

Consumer Insights on the Presence of Acrylamide in Baked Products: Perception, Awareness and Behaviour

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Abstract

Aim: This study examined consumer awareness, attitudes, and purchasing habits regarding the presence of acrylamide in bakery products, with a focus on understanding the level of knowledge and concern about this chemical in food.

Methodology: A survey was conducted among 327 respondents, with 70.34% identifying as women and 29.66% as men. The majority were young adults aged 18 to 24, and 79.82% were from the Republic of North Macedonia.

Results: Over half of the respondents (50.76%) were unaware of the presence of acrylamide in food products, and 30.3% were introduced to the topic through social media platforms. Most participants reported regularly purchasing bakery products, with bread being the most frequently bought item. A significant proportion (68.6%) purchased these products from supermarkets. While 33.03% of respondents expressed concern about acrylamide, 52.29% believed it could pose a health risk, and 42.51% were unsure. Trust in health organizations' information was generally high. Taste and ingredient quality were identified as the most important factors influencing product choices. A large majority (68.2%) considered the nutritional content of bakery products important, and 88.69% preferred products made with natural ingredients. Furthermore, 43.37% of the respondents actively avoided certain bakery products, and 20.18% specifically sought products with lower acrylamide content.

Implications and recommendations: The findings highlight a clear demand for more information about acrylamide, with many respondents expecting support from national health authorities. This suggests a pressing need for increased public awareness and educational initiatives to address consumer concerns about acrylamide in food and its potential health risks. Most respondents expressed the need to obtain health information on acrylamide and expect support from state health agencies, which indicates the need to increase public awareness and education in this regarding acrylamide exposure and risks.

Keywords: consumer awareness, acrylamide, bakery products, social media, health risk

1. Introduction

In recent years, awareness of the food safety and health risks associated with acrylamide and its consumption has increased significantly. Acrylamide is a chemical compound (carcinogenic substance) that forms naturally in starchy food products during high-temperature cooking processes, such as frying, baking, and industrial processing, at temperatures above 120°C and in low-humidity conditions (Nematollahi et al., 2020). One must consider the important impact of consumer education on the safety of food and health of people. Even though the exposure to acrylamide poses threats, the research in this area seem to revolve around the technology aspect that looks into lowering the amount of acrylamide in food as opposed to studying the knowledge and practices of the consumers. This reserch gap advances the case for measuring consumers' risk perceptions regarding the case of acrylamide, the degree of their knowledge on the subject matter and their readiness to make suitable decisions on consuming food. Bread and bakery products are dietary staples across Europe, with consumption patterns varying widely by country. According to the Federation of Bakers (FOB) and the European Bread Market, the average European consumes about 50 kg of bread annually. This ranges from high-consumption countries like Germany and Austria (80 kg per year) to lower-consumption nations like the UK and Ireland (below 50 kg).

Referring to statistics developed by Statista in their report on bread and bakery products in Europe, Germany, despite producing 5.6 million tons of bread in 2020, has seen a gradual decline in consumption. Similarly, Poland experienced a significant drop in average monthly bread consumption, falling from 6.6 kg in 2000 to 2.75 kg in 2020. The UK also reports a decline in bread consumption, though spending has increased due to a preference for premium products. Statistics from Wikipedia on global bread consumption reveal that Turkey had the highest bread consumption in 2000, with an individual consumption of nearly 200 kg annually.

According to the Macedonian National Nutrition Survey provided by UNICEF and Statista's report on bread consumption in North Macedonia, bread remains a dietary mainstay in the country, with an average annual intake of 70 kg per person. Projections estimate this figure would increase to 72.6 kg by 2024.

Research on laboratory animals has shown that exposure to high levels of acrylamide can cause a variety of adverse effects, including damage to the nervous system and an increased risk of some types of cancer. It is important to note that these studies often involve the administration of acrylamide at significantly higher doses than are typically found in food (Başaran et al., 2023). Due to food safety concerns, more and more consumers want to know what they ingest and how such consumption might impact their bodies. However, while much emphasis has been placed on the reduction of the concentrations of acrylamide in food on the technological front, however there is still a lack of sufficient enlightenment and focus on consumer understanding, which entails their behaviour towards the use of products that expose them to acrylamide. Harkness (2018) claimed that, at least in his research sample, the perception of risk associated with exposure to acrylamide does not have a significant effect on consumer willingness to pay (WTP) – meaning that acrylamide's presence or absence does not influence consumers' intention to purchase the affected food product. This insensitivity shows that most consumers are unclear about the risks associated with food and the expectations they have of what is known as food safety. This observation may create a gap between research and the practice of consumption (Harkness, 2018). Moreover, although some authors have reported the toxicological properties of acrylamide such as its carcinogenesis and neurotoxicity (Ali et al., 2020; Hendawy, 2019), little attention has been given to how these health risks are communicated to consumers and the impact of such communication on their purchasing behaviour. According to Alija et al. (2024), the antioxidant-rich additives from natural sources such as fennel, black cumin, and pomegranate flower can significantly reduce acrylamide content in baked goods, contributing to both safer and functional food products.

The influence of North Macedonian bakery products is not restricted to just the health of the individual buyers, it also extends to the overall economy as well as consumer habits. However, the existing literature primarily focuses on the technological improvement in the processes of producing and marketing these bakery products, forgetting about the social economic factors which determine the consumers and their eating patterns. One major study (Shikhova et al., 2022) argued about the economic relevance of bakery producers in this region through a consumer market expectation in terms of what is affordable to the producers. It provided important structural issues of the bakery market, however the focus of this research was not the consumer behaviour with respect to the usage of the bakery products. It is very important to realize what the consumers want, as this determines demand for different bakery products and also informs the producers of the market movements. A study by Alija et al. (2022) also emphasizes the importance of informing consumers about the role of flour additives in improving dough quality and nutritional value, particularly in relation to gluten content and water absorption, which directly affect bread characteristics and consumer satisfaction.

The purpose of this survey research was to examine consumer awareness of acrylamides in bakery products and their perception of the risks associated with their consumption. The research focused on understanding how consumers perceive the potential risks of acrylamides, their willingness to avoid products containing acrylamide, as well as their level of awareness of the existing regulations and preventive measures. By collecting and analyzing the data obtained through this survey, the study provides valuable insights that can help develop better information strategies and regulations to increase consumer awareness and improve food safety. Improved public awareness and understanding of this topic can lead to safer manufacturing practices and effective consumer health protection.

2. Acrylamide and Its Formation in Food

Acrylamide ($\text{CH}_2=\text{CH}-\text{CO}-\text{NH}_2$) is a low molecular weight organic compound consisting of carbon (50.69%), hydrogen (7.09%), nitrogen (19.71%), and oxygen (22.51%), with a molecular weight of 71.08 g/mol. This compound is polar and well soluble in water, methanol, and ethanol. Since 1950, it has been synthesized on an industrial scale. Polyacrylamide is used in various industries and agriculture (Tekkeli et al., 2011).

Prior to 2002 acrylamide was thought not to occur naturally but only due to chemical synthesis. However, in April 2002, the Swedish National Food Agency and researchers from Stockholm University published surprising data on the significant content of acrylamide in food (from 30 µg/kg to 2300 µg/kg), especially in potato and cereal products that had undergone of high heat treatment (SNFA, 2020). In the same year, acrylamide was added to the list of toxic substances present in food. Based on the available studies on acrylamide levels in food and their intake, the World Health Organization estimated the average intake of acrylamide from food at a level of 0.3-2.0 µg/kg bw/day (WHO, 2005), and even several times lower for children due to their lower body mass (Dybing et al., 2005).

It was determined that the main pathway of acrylamide formation in food is through the Maillard reaction (Stadler & Studer, 2016). Acrylamide is formed in heated food by condensing the amino group of an amino acid (asparagine) with the carbonyl group of a sugar. The effect of this reaction is the intermediate product-the Schiff base, which can be transformed into acrylamide during direct conversion or as a result of steps involving several reactions from which acrylamide can be formed (Maan et al., 2020).

An important factor affecting the product's acrylamide level is high temperature (significantly above 120°C) (Torres-Gonzalez et al., 2019). The highest amount of acrylamide was found in food heated above 160-180°C (Maan et al., 2020; Michalak et al., 2017). On the other hand, long-term heating of food products at higher temperatures, noticeably higher than 200°C, can cause acrylamide degradation (Capuano & Fogliano, 2011; Stadler & Studer, 2016).

Numerous studies have shown that the content of acrylamide in food varies greatly, on average less than 100 µg/kg, and in extreme cases even below 10 µg/kg in high protein products and for products with a high sugar content up to 100-4000 g/kg. The highest content of this compound was determined in foods subjected to thermal processes such as frying and roasting potatoes, roasting cocoa and coffee, bread and pastry, and the thermal processing of cereals (Capuano & Fogliano, 2011; Keramat et al., 2010; Krishnakumar & Visvanathan, 2014; Michalak et al., 2019). However, other studies suggested that various raw materials, such as fennel, nigella, pomegranate, wild berries, cumin, black cumin, bamboo leaves, and others, can reduce acrylamide levels due to their antioxidant activity. In addition to this effect on acrylamide levels, these raw materials also possess antioxidant and antimicrobial properties, provide immune support and offer various other health benefits, making products containing these ingredients practical (Abdel-Shafi et al., 2011; Al-Ansi et al., 2019; Ashkezari & Salehifar, 2019; Borczak et al., 2022). Prolonged fermentation can reduce acrylamide formation in bread crust by enabling yeast to consume acrylamide precursors such as asparagine (Alija et al., 2025a). Moreover, the addition of pumpkin flour enhances the nutritional value and antioxidant potential of wheat-based products, while also positively impacting dough behavior and reducing acrylamide levels (Alija et al., 2025b). These enhancements are attributed to the bioactive compounds and fibre content in pumpkin peel and flesh, which improve both the functional and health-promoting properties of the final product (Alija et al., 2025c).

This study contributes to the subject literature by focusing on consumers' knowledge and behaviors related to acrylamide, an area where existing research is limited. While technical studies have proposed solutions to reduce acrylamide levels through additives or alternative cooking methods, understanding consumer awareness and preferences is equally important for effective risk communication and food safety policy (Sarion et al., 2021).

3. Methodology

A questionnaire composed of 19 questions and two short answer sections was employed in the study. Most of the questions comprised a mix of quantitative and qualitative approaches, such as Likert scale items, multiple-choice questions, and closed and open-ended questions. The sample consisted of 230 females and 97 males. To ensure that the sample obtained was systematic and random, the participants were selected randomly. Such selection also fulfilled several criteria, including, but was not limited to the applicant population representing both genders, covering various age groups, and

to geographical locations pertinent to the study. The objective of these measures was to ensure that the representation of the sample closely resembled the actual population in the region.

In the conducted statistical analysis several methods were applied, including trend analysis for evaluating the levels of acrylamide in bakery products, relative statistical figures, mean estimates of ungrouped data, and a *t*-test to compare differences between groups or variables. For the interpretation of results, various tables and graphs are included.

4. Results

Figure 1 shows the percentage distribution of the respondents included in the survey, divided by gender.

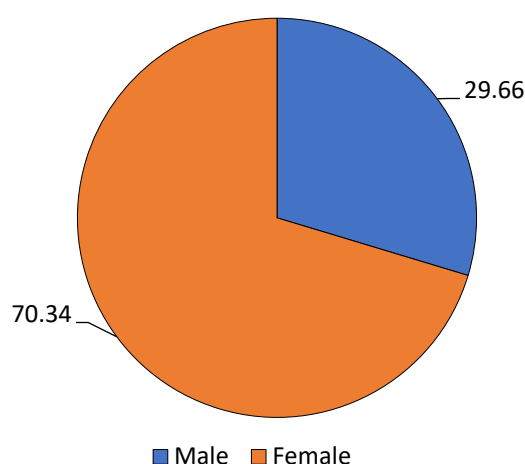
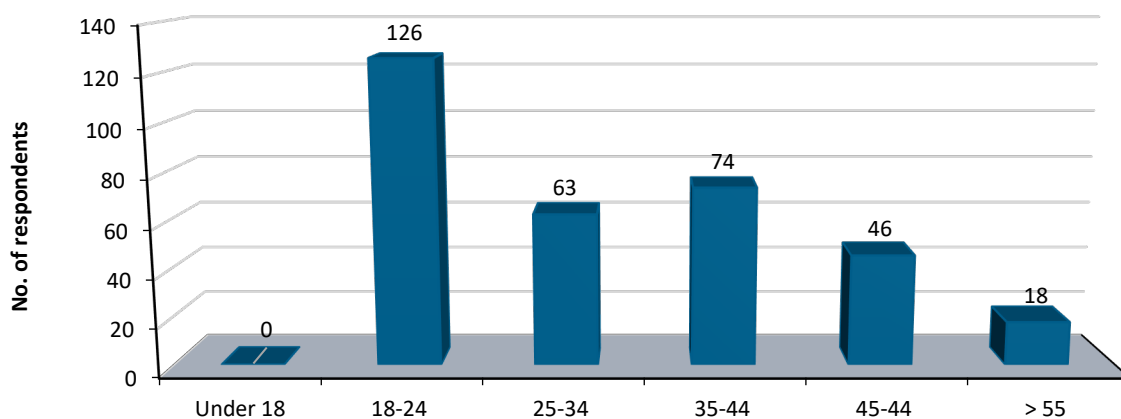


Fig. 1. Percentage distribution of respondents by gender

Source: own work based on survey results.

It can be concluded from Figure 1 that the majority of the respondents were women, comprising 70.34% (230 persons), whereas 29.66% (97) were men. The study examined a representative sample of 327 respondents.



	Under 18	18-24	25-34	35-44	45-44	> 55
■ Respondents	0	126	63	74	46	18

Fig. 2. Distribution of the number of the respondents according to age

Source: own work based on survey results.

Figure 2 shows that most of the respondents (126) were between the ages of 18 and 24.

Table 1 shows the distribution of the respondents who participated in the study according to the country in which they live.

Table 1. Distribution of the respondents who participated in the study according to country

Location	No. of respondents	%
North Macedonia	261	79.82%
Kosovo	55	16.82%
Albania	4	1.22%
Other countries	7	2.14%
Total	327	100.00%

Source: own work based on survey results.

The results presented in Table 1 show that 79.82% of the respondents who participated in this study were from the Republic of North Macedonia.

Table 2 shows the distribution of respondents who answered the question: "Before this questionnaire, did you have information about the presence of acrylamide in food products?"

Table 2. Distribution of the respondents regarding information about the presence of acrylamide in food products

Before this questionnaire, did you have information about the presence of acrylamide in foodstuffs?	No. of respondents	%
Yes	69	21.10%
Partially	92	28.13%
No	166	50.76%
In total	327	100.00%

Source: own work based on survey results.

The survey of 327 participants revealed that the majority, i.e. 50.76%, were unaware of acrylamide in food, while 28.13% had a partial knowledge, and only 21.10% were fully aware. This suggests a serious lack of understanding regarding the existence and dangers of acrylamide. To close this information gap and promote healthy eating, more public education and outreach are essential.

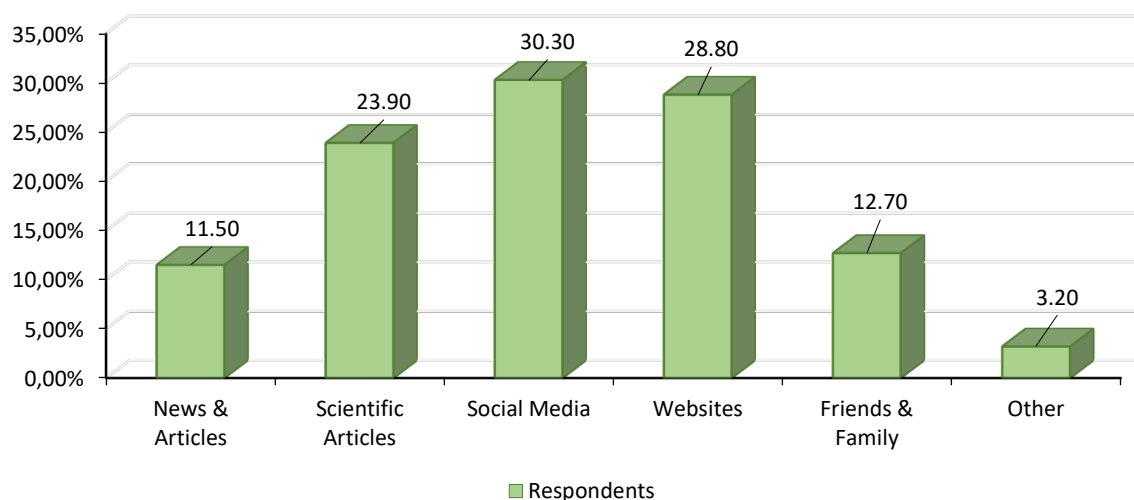


Fig. 3. Percentage distribution of the respondents in answer to "Where did you first hear about acrylamide?"

Source: own work based on survey results.

As can be seen from Figure 3, 30.3% of the respondents said that social media was where they first learned about acrylamide. The findings point to a significant reliance on digital channels (websites and social media) for health-related information. Though the percentages for conventional and academic sources, such as news and scientific publications were quite low, this suggests that more work is required to incorporate trustworthy information into these forms.

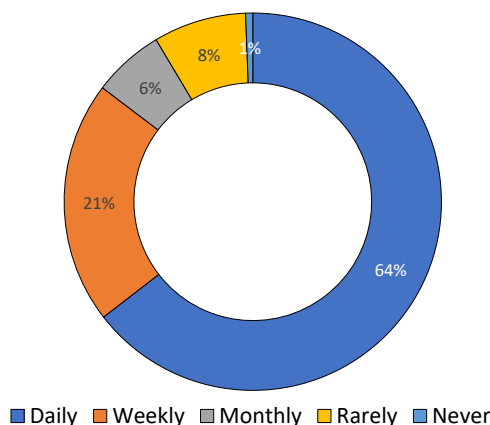


Fig. 4. Percentage distribution of the respondents in answer to “How Often Do You Buy Bakery Products?”

Source: own work based on survey results.

The prevalence of daily purchases (64%) as indicated by the data in Graph 4, emphasized how essential bakery products were in the diet of many respondents. Monthly and weekly purchasing trends reveal different patterns of consumption, which may be impacted by storage requirements, lifestyle choices, or preferences. Dietary limitations, a preference for homemade alternatives, or certain lifestyle choices may lead to rarely purchasing or never-buying behaviour.

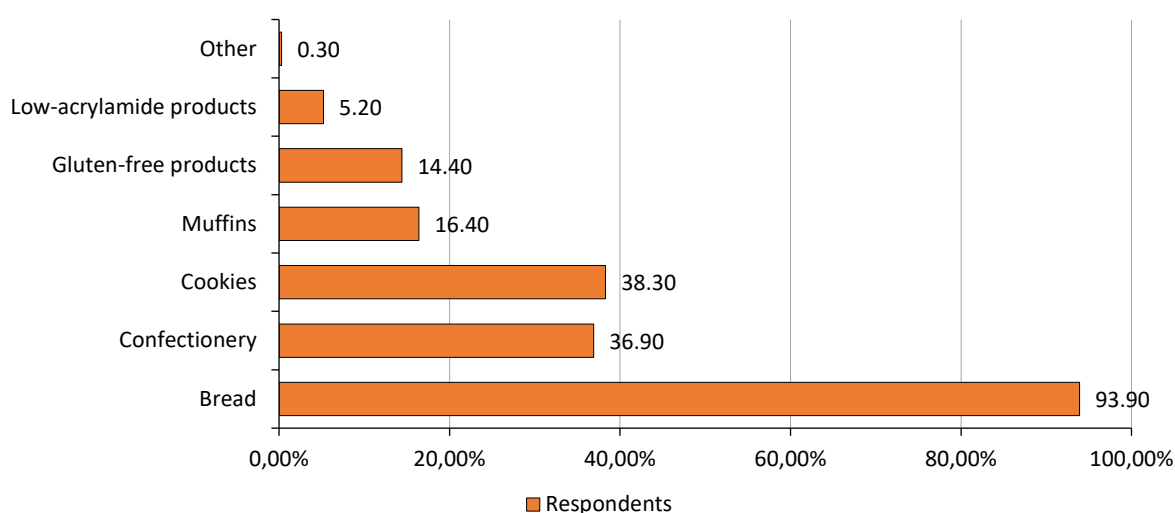


Fig. 5. Percentage distribution of the respondents in answer to “What kind of bakery products do you usually buy?”

Source: own work based on survey results.

According to the results shown in Figure 5, bread was clearly the most popular food type, which can be explained by its easy accessibility among a variety of consumables and the high demand, as most people purchase bread on a regular basis. Customers that want more snacks and nibbles are the target market for the category Cookies and Confectionery Preferences. Both of these products are essentially the same for certain customers, based on their similar buy rates. Products with Specialized Uses

(Gluten Free 14.40% and Low Acrylamide 5.20%) demonstrate increasing awareness of diet-related conditions such as celiac disease and gluten intolerance. The tendency suggests that the demand for health focused and other forms of diet has increased, and provides evidence that understanding about acrylamide and its health problems was relatively low. The negligible interest in Other Products indicated that most consumer preferences were adequately captured within the specified categories.

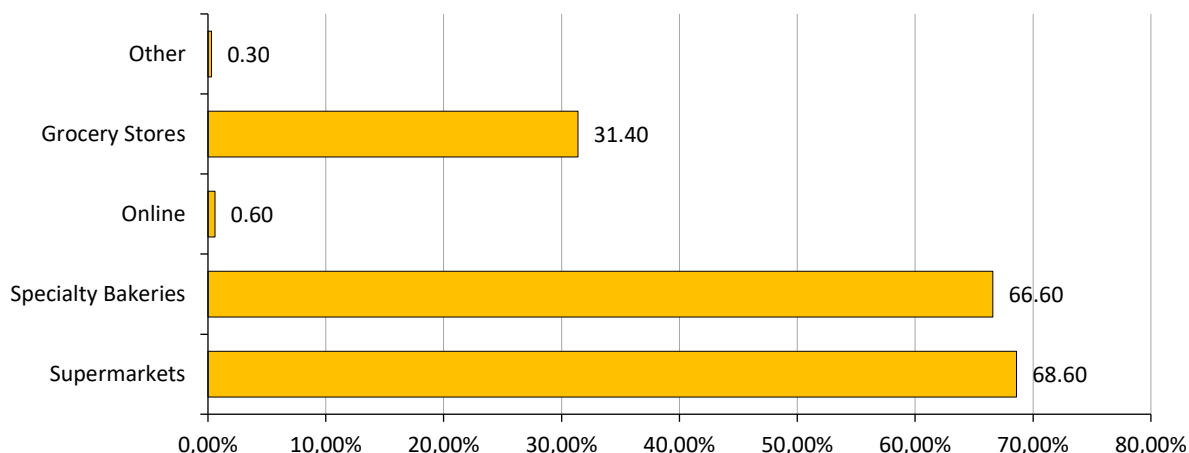


Fig. 6. Percentage distribution of the respondents in answer to “Where do you usually buy bakery products?”

Source: own work based on survey results.

According to the survey results in Figure 6, the majority of the respondents purchased bakery products from supermarkets (68.60%), with specialist bakeries coming in second (66.60%), suggesting a desire for quality, whilst for 31.40%, grocery stores provide convenient, necessary alternatives. The demand for freshness was perhaps the reason why just 0.60% purchased baked products online. Overall, consumers prioritized quality and freshness, with online purchases remaining uncommon.

Table 3 shows the distribution of the respondents who answered the question: "How concerned are you about acrylamide in bakery products?".

Table 3. Distribution of the respondents in answer to “How concerned are you about acrylamide in baked products?”

How concerned are you about acrylamide in baked products?	No. of respondents	%
Very concerned	71	21.71%
Somewhat concerned	108	33.03%
Neutral	104	31.80%
I am not too worried	27	8.26%
I am not worried at all	17	5.20%
In total	327	100.00%

Source: own work based on survey results.

Concerns about acrylamide in baked products were expressed by more than half of the respondents (54.74%), with 21.71% being extremely concerned and 33.03% moderately concerned. Around 31.80% were neutral, showing indifference or lack of strong feelings. A smaller percentage (13.46%) expressed less anxiety, followed by 8.26% who acknowledged the problem but are not overly concerned, and 5.20% who were not bothered at all. This shows that people are slightly aware of the health dangers associated with acrylamide, but it also implies that not everyone is very concerned about it.

Table 4 shows the distribution of the respondents who answered the question: "Do you believe that acrylamide poses a health risk?".

Table 4. Distribution of the respondents in answer to “Do you believe acrylamide poses a health risk?”

Do you believe acrylamide poses a health risk?	No. of respondents	%
Yes	171	52.29%
No	17	5.20%
I am not sure	139	42.51%
In total	327	100.00%

Source: own work based on survey results.

The results of Table 4 indicated that over half of the respondents (52.29%) believed that acrylamide poses a health risk, while 42.51% were unsure, reflecting uncertainty or lack of information. Only a small percentage (5.20%) did not believe it is a health risk, suggesting a general awareness of the potential dangers, even if some were uninformed or uncertain.

Table 5 shows the distribution of the mean scores for the sources of information regarding the presence of acrylamide in food products.

Table 5. Rating the sources for information about acrylamide

Sources of information	Average grade
State health agencies	2.6
Media	2.06
Food manufacturers	2.22
Health organizations	2.94
State food agencies	2.71

Source: own work based on survey results.

From Table 5, it can be seen that health organizations were considered the most reliable source of information, followed by state food agencies (2.6). Media and food manufacturers were viewed as less trustworthy, probably due to skepticism about their accuracy and objectivity. The respondents tended to trust expert, government and scientific sources over commercial or ‘sensationalized’ outlets.

Table 6 shows the distribution of the mean scores for the factors that influence the respondents' decisions when purchasing a food item.

Table 6 demonstrates that customers' top considerations when selecting bakery items were flavor (3.37) and ingredient quality (3.26), followed by availability (2.92) and brand reputation (2.91). Environmental effect (2.57), health issues (2.58), and price (2.61) were viewed as less important. Quality of ingredients and sensory appeal were more important to consumers than sustainability and health considerations. In their marketing, brands should prioritize flavour and premium ingredients over price. Although sustainability can be addressed, product quality and flavour should not be sacrificed for sustainability.

Table 6. Distribution of the mean scores

Factors	Average grade
Price	2.61
Quality of Ingredients	3.26
The taste	3.37
Brand reputation	2.91
Packaging	2.74
Availability	2.92
Marketing and advertising	2.51
Health considerations	2.58
Impact on the environment	2.57

Source: own work based on survey results.

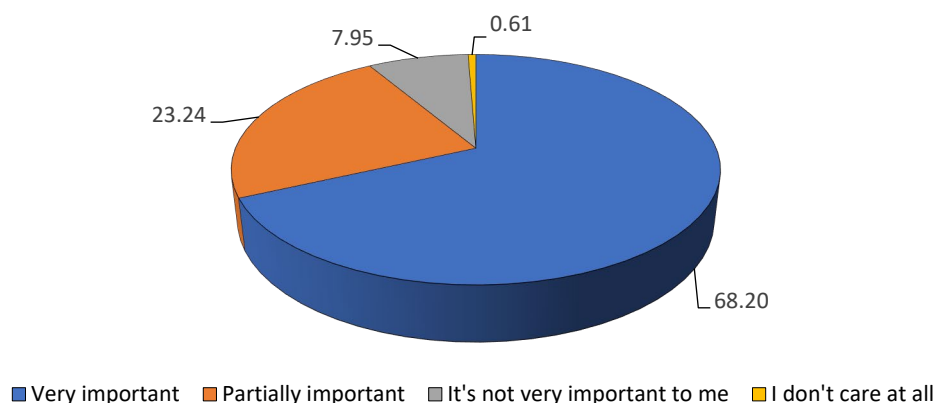


Fig. 7. Percentage distribution of the respondents in answer to “How Important Is the Nutritional Content of Bakery Products to You?”

Source: own work based on survey results.

The results presented in Figure 7 indicate that the majority of the respondents (68.20%) placed a high value on bread items' nutritional composition, which is indicative of the increasing awareness of the health benefits. A sizable percentage (23.24%) considered it to be partially important, whereas a smaller number (7.95%) believed it to be less important, whereas merely 0.61% expressed no opinion at all. By highlighting nutritional advantages and striking a balance between flavour and quality, brands may appeal to consumers who value both health and quality.

Table 7 shows the distribution of respondents who answered the question: "Do you prefer products with natural ingredients over those with artificial ingredients?".

Table 7. Distribution of the respondents in answer to “Do you prefer products with natural ingredients over those with artificial ingredients?”

Do you prefer products with natural ingredients over those with artificial ingredients?	No. of respondents	%
Yes	290	88.69%
No	19	5.81%
No preferences	18	5.50%
Total	327	100.00%

Source: own work based on survey results.

According to the results in Table 8, the majority of the respondents (88.69%) preferred products with natural ingredients, highlighting a strong trend towards health-conscious choices. A small group (5.81%) liked artificial ingredients, and 5.50% had no preference, which indicates that the trend for natural products was dominant. Brands should focus on natural ingredients in their products and marketing to appeal to health-conscious consumers.

Table 8. Distribution of the respondents in answer to “Does your awareness of the presence of acrylamide affect your purchasing decisions regarding bakery products?”

Does your awareness of the presence of acrylamide affect your purchasing decisions when it comes to bakery products?	No. of respondents	%
Yes, I avoid certain products	143	43.73%
Yes, I look for products with low acrylamide %	66	20.18%
No, it does not affect my decisions	44	13.46%
I am not sure	74	22.63%
Total	327	100.00%

Source: own work based on survey results.

Table 8 shows the distribution of the respondents who answered the question: "Does your awareness of the presence of acrylamide affect your purchasing decisions when it comes to bakery products?".

Table 8 indicates that 43.73% of the respondents stated that they avoided certain bakery products, and 20.18% indicated that they purchased bakery products with a low percentage of acrylamide.

Table 9 shows the distribution of the mean scores for the factors influencing the purchase of bakery products among the respondents.

Table 9. Factors influencing the purchase of bakery products

Factors	Average grade
The presence of information about acrylamide on the packaging	3.22
Health claims	3.43
Quality of ingredients	3.78
Brand reputation	3.06
Price	3.22

Source: own work based on survey results.

Table 9 showed that when buying bakery items, the respondents placed the highest priority on ingredient quality (3.78), closely followed by health claims (3.43), which have a big impact on their choices. While acrylamide information on the packaging (3.22) was seen as relatively significant, it did not have the same impact as ingredient quality or health claims. Price (3.22), ranked on a par with acrylamide information, was likewise of moderate relevance. The least important component, but nonetheless influencing buying decisions, was brand reputation (3.06). The results indicate that customers are seeking products that not only taste good but also suit their health-conscious preferences, with the highest value being placed on ingredient quality and health-related claims. The presence of acrylamide information on packaging, while noted as important, appears secondary to broader health claims and ingredient quality, which may be more directly tied to consumer concerns about product safety. Customers are more likely to value quality and health over price or brand familiarity, suggesting that price and brand reputation have less of an impact on purchasing decisions.

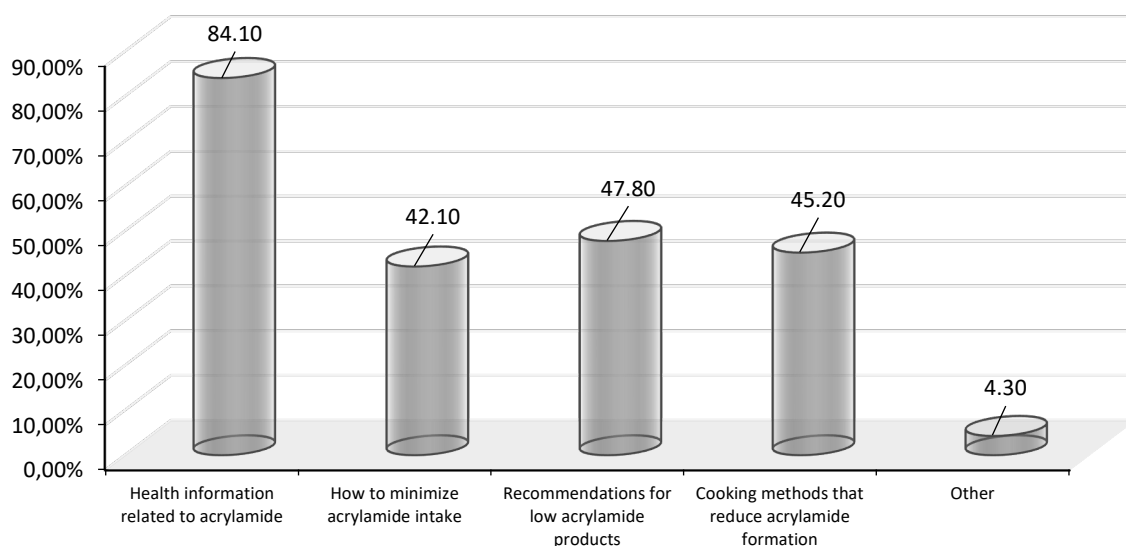


Fig. 8. Percentage distribution of the respondents in answer to "What kind of information would you like to see regarding acrylamide in bakery products?"

Source: own work based on survey results.

As can be seen from Figure 8, the majority of the respondents (84.10%) were highly concerned about the possible health hazards and interested in learning more about acrylamide's role in baked products. Nearly half (47.80%) were seeking suggestions about low-acrylamide items, and a comparable percentage (45.20%) were interested in finding out about cooking techniques that reduce the production of acrylamide. Furthermore, 42.10% were looking for advice on reducing their intake of acrylamide in general, whilst just 4.30 percent sought additional acrylamide-related information. Customers are keen to learn more about acrylamide's possible health hazards and are well aware of them. Additionally, there is a strong need for useful advice, such as suggestions for products and cooking techniques that lower acrylamide levels. This reflects a proactive approach among consumers, who want to not only understand the risks but also take steps to minimise their exposure to acrylamide in baked products.

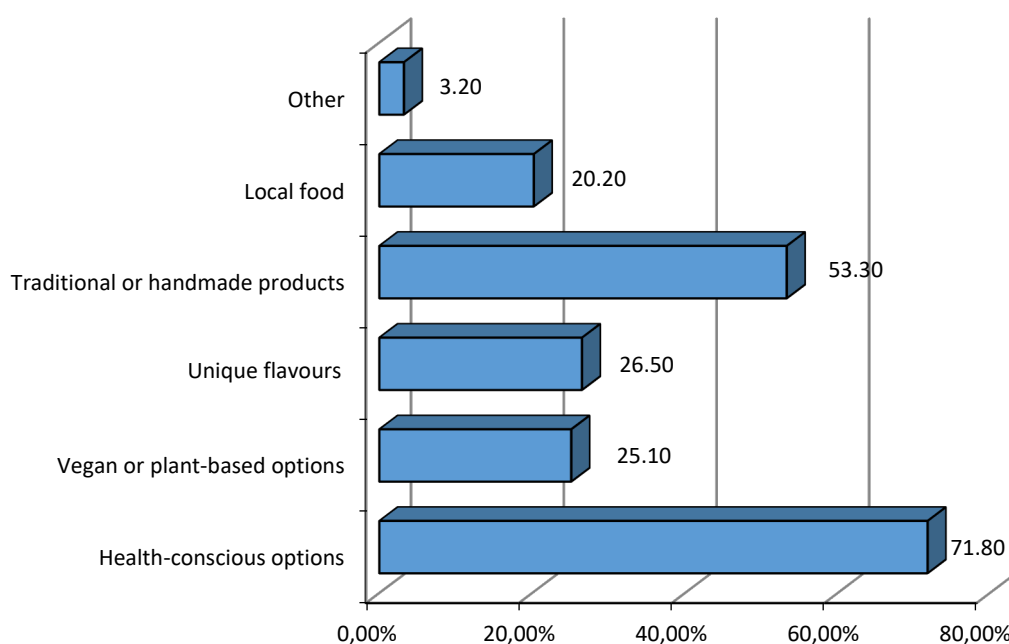


Fig. 9. Percentage distribution of the respondents in answer to “Which trends are most attractive to you in bakery products?”

Source: own work based on survey results.

Figure 9 makes it clear that the respondents were most interested in health-conscious options (71.80%), suggesting that there is a rising market for bakery products that emphasize nutritional advantages. The appreciation of authenticity, artistry, and artisan features in bakery items was reflected in the next highest value given to traditional and handcrafted products (53.30%). A sizable percentage of the respondents (25.10%) chose vegan or plant-based options, indicating a trend towards plant-based diets and more inclusive food options. Furthermore, many were drawn to distinctive flavours (26.50%), indicating a willingness to try new and varied bakery products. Local food (20.20%) also drew attention, with some consumers preferring products made with locally sourced ingredients, which supports sustainability and community-based food systems.

The interpretation of these findings indicates that consumers are prioritising health and wellness, with a strong demand for bakery items that cater to these needs. The interest in traditional or handmade items suggests a desire for authenticity and high-quality craftsmanship, while the popularity of vegan and plant-based options points to the growing importance of inclusivity and environmental considerations in food choices. While the desire for local cuisine represents a trend toward supporting sustainability and local sources, the attractiveness of distinctive flavours stresses that customers are seeking originality and diversity.

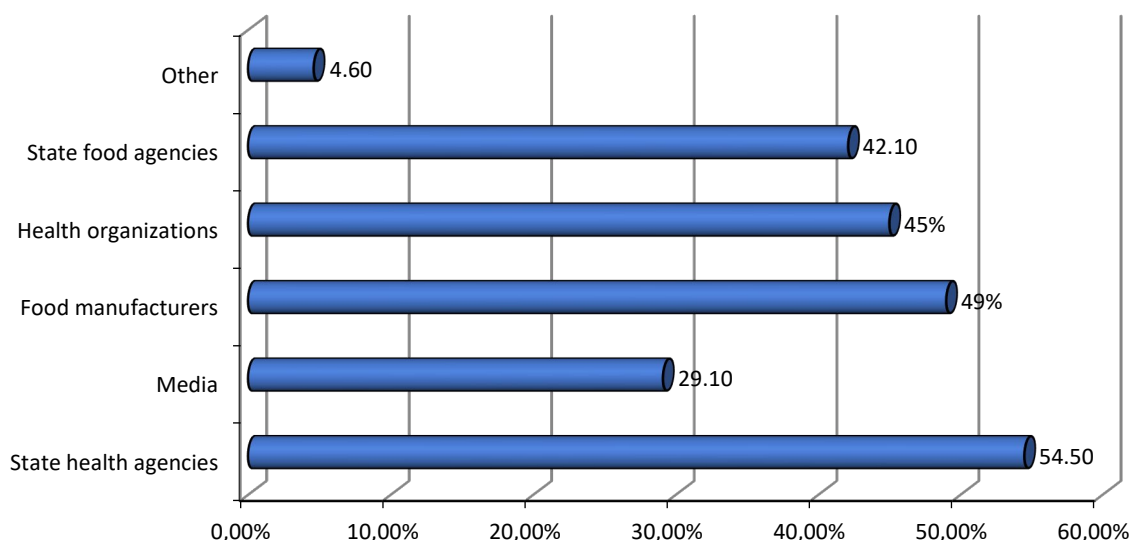


Fig. 10. Percentage distribution of the respondents in answer to “Where do you prefer to get information about food safety issues such as acrylamide?”

Source: own work based on survey results.

Figure 10 shows that when it comes to food safety problems like acrylamide, the respondents placed a high importance on official and authoritative sources, as seen by their highest preference for state health authorities (54.50%). Food producers (49%) were also regarded as important sources, which can be a reflection of customers' demands that businesses reveal product safety information. Health groups were somewhat less valued than government agencies or food producers, trusted by 45% of the respondents. The important role of government-supported specialist organizations in guaranteeing food safety was further shown by the function of state food agencies (42.10%). The lower preference for media (29.10%) suggested that there may be more skepticism about sensationalist coverage or inconsistent reporting. Lastly, a small group of the respondents (4.60%) sought out other sources, possibly relying on independent studies or alternative health channels. According to the interpretation of these results, consumers give priority to authoritative and knowledgeable sources when seeking information on food safety, particularly when it comes to complicated topics such as acrylamide.

Regarding the question "What improvements would you like to see from bakery manufacturers regarding acrylamide?", the respondents suggested the following points:

- Products should include information on acrylamide concentration and low acrylamide labeling.
- Recommendations to use modern baking methods, such as baking at lower temperatures to reduce acrylamide formation.
- Customers should receive complete and transparent information about each product.
- Products sold should have the acrylamide level indicated on the label and strive to maintain the lowest acrylamide concentrations.
- Manufacturers can make improvements such as lowering baking temperatures, improving dough composition, and developing new technologies to reduce acrylamide.

In the section for additional comments or suggestions regarding acrylamide in bakery products, the respondents suggested that food institutions, such as the Food and Veterinary Agency and the Institute of Public Health, should improve public education about the amounts and risks associated with acrylamide, as well as enforce compliance with acrylamide regulations. Manufacturers are being encouraged to invest in research and development to test and monitor acrylamide levels. Additionally, cooking temperatures and moisture content should be controlled to reduce acrylamide, as these factors can affect processing and product quality.

5. Discussion

Consumer awareness of acrylamide is highly diversified. Research indicates that while some consumers express concern about acrylamide as a food safety issue, overall awareness remains low (Johnson et al., 2019; Kowalska et al., 2017). For instance, a study involving Canadian consumers highlighted that acrylamide was ranked the top concern among food safety issues, yet many participants were unaware of its presence in everyday foods (Johnson et al., 2019). Similarly, a survey among medical students revealed a lack of knowledge regarding acrylamide's health risks, despite its established link to neurotoxic and carcinogenic effects (Kowalska et al., 2017). This gap in awareness is critical, as it suggests that consumers may not be taking the necessary precautions or making informed choices regarding their food consumption.

Various factors, including demographic variables and the type of food products consumed, influence the perception of acrylamide's risks. For example, younger consumers, who tend to favor processed and baked foods, may be at a higher risk of exposure due to their dietary preferences (González-Mulero et al., 2021). Additionally, the cooking methods employed at home can significantly affect acrylamide levels in food, with homemade preparations often yielding higher concentrations compared to industrially processed foods which are subject to stricter regulations (González-Mulero et al., 2021; Hanlon et al., 2016). This highlights the importance of consumer education regarding cooking practices and their impact on acrylamide formation.

The results suggest that even though the state health authorities are the most credible body when it comes to safety concerning issues like acrylamide, the knowledge of the potential implications of acrylamide among consumers is still quite unsatisfactory. This paradox may be explained by ineffective information dissemination campaigns or the lack of stringent measures that would compel the public to appreciate relevant health issues. Despite the high degree of confidence in health agencies, there are barriers to communicating or obtaining such information, which may make consumers misguided about the potential risk. Accordingly, it is recommended that both state agencies and food companies implement measures that will enable better understanding by the public through simple and far-reaching campaigns, and also advocate for better laws aimed at increasing the degree of openness and consumer awareness about food safety.

6. Conclusions

The study's conclusions reveal a significant need to improve consumer awareness and education regarding acrylamide in bakery products. The respondents, namely young women from the Republic of North Macedonia, expressed deeper concern about the health risks of acrylamide due to heightened awareness of health, diet, and potential impacts on reproductive health, which are often more emphasised among women in public health campaigns and societal expectations. Although many have been informed through social media, there is a strong emphasis on the need for official and accurate information from health agencies.

The respondents frequently purchase bakery products, with bread being the most commonly bought item, and prefer products with natural ingredients. They show interest in products with low acrylamide levels and are willing to pay more for healthier options. However, greater transparency from manufacturers and regulatory changes are necessary to label acrylamide levels clearly.

Social media play a vital role in informing consumers, indicating their potential as a platform for educational purposes. This study underlines the need for increased public information and education, better transparency from manufacturers and health agencies, and potential regulations on clear labelling and information about acrylamide. By improving education, transparency, and the regulatory framework, consumers will be better equipped to make healthy choices and reduce their health risk.

Additionally, the respondents suggested that food institutions such as the Food and Veterinary Agency and the Institute of Public Health should encourage citizen education about acrylamide and ensure that food companies comply with acrylamide regulations. Manufacturers should invest in research and development to create methods for testing and monitoring acrylamide levels. Controlling cooking temperatures and moisture content is essential to reduce acrylamide levels, which can affect processing and product quality.

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Opinia konsumentenka na temat obecności akrylamidu w produktach piekarniczych: postrzeganie, świadomość i zachowania

Streszczenie

Cel: Przedstawione w artykule badania miały na celu analizę świadomości konsumentów, ich postaw oraz nawyków dotyczących obecności akrylamidu w produktach piekarniczych.

Metodologia: W badaniu ankietowym wzięło udział 327 respondentów, z czego 70,34% stanowiły kobiety, a 29,66% mężczyźni. Większość uczestników to osoby młode w wieku od 18 do 24 lat, przy czym 79,82% pochodziło z Republiki Macedonii Północnej.

Wyniki: Ponad połowa badanych (50,76%) nie jest świadoma obecności akrylamidu w produktach spożywczych, a 30,3% usłyszało o nim po raz pierwszy za pośrednictwem mediów społecznościowych. Respondenci regularnie kupują produkty piekarnicze, z których najczęściej wybieranym jest chleb. Znacząca część badanych (68,6%) nabywa te produkty w supermarketach. Chociaż 33,03% respondentów wyraża obawy związane z obecnością akrylamidu, 52,29% uważa, że stanowi on zagrożenie dla

zdrowia, podczas gdy 42,51% jest tego niepełna. Respondenci wykazują wysokie zaufanie do informacji przekazywanych przez organizacje zdrowotne, a kluczowymi czynnikami wpływającymi na wybór produktów są smak oraz jakość składników. Duża część badanych (68,2%) uważa, że wartość odżywcza produktów piekarniczych jest bardzo istotna, a 88,69% preferuje produkty zawierające naturalne składniki. Ponadto 43,37% respondentów unika niektórych produktów piekarniczych, a 20,18% kupuje produkty o niskiej zawartości akrylamidu.

Implikacje i rekomendacje: Większość respondentów wyraża potrzebę uzyskania informacji zdrowotnych dotyczących akrylamidu oraz oczekuje wsparcia ze strony państwowych agencji zdrowotnych, co wskazuje na potrzebę zwiększenia świadomości społecznej i edukacji dotyczącej narażenia na akryloamid i związanych z tym zagrożeń.

Słowa kluczowe: świadomość konsumentów, akrylamid, produkty piekarnicze, media społecznościowe, ryzyko zdrowotne
