ULUSLARARASI 3B YAZICI TEKNOLOJİLERİ
VE DİJİTAL ENDÜSTRİ DERGİSİ

INTERNATIONAL JOURNAL OF 3D PRINTING
TECHNOLOGIES AND DIGITAL INDUSTRY

ISSN:2602-3350 (Online)

URL: https://dergipark.org.tr/ij3dptdi

AN EXAMINATION ON THE OPINIONS OF GASTRONOMY AND CULINARY ARTS DEPARTMENT STUDENTS TOWARDS THREE-DIMENSIONAL FOOD PRINTERS

Yazarlar (Authors): Gaye Kızılcalıoğlu*, Cem Oktay Güzeller

Bu makaleye şu şekilde atıfta bulunabilirsiniz (To cite to this article): *Kızılcalıoğlu G., Güzeller C.O., "An Examination On The Opinions Of Gastronomy And Culinary Arts Department Students Towards Three-Dimensional Food Printers", Int. J. of 3D Printing Tech. Dig. Ind., 5(3): 709-720, (2021).*

DOI: 10.46519/ij3dptdi. 958975

Araştırma Makale/ Research Article

Erişim Linki: (To link to this article): https://dergipark.org.tr/en/pub/ij3dptdi/archive

AN EXAMINATION ON THE OPINIONS OF GASTRONOMY AND CULINARY ARTS DEPARTMENT STUDENTS TOWARDS THREE-DIMENSIONAL FOOD PRINTERS

Gaye Kızılcalıoğlu[a*], Cem Oktay Güzeller[b]

[a] Antalya AKEV University, Art & Design Faculty, Gastronomy and Culinary Arts Department, TURKEY
[b] Akdeniz University, Tourism Faculty, Gastronomy and Culinary Arts Department, TURKEY

[*] *Corresponding Author: gaye.kizilcalioglu@akev.edu.tr*

(**Received:** 28.06.2021; **Revised:** 12.07.2021; **Accepted:** 28.12.2021)

ABSTRACT

This research aims to determine the Department of Gastronomy and Culinary Arts students' perceptions towards 3D (Three-Dimensional) food printers in new food technologies. 20 students were included in the study with a culinary experience at Antalya AKEV University. Semi-structured interview technique, which is one of the qualitative research methods, was used in the study. The interview protocol was prepared beforehand by the researcher. The researcher was also allowed to redirect the flow of the interview with different sub-questions whenever needed. Students' perceptions of 3D food printers were evaluated under the main headings of perceived risk, perceived benefit, and perceived cost by examining the data obtained from the interview. The findings indicated that students are willing to use 3D food printers in a restaurant if their perceived benefit for them is higher than their risk. Besides, it is also determined that purchasing a 3D food printer will create an additional cost but have a tendency to reduce the cost of raw materials.

Keywords: 3D Food Printer, Food Technology, Perceived Risk, Perceived Benefits, Perceived Cost.

1. INTRODUCTION

Nowadays, consumers expect food products to be more delicious and healthier with a better appearance [1]. For this reason, scientists have been spending remarkable efforts to improve food technologies in recent years. Thanks to new food technologies, the amount of energy consumed for food production is expected to decrease, food production would become safer and healthier, and individual production would generate less waste and contribute to sustainability in this regard [2,3]. New food technologies are very significant in terms of responding to the increasing world population and making use of limited resources [4].

There are many application areas contained by food technologies. For instance, genetically modified products, products created by food enrichment, food irradiation, food processing technology, edible films that packaging materials covering food produced with nanotechnology, artificial meat products created with genetic technology, synthetic food additives, robotics applications, and digital applications [4,5].

Even it appears that people are enthusiastic about obtaining new technology, they are not so enthusiastic about purchasing and experiencing food produced with food technology. Individuals' perception of risk towards the product or technology will be effective in accepting the new product. Slovic mentioned two dimensions of risk. The first one is uncontrollable and carries a high degree of risk for the future while the second one is a risk related to innovation. Since the new product or new technology is not yet well-known, the uncertainty caused by the unknown creates a perception of risk [6] Therefore, consumers are skeptical of new food technologies due to perceived risks and insufficient benefit dimensions [7].

Under today's tight competitive conditions, food and beverage businesses have been in search of innovative solutions. Restaurants have benefited from food technologies in recent years. For instance, 3D printers, one of the food technologies, brought an innovative solution to restaurants [8].

Food products are in progress depending on technological developments as well as research and development (R&D) activities. Therefore, food, and beverage business operators must be aware of the change in customer expectations, the most up-to-date kitchen practices, tools that increase business efficiency, and the latest innovations in the industry to quickly integrate these changes and innovations into their businesses. In this framework, 3D food printers are considered as an advantage in terms of enabling personalized food production within various customer expectations [9].

While the 2D printer has limited possibilities such as embellishing food, it has become possible to produce completely personalized presentations with the 3D printer [10]. A three-dimensional food printer is a software that shapes objects in a three-dimensional way in layer order with computer support. This technology, which emerged as a prototype sample in 1980, has also been used for food in recent years [11]. Two researchers from Cornell University have produced a model called Fab@Home and have succeeded in producing different food products from different raw materials. In this study, cartridges contain pastes or gels made of edible ingredients while materials are printed by the spraying method [12].

For a food product that comes out of the 3D food printer to be cooked, the printer must be laser coated. While the food product is printed, then the cooking process takes place. The usage area of the 3D printer is quite common. It can be used for many diverse purposes and in different geographies such as from an ordinary restaurant to a spacecraft as well as from places where only officials are required for security reasons to the hunger problem of Africa [13].

Besides, 3D food printers are also used for the nutrition of individuals with different health problems. For example, a paste-like product is produced for individuals with chewing problems [14]. Moreover, it provides the opportunity to prepare consumer-specific products by integrating substances that contribute to a healthy and balanced diet of children and elderly people [15]. It provides the opportunity to prepare personalized plates for chefs interested in molecular gastronomy and thus meets the expectations of both chefs and consumers [14]. Also, it enables the evaluation of ugly food products that are not preferred because of their appearance [16].

Despite the many advantages of 3D food printers, individuals today prefer natural products since they find processed and packaged foods unhealthy. Also, the trend of sustainability results in a skeptical approach to technology. Food technologies are not readily acceptable for individuals who are closed to innovation and are afraid of innovation. However, for individuals who are more open to innovation, technology is considered to be a tool that reduces risks and increases productivity [17].

Lupton and Turner [18] examined consumer perception towards 3D food printers and concluded that consumers do not have enough information about 3D food printers, indeed have a negative prejudice on this issue. Only individuals who identify themselves as adventurous have stated that they are open to consuming food produced by the 3D food printer. So, consumers with a lack of knowledge about new foods prevent themselves from adopting food technologies.

Cardello, Schutz, and Lesher [19] reported that their resistance to the new product can be reduced by accessing information about the food product, product trials, or user comments via social media. The media has a great influence on informative news about new food technologies. As long as consumers do not suspect that the media is biased, they would have confidence in the news. From this perspective, news about new food technologies would be effective in reducing the risk factor perceived by [20]. Lupton [21] stated that the news about 3D food printers on Google is generally positive. Lupton and Turner [18] conceptualized digital food activism not only to provide information about the new product but also to convince individuals that new food preparation and processing techniques are acceptable,

edible, and valuable to humans. In the studies of Cox, Evans, and Lease [7], the researchers first provided information about the product and then measured the perceived risks of the new product once again. According to the results of the study, only providing information about the product did not affect the perceived risks.

In the 21st century, although the marketing department has a customer-oriented production approach in the new product development process, research shows that consumers cannot easily admit new products [22]. Therefore, before developing a new product, it is necessary to conduct field research on the perceptions of consumers. Because when consumers encounter new food technology, they tend to be cautious rather than accepting it immediately. For instance, when the pasteurization of milk was first introduced, it was welcomed with suspicion by the consumers. Recently, some consumers are skeptical about pasteurized milk although it provides milk to be purified from microbiological hazards. Therefore, the bases that Cox and Evans [23] declared that risk, uncertainty, perceived cost, benefit, and behavioral control will be effective on fear of innovation at the scale that consumers develop on their fear of new food technologies and new food. Besides, the characteristics of the technology product and the health factor can also be effective in neophobia.

The 3D food printer enables to make special production for people to eliminate the problems that may pose a risk in food safety such as cross-contamination as well as to create more artistic plates and presentations by creating a variety of tastes and shapes for food products [24, 25]. Also, many researchers from different disciplines can come together to develop new products. For example, biscuits can be produced from the dessert obtained by cutting the layer that gives sweetness to the potato [26]. For this reason, this study aims to determine the motivation factors that affect the consumers' choice of 3D food printer, the two main motivation factors for choosing foods printed by the 3D food printer were determined as health and preference.

2. METHOD

2.1. Purpose of Research: To determine the foresight, thoughts, and attitudes of chef candidates towards 3D food printers.

2.2. Research Model: Qualitative research method and descriptive research model were used in this study. In the descriptive research model, the data are themed according to the dimensions of the research questions obtained from the literature. Findings are presented as direct quotes or evaluated together with the researchers' comments and summary. Then, the findings are examined to determine the possible relationship available within the data [3]. Four stages determined by Yıldırım and Şimşek [28] for descriptive analysis were applied in this study. In the first stage, the themes are determined to be included in the analysis. In the second step, the data are associated with the determined theme while the findings are summarized in the third stage. In the final stage, the interpretation and discussion of the findings are introduced.

2.3. Data Collection Method: The interview technique, which is one of the qualitative research methods, was used in this study. The interview technique is performed by the researcher in the form of questions and answers from the participants determined on the relevant subject. It also helps to understand the opinions of the interviewee on the subject [26]. This method was preferred since this study aims to examine research questions in detail. Besides, a semi-structured interview method was performed in the study where research questions were prepared beforehand and shaped according to the answers from the participants.

2.4. Data Collection Process: In the data collection stage, the interview method was used. The interviews were held face-to-face through Zoom, which is an online interview program, between April 23 and May 10, 2020. Before the interview, a presentation about 3D food printers was introduced to the students which were then supported by videos. Visual and verbal information about 3D food printers was conveyed to the participants. After the interviews were recorded with audio and video, they were arranged as text by the researchers.

2.5. Study Group: The study group consists of 20 people studying at 2nd and 3rd grade in Antalya AKEV University. Ten participants from each grade level were included in the research group. The individuals in the study group were determined by the purposive sampling technique. During the selection criteria, it was paid attention that the participants had work experience and were volunteers. Twenty participants between the ages of 18 and 23 were interviewed.

3. RESULTS AND FINDINGS

3.1. Perceived Risk

The concept of perceived risk is based on the uncertainties that individuals perceive while making a purchasing decision and on possible unwanted consequences. For this reason, research questions were categorized according to the dimensions of the perceived risk in the study conducted by Jacoby and Kaplan [30]. The perceived risk dimensions used in this study are financial risk, functional risk, social risk, physical risk, psychological risk, and sensory risk as the research questions involved the same types of risks. For example, to determine the physical risks they take about 3D food printers, the participants were asked whether they think food produced with 3D food inscriptions is riskier than traditionally produced food or not. When the answers given in terms of perceived risk were examined, 6 students stated that the machine would be less hygienic than the human hand while one student reported that he might pose a risk in terms of savor. However, 13 students in total stated that they found 3D food printers safer in terms of food safety than human hands. All of the participants are gastronomy students and have industry experience so the risk factor is important. Therefore, the participants think that 3D food printers will be more sanitary.

The question of "Do you think consumers will find foods produced with 3D food printers healthy?" was directed to determine what physical risks the participants perceived for 3D food printers. Half of the answers to this question were “no”. It is considered that the products made by the device might cause an artificial appearance. It is anticipated that the products would be found unhealthy due to reasons such as waiting in the cartridges, being suspicious about unhygienic use, and the use of poor-quality products. In the studies of Loebnitz and Bröring [31], it was observed that consumers accept the use of technology in products that they find less healthy and not natural when compared to more natural and healthy products. But it varies according to the characteristics of the food products and with respect to the individual. The individual's characteristics, values, attitudes, beliefs, and demographic characteristics are also influential in their adoption of new food technologies. Similarly, in the studies of Seçuk and Pekerşen [32] in which they examined the perspectives of chefs towards molecular cuisine, 20% of the chefs found molecular cuisine unhealthy. The participants who found it healthy stated that people should be informed about this issue. Visual or verbal information and advertisements would cause the question marks to find answers. The study by Lu and Chi [33] investigated the role of menu stimulants and involvement in the decision to purchase local food. They concluded that people with high levels of involvement were in search of deeper knowledge. Also, it was found that people with low levels of involvement tend to receive information by visual stimuli. From this perspective, it is possible that the information given to chefs and chef candidates can be in-depth, as the students of gastronomy will have a high level of involvement in a device that is directly related to their profession. On the other hand, it is possible to say that people with a lower level of involvement have information through visual expressions such as advertising that can reduce perceived risks.

In order to determine which financial risks the participants perceived to 3D food printers, the related questions of "Do you see new food technologies such as 3D food printers as a threat to employment?" and "Do you think they will replace assistant chefs when these become widespread in the industry?" were addressed. Overall, the majority of respondents thought that 3D food printers would affect employment while only 8 students reported that they could replace assistant chefs. Besides, 12 students think that assistant chefs can take their place in the kitchen as a device that facilitates their work but cannot replace the assistant chef in terms of hand taste, knowledge, experience, and management ability.

Moreover, the advantage of 3D food printers was emphasized in terms of shortening the cost and time, producing perfect products, and providing convenience as well as standardization.

Questions of "If you had a restaurant, would you want your restaurant to have a 3D food printer?" and "Are you concerned about the difficulty in use?" were directed to determine which participants perceived functional risks to 3D food printers. 90% of students stated that they want the 3D food printer to be in their restaurant. However, it is anticipated that 3D food printers will be preferred for making desserts and cakes or to enrich presentations rather than main meals. Moreover, the participants stated that they could easily use the device with very short machine training.

Another question addressed to determine the functional risks they perceive for 3D food printers was “Do 3D food printers prevent chefs from revealing their creativity?”. 3 of the 20 participants stated that the work done by a machine would hinder the chef's creativity while 17 of the participants stated that they would not hinder the creativity of chefs but would support them on the contrary. It is a common belief that it will help chefs to learn a different design method and thus contribute to new designs. Akoğlu, Çavuş, and Bayhan [34] stated in their study on the molecular cuisine perceptions of chefs that molecular techniques would contribute to the development of the chefs themselves.

To determine what the participants perceived as functional risks to 3D food printers, the question of "Do you think 3D food printer has a complicated use" was asked. All participants think that it is not a complicated use. They think that they can be easily used after a mini education program. The other question was, "Does it require expertise other than the competencies of chefs?". Since the question may require expertise in terms of design and technology, it is thought that chefs may initially be biased against the 3D food printer but will be accepted if they see 3D food printers as a device that facilitates their work. For the questions of, "What are the factors that make it difficult to use a 3D food printer in restaurants?" and "Does the device require an expert for its maintenance and service affect its preference by the restaurant?" as well as why 3D food printers are not widely used today, the reasons are expressed as they are not demanded by chefs and consumers, they are not practical, the costs are high, they are slow, they are not advertised, and a different kitchen layout must be established. It is assumed that it requires a specialist for maintenance and service will not negatively affect its preference since it covers all kitchen equipment.

Questions like "Do you think technologies such as 3D food printers are necessary today?" were also directed to determine the participants' perceived psychological risks to 3D food printers. The majority of the participants stated that they thought 3D food printers were necessary. However, the necessity is generally considered for the production of dessert and cake instead of the main meal. It is thought that the vast 90% of students find 3D food printers necessary because they are studying in a destination such as Antalya and doing internships in 5-star hotel restaurants located in Belek. Similarly, Shaw and Iomaire [35] conducted a study to measure the attitudes of people living in rural and urban areas towards artificial meat consumption. The findings of the study indicated that people living in the city adopt a closer attitude to artificial meat consumption due to ethical concerns, while those living in the countryside are concerned that artificial meat consumption will create an unemployment problem. It was also determined that males have a more positive attitude towards artificial meat consumption than females while consumers under the age of 35 are more positive than those over the age of 55.

The question of "Would you like to design using software or traditional methods?" was asked to determine the participants' perceived psychological risks to 3D food printers. The responses of 15 participants were on designing with traditional methods while 2 participants stated that they would design by combining 3D technology with traditional methods and 3 participants stated that they chose this method because more perfect designs could be made with 3D food articles. Siegrist, Stampfli, and Kastenholz [36] examined consumers' attitudes towards foods and packaging materials produced with nanotechnology. The findings of the study indicated that consumers preferred natural products to products obtained through nanotechnology. Although consumers think that functional foods do not

provide a tangible benefit, they have a positive attitude towards food packaging materials produced with nanotechnology.

In order to determine what sensory risks the participants perceived for 3D food printers, the question of "Was it different from the traditional images of the steaks, pizza, burgers, pasta, and pastries you watched in the videos?" was addressed. It was determined that the images of food produced by 3D food printers are more striking and flawless than the original images. For the question of "How do you anticipate their taste?", they stated that it may not be as good as the original taste although they do not think that their taste will be bad. Another question was "Do you think their taste will be better or worse than a traditional pizza?". For this question, only 3 participants stated that pizza produced by 3D food printers could be better while 17 participants stated that pizza produced with 3D looks like pizza in terms of appearance but they are worried about taste. Although there is not a big difference in taste, they stated that they would prefer traditional pizza. While food from 3D food printers satisfies participants in terms of appearance, it is clear that they are concerned about taste and texture. While individuals think that organic foods are more delicious and healthier because they find them more natural, they prefer less genetically modified and functional foods since they find them unhealthy. The sensory properties of food are significant for the acceptance of 3D food printers by the public [37]. As a result of the study, it was found that there is a positive relationship between naturalness and preference [38, 39]. In a study by Lupton and Turner [40], the cultured meat produced with 3D printers perception by the consumers is examined. The findings showed that the consumers do not find 3D foods natural and fresh since they do not taste good. The study of Ghazal, Zhang, and Liu [41] evaluated the differences between the newly developed 4D printer and the 3D printer. They found that the colors of the food produced from the 4D printer did not change so that it may positively affect the perceptions of consumers. On the other hand, the fading in the color of food printed with a 3D printer can affect the perception of reality. Thanks to the 4D food printer, consumers' sensitivity to unnatural products and the artificial image problem caused by 3D printers have been solved today.

The question of "Do you think 3D food printers will be easily accepted by consumers?" was directed to determine the societal risks perceived by the participants for 3D food printers. In response to this question, they stated that the products produced with a 3D food printer would not be easily accepted by people since there would be a resistance to innovation at first. Also, it was stated that production by a machine would cause the product to be found artificial. It would not be natural to mash it and then inject it into the plate with cartridges. Previous studies also confirm that the desire to experience new foods and technologies decreases as the perceived risk of new foods or new food technologies increases [39, 42]. Consumer groups were divided into groups with respect to age, gender, marital status, income, and education level and they were asked which consumer group would or would not accept most. All of the participants anticipate that older people will prefer traditional dishes and will not accept 3D food printers. It is predicted that consumers with a higher income and education level will generally be open to innovations and will be able to purchase products produced with 3D food printers as they will have high purchasing power. In general, it is not thought that gender and marital status will make a difference. As a result of the study of Şahin and Tosun [43] on new food consumption, it was concluded that age and education status show significant differences in new food consumption. As a consequence of the study, it was determined that the interest in new food consumption decreases as the age increases and the education level decreases.

3.2. Perceived Benefit

Perceived benefit is expressed as gains from the purchase of a product or service [44, 45]. The question of "Do you think 3D food printers will produce products faster so you can serve more people?" was asked to determine what the participants perceived as a functional benefit for 3D food printers. 15 participants reported that 3D food printers will be faster than a human's speed so that more 3D food printers can serve more consumers. On the other hand, 5 participants stated that 3D food printers are currently working slowly due to their technology. Also, they reported that they would prefer the

workforce because the time for a plate to be ready would be faster by human hands and it would be costly to purchase more 3D food printers.
Another question was, "How do you think 3D foods will benefit in addition to traditional cooking techniques?". In response, 3 of the participants stated that it would not be an additional benefit because the laser was used as a cooking technique. The rest of the participants stated that 3D food printers will provide additional benefits such as functionality, speed, reduction of product losses, enabling personalized production, facilitating the work of chefs, and untouched products. When two other questions of "Will increase interest in your restaurant?" and "Does it make your restaurant innovative?" asked, the participants stated that the interest in the restaurant would be higher since people were initially curious but they also had a perception that they would not be permanent after experiencing it. All participants think that 3D food printers will make the restaurant innovative today. In the studies of Akoğlu, Çavuş, and Bayhan [34], it was stated that concepts such as a molecular restaurant may be temporary but such techniques will be popular in the future.

In order to determine the ecological benefit of the participants perceived for 3D food printers, the question of "How can 3D food printers contribute to sustainability?" was addressed. Almost all participants considered 3D food printers to be more environmentally friendly. They assume that the hotels and restaurants where they work are wasting too much food and have a wasting problem so that 3D food printers would be a good alternative to eliminate it. For the questions of "Would a restaurant be environmentally sustainable attract more consumers to the restaurant?", they stated that the restaurants conceptualized as eco-friendly, green, or eco would be demanded by more people. So, it was predicted to create a positive restaurant image. Similarly, Yay and Çalışkan [46] found that individuals' thoughts about environment friendly restaurants are the most important factor in choosing a place to eat.

To determine the participant's perceived financial benefit for 3D food printers, the question of "Do you think 3D food printer products will find a buyer at a better price?" was directed. As the response, all of the participants stated that 3D food printers can attract buyers at higher prices than traditional products. The reason is expressed as not experiencing it before as well as it is a new and different technology. There are also other reasons such as the desire of people to share a 3D food printer product with others and the desire to experience what the prominent people on social media are doing. However, it is also a common opinion that agreeing to product prices will only be effective when they first try the product and will not be a constant demand.

For the question of "Do you think that products produced with a 3D food printer will find more fun for consumers?", only one of the participants stated that it would not be fun while 19 participants stated that the plates produced by the 3D food printer would be entertaining in terms of being produced by a machine, being able to make personalized production as well as enjoyable to watch and produce special products for special occasions. Considering the other questions of "What are the things that make 3D printers fun?" and "Do you think the entertainment factor is effective in choosing the restaurant?" some participants stated that the entertainment factor can vary depending on who is going to the restaurant. For instance, they stated that while the factor of entertainment is not sought for a business or family dinner, it may be significant if you go with friends or children but it is still a factor that affects the choice of restaurant. According to Albayrak's [47] study on the factors that affect the choice of restaurant, the entertainment factor fell behind factors such as family-friend unity, affordable prices, and difference.

When the question of "Do you think you can easily diversify the menu with 3D food printers?" is addressed, only one participant stated that there was no difference between traditional methods and menu diversification while the other 19 participants stated that menu diversification could be done easily.

In order to determine what the participants perceived social benefit for 3D food printers, the question of "Which kitchen would you say 3D food printers are best suited for and not?" was asked. The majority of the participants stated that French cuisine is considered suitable for desserts and pastries and 3D food

printers while it is Italian cuisine for pizza and pasta varieties. However, they expressed that it is not considered suitable for Turkish cuisine while its juicy and multi-stage foods are mentioned as the main reasons. Çifçi and Demirkol [48], who thought that this situation would affect the development of Turkish cuisine, suggested that the techniques used in Turkish cuisine should be enriched with food science applications. When the other question of "Is it possible to build a molecular kitchen that only consists of 3D food printers?" is addressed, the majority of respondents considered 3D food printers to be more suitable for molecular kitchens. Then the question of "What would be the reaction of chefs and consumers to this?" is forwarded. It was stated that it will depend on how chefs are open to innovation and see the 3D food printer as a device that makes their job easier. If chefs see 3D food printers as a threat, then their reaction is predicted to be negative and consumers will be cautious in the first place. The majority of cooks anticipate that consumers will react positively to the use of local products in molecular gastronomy. However, in the same study, consumers were not positive to make local products with molecular techniques. It was concluded that consumers are more conservative, especially in terms of local foods [49].

3.3. Perceived Cost

Participants were also asked about the perceived cost of 3D food printers. For such a purpose, the question of "How much of the total order quantity do you foresee will consist of products produced by 3D food printer?" is addressed. The responses indicated that the total food sales among wholesale numbers of daily restaurant income amount of 3D food printers will be between 20-30%. For the other question of "What are the factors that have influenced the spread of 3D food printers like traditional cooking methods?", the participants stated that as the number of people who tried 3D food printers increased, they would share this experience with others and reach more people through the word-of-mouth advertising. Also, the participants stated that other people who are aware of the 3D food printer would desire to experience the 3D food printer. Moreover, they stated that the good 3D food printer features and the effect of advertising will also be effective in the spread of the 3D food printer.

For the question "How do you think 3D food printers will affect the cost of restaurants?" and "Will it reduce total costs?", most of the respondents indicated that 3D food printers will reduce the workforce as well as the labor cost. Then when the question of "Does it increase total profitability?" is addressed, only 3 of the participants predicted that 3D food printers will decrease profitability in the long term due to reasons such as losing popularity, high costs, and not being demanded by the consumer while 17 of the participants think that it will increase profitability in terms of reducing labor costs, reducing product losses, and attracting people to the restaurant.

The most important cost factors in food and beverage businesses are the costs of raw materials based on food and beverage [50]. Gastronomy students generally think that 3D food printers will reduce the cost of raw materials. However, although purchasing 3D food printers is costly, it is anticipated to reduce the labor cost in the long run. Today, although restaurants use menus as a cost control tool, they should turn to sales-enhancing strategies to increase profitability.

4. CONCLUSION

People are generally interested to know whether technology will reduce risk or not. The potential risk they consider is especially related to technology as it affects the choice of products. Besides, individuals tend to perceive potential risks rather than seeing the benefits of technology [51]. So, the features that increase the perceived benefit should be brought to the forefront for new food technologies to be accepted more quickly by society. Also, information about 3D food printers should be given to reduce the perceived risk and should be introduced in a way that highlights the benefit in cost-benefit analysis. In this study, it was concluded that the risks perceived by the gastronomy department students towards 3D food printers are not very high. However, students do not find the functional benefit of 3D food printers sufficient. Although they think that it will be accepted by society in the future and will take its place as a kitchen tool, it is considered that it will not be the same with traditional methods so that traditional cooking techniques will be preferred more.

Most people are not aware enough of food technologies. When information is available, the reliability of the information is questioned. The perceived benefit and risk affect the acceptability of new food

technologies. For instance, food irradiation technology has been approved by experts in ensuring food safety, however, people are skeptical of this method since it contains radiation. As a result of a study conducted in England, it has been determined that genetically modified products can be preferred if they are cheaper than traditional products. In this study, it was determined that the product can be preferred if the perceived benefit is higher than the perceived risk. Individuals can ignore the risks as the perceived benefit level increases [39]. In this context, for new food technologies to be acceptable, factors that will increase the perceived benefit and reduce the perceived risk should be determined.

In addition to the functional benefits of 3D food printers, it is predicted that they will have symbolic meanings specified by the participants. It was emphasized that individuals may prefer 3D food printers because of the prestige they will gain by experiencing it, apart from seeing it as a cooking technique. Also, it was emphasized that it can be preferred with an ostentatious understanding of consumption due to someone who has shared with a 3D food printer before on social media. Studies in the literature have indicated that symbolic meanings for a product and service are effective on preference and satisfaction [52, 53, 54, 55].

It has been observed that psychological risks decrease as the income levels of consumers increase. It was determined that there is a significant difference in terms of psychological risks between those who have the product and those who do not. The psychological risks perceived by those who do not own the product are higher [56]. A comparison can be performed between chefs using 3D food printers for future work and chefs who are knowledgeable but do not yet have a 3D food printer.

There may be positive or negative interactions among the dimensions that constitute the perceived risk. For instance, the preference for 3D food printers by a restaurant may reduce functional risk but if it is not accepted by society then it can increase social risk [30]. Therefore, instead of a holistic study on the perceived risk of 3D food printers, which are among new food technologies, it is recommended to examine the risks in all dimensions separately.

As a result of Peterson, Dodd, Kim, and Roth's [57] study on diet and fatty foods, people with lower income perceive the price of diet foods higher so they prefer fatty foods more. The perceived cost of purchasing diet foods is that people with higher income levels can buy them. Similarly, as a result of this research, it was emphasized that 3D food printers will be demanded by people with higher income levels. It has also been reported that those with high-income levels will be more open to innovation. In this context, it is recommended that the visual and verbal stimulants to be prepared are suitable for individuals who have the potential to consume 3D food printers.

ACKNOWLEDGEMENTS

Approval was obtained from the Scientific Research and Publication Ethics Committee of Antalya AKEV University on 28.12.2021 by decision No. 1/2 for this study.

REFERENCES

1. Millen, C. I., “The development of colour 3D food printing system” [Unpublished master thesis] Massey University, Palmerston, 2012.

2. Chaudhry, Q., Scotter, M., Blackburn, J., Ross, B., Boxall, A., Castle, L., Aitken, R. and Watkins, R., “Applications and implications of nanotechnologies for the food sector”, Food Additives and Contaminants, Vol. 25, Issue 3, Pages 241-258, 2008.

3. Rollin, F., Kennedy, J., and Wills, J., “Consumers and new food technologies”, Trends in Food Science & Technology, Vol. 22, Issue 2-3, Pages 99-111, 2011.

4. Egolf, A., Hartmann, C., and Siegrist, M., “When evolution works against the future: disgust's contributions to the acceptance of new food technologies”, Risk Analysis. Vol. 39, Issue 7, Pages 1546-1559, 2019.

5. Kamrath, C., Wesana, J., Bröring, S., and De Steur, H., "What do we know about chain actors' evaluation of new food technologies? A systematic review of consumer and farmer studies", Comprehensive Reviews in Food Science and Food Safety, Vol. 18, Issue 3, 798-816, 2019.

6. Lusk, J. L., Roosen, J., and Bieberstein, A., "Consumer acceptance of new food technologies: Causes and roots of controversies", Annual Review of Resource Economics, Vol. 6, Issue 1, Pages 381-405, 2014.

7. Cox, D. N., Evans, G., and Lease, H. J., "The influence of information and beliefs about technology on the acceptance of novel food technologies: A conjoint study of farmed prawn concepts", Food Quality and Preference, Vol. 18, Issue 5, Pages 813-823, 2007.

8. Cattaneo, C., Lavelli, V., Proserpio, C., Laureati, M., and Pagliarini, E., "Consumers' attitude towards food by-products: the influence of food technology neophobia, education and information", International Journal of Food Science & Technology, Vol. 54, Issue 3, Pages 679-687, 2019.

9. Godoi, F. C., Bhandari, B. R., Prakash, S., and Zhang, M., "An Introduction to the Principles of 3D Food Printing", In F. C. Godoi, B. R. Bhandari, S. Prakash, & M. Zhang et al editors, Fundamentals of 3D Food Printing and Applications, Pages 1-18, Academic Press, Cambridge, 2019.

10. Pallottino, F., Hakola, L., Costa, C., Antonucci, F., Figorilli, S., Seisto, A., and Menesatti, P., "Printing on food or food printing: a review", Food and Bioprocess Technology, Vol. 9, Issue 5, Pages 725-733, 2016.

11. Brunner, T. A., Delley, M., and Denkel, C., "Consumers' attitudes and change of attitude toward 3D-printed food. Food Quality and Preference", Vol. 68, Pages 389-396, 2018.

12. Turner, B., and Lupton, D., "Both fascinating and disturbing': Consumer responses to 3D food printing and implications for food activism", In K. Eli, C. Dolan & S. Ulijaszek et al editors, Digital Food Activism, Pages 169-185, Routledge, London, 2016.

13. Lin, C., "3D food printing: a taste of the future", Journal of Food Science Education, Vol. 14, Issue 3, Pages 86-87, 2015.

14. D'Angelo, G., Hansen, H. N., and Hart, A. J., "Molecular gastronomy meets 3d printing: Layered construction via reverse spherification", 3D Printing and Additive Manufacturing, Vol. 3, Issue 3, Pages 152-159, 2016.

15. Godoi, F. C., Prakash, S., and Bhandari, B. R., "3d printing technologies applied for food design: Status and prospects", Journal of Food Engineering, Vol. 179, Pages 44-54, 2016.

16. Manstan, T., and McSweeney, M. B., "Consumers' attitudes towards and acceptance of 3D printed foods in comparison to conventional food products", International Journal of Food Science & Technology, Vol. 55, Issue 1, Pages 323-331, 2020.

17. Bruhn, C. M., "Enhancing consumer acceptance of new processing technologies", Innovative Food Science & Emerging Technologies, Vol. 8, Issue 4, Pages 555-558, 2007.

18. Lupton, D., and Turner, B., "Both Fascinating and Disturbing: Consumer Responses to 3D Food Printing and Implications for Food Activism", In Eli, K., Dolan, C. and Ulijaszek, S. et al editors, Digital Food Activism, Pages 151-167, Routledge, London, 2016.

19. Cardello, A. V., Schutz, H. G., and Lesher, L. L., "Consumer perceptions of foods processed by innovative and emerging technologies: A conjoint analytic study", Innovative Food Science & Emerging Technologies, Vol. 8, Issue 1, Pages 73-83, 2007.

20. McCluskey, J. J., Kalaitzandonakes, N., and Swinnen, J., "Media coverage, public perceptions, and consumer behaviour: insights from new food technologies", Annual Review of Resource Economics, Vol. 8, Pages 467-486, 2015.

21. Lupton, D., "Download to delicious: Promissory themes and sociotechnical imaginaries in coverage of 3D printed food in online news sources", Futures, Vol. 93, Pages 44-53, 2017.

22. Dijksterhuis, G., "New product failure: Five potential sources discussed", Trends in Food Science & Technology, Vol. 50, Pages 243-248, 2016.

23. Cox, D. N., and Evans, G., "Construction and validation of a psychometric scale to measure consumers' fears of novel food technologies: The food technology neophobia scale", Food Quality and Preference, Vol. 19, Issue 8, Pages 704-710, 2008.

24. Lipton, J. I., "Printable food: the technology and its application in human health", Current Opinion in Biotechnology, Vol. 44, Pages 198-201, 2017.

25. Sun, J., Peng, Z., Zhou, W., Fuh, J. Y., Hong, G. S., and Chiu, A., "A review on 3D printing for customized food fabrication", Procedia Manufacturing, Vol. 1, Pages 308-319, 2015.

26. Mizrahi, M., Golan, A., Mizrahi, A. B., Gruber, R., Lachnise, A. Z., & Zoran, A., "Digital gastronomy: Methods & recipes for hybrid cooking". Proceedings of the 29th Annual Symposium on User Interface Software and Technology, Pages 541-552, Tokyo, 2016.

27. Akbulut, Y., "Verilerin analizi". In Kurt A. A., editor, Bilimsel araştırma yöntemleri, Pages 139-162, Anadolu University Publishing. Eskişehir, 2013.

28. Yıldırım, A., ve Şimşek, H., "Sosyal bilimlerde nitel araştırma yöntemleri", Seçkin Yayıncılık, Ankara 2006.

29. Kozak, M., "Bilimsel araştırma: tasarım, yazım ve yayım teknikleri". Detay Yayıncılık, Ankara, 2017.

30. Jacoby, J. & Kaplan, L.B., "The Components of Perceived Risk", Proceedings of the Annual Conference of the Association for Consumer Research, Vol. 10, Pages 382-393, 1972.

31. Loebnitz, N., and Bröring, S., "Consumer acceptance of new food technologies for different product categories: The relative importance of experience versus credence attributes", Journal of International Consumer Marketing, Vol. 27, Issue 4, Pages 307-317, 2015.

32. Seçuk, B. ve Pekerşen, Y., "Bursa ili beş yıldızlı şehir otellerinde çalışan aşçıların moleküler gastronomi konusundaki görüşlerinin belirlenmesi", Journal of Turkish Tourism Research, Cilt. 4, Sayı 1, Sayfa 181-201, 2020.

33. Lu, L., and Chi, C. G. Q., "Examining diners' decision-making of local food purchase: The role of menu stimuli and involvement", International Journal of Hospitality Management, Vol. 69, Pages 113-123, 2018.

34. Akoğlu, A., Çavuş, O., ve Bayhan, İ., "Michelin yıldızlı restoran şeflerinin moleküler gastronomi algı ve eğilimleri: San Sebastian, İspanya örneği". Journal of Tourism and Gastronomy Studies, Cilt 5, Sayı 1, Sayfa 43-59, 2017.

35. Shaw, E., and Mac Con Iomaire, M., "A comparative analysis of the attitudes of rural and urban consumers towards cultured meat", British Food Journal, Vol. 121, Issue 8, Pages 1782-1800, 2019

36. Siegrist, M., Stampfli, N., and Kastenholz, H., "Acceptance of nanotechnology foods: a conjoint study examining consumers' willingness to buy", British Food Journal, Vol. 111, Issue 7, Pages 660-668, 2009.

37. Lupton, D., and Turner, B., "I can't get past the fact that it is printed: consumer attitudes to 3D printed food", Food, Culture & Society, Vol. 21, Issue 3, Pages 402-418, 2018a.

38. Rozin, P., Spranca, M., Krieger, Z., Neuhaus, R., Surillo, D., Swerdlin, A., and Wood, K., "Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines", Appetite, Vol. 43, Issue 2, 147-154, 2004.

39. Siegrist, M., "Factors influencing public acceptance of innovative food technologies and products", Trends in Food Science & Technology, Vol. 19, Issue 11, Pages 603-608, 2008.

40. Lupton, D., & Turner, B., "Food of the Future? Consumer Responses to the Idea of 3D-Printed Meat and Insect-Based Foods", Food and Foodways, Vol. 26, Issue 4, Pages 269-289, 2018b.

41. Ghazal, A. F., Zhang, M., and Liu, Z., "Spontaneous color change of 3d printed healthy food product over time after printing as a novel application for 4d food printing", Food and Bioprocess Technology, Vol. 12, Issue 10, Pages 1627-1645, 2019.

42. Siegrist, M., Gutscher, H., and Earle, T. C., "Perception of risk: the influence of general trust, and general confidence", Journal of Risk Research, Vol. 8, Issue 2, Pages 145-156, 2005.

43. Şahin, S. Z., ve Tosun, C., "Turistlerin yeni gastronomi ürünlerine yönelik tutumları", Electronic Journal of Social Sciences, Cilt 19, Sayı 74, Sayfa 564-586, 2020.

44. Basaran, Ü., ve Aksoy, R., "Algılanan fayda ve fedakarlık bilesenlerinin algılanan müsteri degeri üzerindeki etkisi". Ege Akademik Bakış, Cilt 15, Sayı 3, Sayfa 379-399, 2015.

45. Park, J., Snell, W., Ha, S. and Chung, T. L., "Consumers' post-adoption of m-services: interest in future m-services based on consumer evaluations of current m-services", Journal of Electronic Commerce Research, Vol. 12, Issue 3, Pages 165-175, 2011.

46. Yay, Ö., ve Çalışkan, O., "Planlı davranış teorisi bağlamında çevreci otel restoranında yemek yeme niyeti", Seyahat ve Otel İşletmeciliği Dergisi, Cilt 13, Sayı 2, Sayfa 103-122, 2016.

47. Albayrak, A., "Müşterilerin restoran seçimlerini etkileyen faktörler: İstanbul örneği". Anatolia: Turizm Araştırmaları Dergisi, Cilt 25, Sayı 2, Sayfa 190-201, 2014.

48. Çifçi, İ., ve Demirkol, Ş., "Moleküler gastronomide yeni mutfak akımı: Nbn mutfak", Safran Kültür ve Turizm Araştırmaları Dergisi, Cilt 2, Sayı 2, Sayfa 150-162, 2019.

49. Alpaslan, K., "Yöresel yemeklerde moleküler gastronomi kullanımı". [Unpublished master thesis] Kastamonu Üniversitesi, Kastamonu, 2019.

50. Aktaş, A. ve Özdemir, B., "Otel İşletmelerinde Mutfak Yönetimi", Detay Yayıncılık, Ankara, 2012.

51. Bruhn, C. M., "Consumer acceptance of food innovations", Journal of Innovation Management Policy and Practice, Vol. 10, Issue 1, Pages 91-95, 2008.

52. Yıldırım, Y., "Tüketicilerin sembolik tüketim eğilimlerinin öğrenilmesi: Akçakoca örneği", Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, Cilt 7, Sayı 6, Sayfa 257-267, 2019.

53. Yılmaz, A., Uyanık, B., ve Yaman, M., "Küreselleşen Gıda Sembolizmi", The Journal, Cilt 12, Sayı 68, Sayfa 1298-1308, 2019.

54. Azizağaoğlu, A., and Altunışık, R., "Postmodernizm, sembolik tüketim ve marka", Tüketici ve Tüketim Araştırmaları Dergisi, Cilt 4, Sayı 2, Sayfa 33-50, 2012.

55. Uygun, M., ve Akın, E., "Markaların işlevsel, sembolik ve deneyimsel yararlarına ilişkin tüketici değerlendirmelerinin incelenmesi", Anadolu University Journal of Social Sciences, Cilt 12, Sayı 2, Sayfa 107-122, 2012.

56. Dal, Ö. G. V., ve Eroğlu, A. H., "Farklı kişilik özelliklerine sahip bireylerin risk algılarının tüketici davranışı açısından incelenmesi: Üniversite öğrencileri üzerine bir araştırma", Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, Cilt 20, Sayı 2, Sayfa 361-385, 2015.

57. Peterson, S. L., Dodd, K. M., Kim, K., and Roth, S. L., "Food cost perceptions and food purchasing practices of uninsured, low-income, rural adults", Journal of Hunger & Environmental Nutrition, Vol. 5, Issue 1, Pages 41-55, 2010.