was observed. Greater scepticism among residents of large cities and well-educated people in the use of technologies may result from their greater nutritional awareness and perception of the risks resulting from the consumption of highly processed foods [36,44,59].

It is worth noting that the relationship between gender and the acceptance of food with increased health values are different to the case of technology perception. Women were more willing than men to eat cereal products enriched with fibre, which is supported by other studies [60]. However, there are also studies that do not confirm a significant relationship between gender and the acceptance of functional food [57], proving that the differences in acceptance may result from the specifics of the tested product. For example, the study by Dean et al. [19] has shown that women evaluated pasta fortified with fibre more positively than men, while in the case of bread such differences were not found. The differences between women and men when choosing food may result from a women's tendency to pay more attention to health, which is reflected in their more correct eating behaviours [61–63]. Similarly, a greater importance of health is noted amongst people with better education [62]. Moreover,

health as value determines a healthy lifestyle, which also includes consumer awareness of food safety as well as knowledge about nutrition and nutritional behaviours [64–66]. Other studies have shown that men with lower education and living in rural areas were more suspicious of new products [60], whereas in our study such a sociodemographic profile was combined with greater acceptance of technologies that guarantee receiving cereal products with increased health benefits.

Our study did not show significant differences between different age groups in the acceptance of the use of technologies to produce cereals with increased health value. However, other studies reported differences in the acceptance of functional products obtained with the use of new technologies. It was found that older consumers showed higher acceptance towards the product labelled as containing fibre and a greater willingness to purchase them as well [21]. The lack of existing differences between older people and younger people in our study may result from the fact that it was about the acceptance of technologies and not the product itself. Greater acceptance of functional products by the elderly paired with more knowledge about new technologies and their safety among young people could determine the lack of differences.

This study presents original findings concerning Polish consumers' acceptance of technologies used in the production of cereals and cereal products and consumers' self-perceptions regarding selected values that are important for individuals and society (health, environment, naturalness, tradition, quality of life). It is well known that personal values affect food choice motives [46,67]. Therefore, the question arises as to whether such influence is observed in the case of technologies used in food production. Own study has shown that compared to other participants, the Tech-Trad cluster was dominated by respondents perceiving themselves to a higher extent as people paying a lot of attention to the naturalness of food, valuing health, tradition and quality of life, and being environmentally conscious. In contrast, the Tech-Enth cluster compared to the Tech-Scep cluster was characterized as paying less attention to tradition but also to the quality of life. The unexpected result of our study is that technological traditionalists and people who value tradition constitute a large share in the group of people living in cities. Tradition as a value and lower acceptance of novelties was usually associated with the rural environment [68]. A small representation of Tech-Trad in the studied sample (15%) may explain this unexpected result. The fact that part of the urban population in Poland represents the characteristics of the rural community may also result from increased mobility conditioned by the labour market. The relatively short period of residence in the city makes it impossible to take over urban culture and, therefore, values typical for the rural community are still cultivated by people who migrated to the cities.

The results of the study regarding the perception of the natural environment have indicated that people who perceive themselves as ecologically conscious and appreciating the naturalness of food represented the Tech-Trad, while the Tech-Enth and Tech-Scep representatives did not show differences in the perception of these values. Furthermore, the results are consistent with other studies about gender differences in research on eco-friendly attitudes [9,69–72]. For example, females were more likely to choose an environmentally friendly airline when travelling [73] and they tended to rate categories of green attributes of restaurants higher [69]. Additionally, the higher the level of education of a customer, the greater is the willingness to pay for environmentally friendly products. People with better education are also more likely to be willing to enhance their animal welfare-friendly behaviour [74,75]. In our study, respondents with a higher level of education represented Tech-Trad, who perceive themselves as ecologically conscious and who pay more attention to the naturalness of food than the other groups of consumers.

Our research shows that in terms of opinions about new technologies, Tech-Trad were similar to Tech-Scep. People allocated to these clusters perceived more negative effects of using new technologies in food production. The results of other researchers have confirmed that a greater interest in sustainability has led to the rejection of technology [76]. A similar approach by Tech-Scep and Tech-Trad to the new technologies was associated with the perception of a greater threat to the environment, limited naturalness of food and negative health consequences. Simultaneously,

significant differences in the perception of technologies used in the production of cereals and cereal products have been observed between traditionalists and sceptics, with the exception of the use of enzymes to improve the texture. Sceptics demonstrated a more negative attitude than traditionalists with the exception of modern breeding with the use of genetic modification. At the same time, the Tech-Scep cluster expected changes with regard to bread—i.e., prolonging its durability and the availability of frozen bread—more than the Tech-Trad. This can be explained by the fact that they appraised all of the values less in comparison with traditionalists. Especially, a smaller significance of naturalness of food and of tradition can be considered as a factor favouring the anticipation of changes in the food market that result from the application of new technological solutions in food production.

Technological enthusiasts expected more changes than the other clusters in the offer of bread consisting of extending the expiration date and selling frozen bread to be baked at home more. These changes were expected to the smallest degree by technological traditionalists, which can be linked with their satisfaction with the status quo or unwillingness to make any changes. Although Tech-Enth and Tech-Scep perceived themselves similarly taking into account the naturalness of food, environment and health, Tech-Scep noticed more environmental threats resulting from the use of new technologies in food production. This characteristic may reflect their greater attachment to tradition and quality of life.

The results of the study have shown that opinions on the applied food technologies and perception of values varied significantly in the expectations towards bread available on the market. These results can therefore be helpful in predicting consumers' behaviour, which is of great cognitive and application importance. Despite its valuable contribution, this study has limitations. The data used in this study was collected from Polish consumers; therefore, the extent to which the results are cross-culturally generalizable can be limited. The opinions of the study participants reflect the Polish cultural specificity, so the results obtained may significantly differ from the opinions of people representing other cultures. It is recommended that future research should be carried out in a different sample set in other countries or cultures. In addition, although the criterion of including only persons making purchases in the sample seems justified, it can cause selection biases. Therefore, in future research, it is necessary to decrease response bias through the inclusion of other individuals. A further limitation of this study relates to the explorative nature of the results provided by cluster analysis that need to be kept in mind when interpreting them. The results demonstrate that consumers differ in regard to the assessment of technologies, but this result is descriptive in its nature. The relevance of these clusters in different countries needs further verification with another dataset. Lastly, there is a need to include other food products and methods of food production in research carried out using the proposed research methodology. This would enable verifying the types of consumers identified due to the perception of technologies used in food production. In addition, it would be possible to check whether self-perception in the context of values and the perception of modern technologies used in food production exhibit similar correlation as in the case of cereal and cereal production.

5. Conclusions

This study demonstrates that respondents have a neutral attitude towards the technologies used in the production and processing of cereals that increase the cereal's nutritional value, with a relatively greater acceptance of traditional crossbreeding of varieties and enrichment processes. Nevertheless, these attitudes differed in the sample, which allowed for the separation of three homogeneous groups including traditionalists, sceptics, and enthusiasts of the above-mentioned technologies. It turned out that these groups differ not only in terms of sociodemographic characteristics but also in terms of values and opinions regarding new food technologies.

Perceiving oneself as a person who values naturalness of food, tradition, natural environment, quality of life and health favoured being a technological traditionalist, although only 15.0% of respondents reflected the characteristics of this group. Moreover, the perception of oneself as a person valuing tradition and quality of life was associated with belonging to the technological sceptics

cluster (33.6%). Both sceptics and traditionalists declared greater fears resulting from the application of new technologies in food production, including threats to the environment, health, naturalness of food and quality of life. Nevertheless, these types of consumers differ in the acceptance of the methods that are used to produce cereals and cereal products, and the biggest differences relate to the traditional crossbreeding and the addition of bacteria and yeast to improve texture, flavour and nutritional value of food. Traditionalists accept all methods, except for genetic modifications, to a higher extent than sceptics.

Technological enthusiasts identified themselves with values such as tradition, naturalness of food, natural environment, good quality of life and, to a smaller extent, health. At the same time, they presented more positive opinions about new technologies used in food production. This approach towards new technologies was associated with greater expectations for the modification of bread available on the market.

The results of our study may provide important data for those who develop educational strategies and interventions. The differences between the separated clusters, especially ones based on values that are important for individuals, such as natural environment, health and naturalness of food, require communication that is adapted to the specificity of the group. Nevertheless, the study results are of benefit mainly for companies operating in the food market with a particular emphasis on bread. The improvements in the characteristics of bread expected by the respondents were accompanied by a wide variety of opinions about the applied production technologies, which poses a challenge for producers. However, the types of consumers identified in this study can be helpful in the development of market strategies. They allow the manufacturer to predict the demand and deliver against it. Moreover, our results can be useful for marketers who are responsible for the process of effective product labelling in order to meet the needs of health- and sustainability-oriented consumers. Respondents' self-perceptions regarding the environment indicate that the sustainable education still needs strengthening in Poland.

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