Investigation of Knowledge and Awareness about Food Nanotechnology of Nutrition and Dietetics Students

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Abstract

In this study, it was aimed to examine the knowledge and awareness levels of nutrition and dietetics department students about food nanotechnology. This descriptive study was conducted with 242 students aged 18 and over who were studying at the Department of Nutrition and Dietetics.52.1% of the participants are 22 years old and over, and 66.9% have heard of the concept of food nanotechnology (nano food). In the study, it was determined that the level of knowledge and awareness about food nanotechnology was high among those who had heard of the concept of food nanotechnology (nano food) before (p=0.017) and those who had knowledge of food nanotechnology (nano food) (p=0.000). Those who think that smart packaging systems that provide information about the quality of packaged food during storage and transportation will not be useful (p=0.001), those who think that smart packaging methods will be preferred instead of traditional packaging techniques with the development of nanotechnology (p=0.000), have ethical concerns about the use of nanotechnology in the field of food. The level of knowledge and awareness about food nanotechnology was found to be high among those who thought that the use of nanotechnology in the field of food was very low (p=0.000) and those who stated that the perceived risk level was very low (p=0.000). It shows that nutrition and dietetics students have limited knowledge about the wide application of food nanotechnology.

Keywords: Knowledge and awareness, Nano food, Nanotechnology, Nutrition and Dietetics Students.

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1. Introduction

Nanotechnology is an interdisciplinary branch of science with countless applications in many fields, including the food industry. Nanoscale structures can affect the stability, processability, texture, flavor and many other features of foods during storage (Jafari, 2017a). The principle of nanotechnology is based on changing the physicochemical features of the material by reducing the particle size to an average of less than 1 micrometer (μm), that is, to the nano size (Müller & Keck, 2008). The food industry is facing huge difficulties in developing and implementing environmentally acceptable and sustainable systems for the production of efficient, high quality and safe food. Many innovations for processes, products and tools are being developed to meet these difficulties (Anandharamakrishnan, 2014). The applications of food nanotechnology in the food industry are developing rapidly and nanotechnology offers many innovations and opportunities to solve these problems. The use of various nanoscale materials can improve or change the features of foods during their shelf life, leading to changes in macro-scale properties such as texture, taste, other sensory properties, coloring power, processability and stability. In addition, food nanotechnology has the potential to improve the water solubility, thermal stability and bioaccessibility of bioactive compounds (Akhavan et al., 2018; Huang et al., 2010; Jafari, 2017b; Mcclements et al., 2009; Silva et al., 2012). Food nanotechnology has areas of application in all stages and processes that food undergoes from farm to fork (Çakır, 2020).

In food applications, nanosensors, nanocomposites, nanofibers, nanotubes, nanoparticles and nanoemulsions that contain food components have been used for numerous purposes (Duncan, 2011). Thereby enabling the production of foods with better solubility, thermal stability and higher bioavailability

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and bioaccessibility (Hamad et al., 2018; Ni et al., 2017). Progress in the field of nano foods has also enabled the development of healthier foods (Saka and Gülel, 2015). Food nanotechnology will contribute greatly to the production of functional foods by enabling more effective use of bioactive compounds and nutraceuticals that have positive effects on health (Dağ, 2014). Thus, new products for health-improving nutrition can be developed (Pogarska et al., 2017). The preparation of food nanoemulsions that increase the bioavailability of vitamin D in order to eliminate vitamin deficiency in elderly populations (Walia & Chen, 2020) and the development of nanosized droplets that increase the uptake of polyunsaturated fatty acids for use in oral therapies (Dey et al., 2019) are examples of their use for this purpose. The long-term health risks of nanotechnology, which is a new area, are not yet completely understood. Very few in vivo studies have been conducted on the possible effect of the use of nano foods on human health (Sağlam & Var 2015). Due to these areas of application, food nanotechnology is important for nutritional sciences.

Food and nutrition professionals who understand the structural and functional characteristics of foods, nutrients, and metabolites can develop new food distribution systems. Improvements in food safety and sanitation practices can be created with the vision of food and nutrition professionals who comprehend post-harvest critical points in the post-production flow of food. Patient services for the treatment of specific diseases can be refocused or redirected. Food and nutrition experts can develop educational materials for all segments of the population to better understand the science behind nanotechnology and its applications. To better inform public policies related to health and medicine, the environment, and food and water supply, food and nutrition professionals can enhance their knowledge about nanotechnology (Nickols Richardson, 2007). In this respect, the knowledge and awareness of nutrition and dietetics students are crucial.

Although nanotechnology education in universities is progressing, it is still reported to be insufficient. It is observed that the importance of nanotechnology education, particularly in the field of engineering, has increased in the curriculum of universities in Turkey. As food nanotechnology emerges and is utilized in daily food items, individuals need to be aware not only of the benefits of this technology but also of its consequences. The concept of nano food is crucial for both individuals' nutrition and their health. Therefore, the knowledge and awareness of nutrition experts on this matter are of great importance. For the issues related to public health that may arise with the development of food nanotechnology, which has beneficial effects on health in the field of nutritional sciences, stakeholders in the field of nutrition and dietetics have a lot of work to do. For these reasons, it is necessary to determine the knowledge and awareness levels of students studying in these departments. In this regard, this study will provide a better understanding of students' knowledge and awareness of the risks and benefits of food nanotechnology applications.

2. Material and Methods

2.1. Study Design

This descriptive study was conducted between July and August 2021. The population of the study consisted of students aged 18 years and over studying in the Department of Nutrition and Dietetics at Kırklareli University. No sample selection was made in the study, and 242 people who volunteered to participate in the study were reached. Approval for the study was obtained from the Ethics Committee of the Institute of Health Sciences of Kırklareli University (21.06.2021-PR0340R0).

2.2. Data Collection Tools

Google form was prepared for the data and administered online. The first question of the questionnaire asked the participants to confirm their voluntary participation in the study. The participants who voluntarily agreed to participate in the study were not allowed to answer the questionnaire afterwards. The questionnaire form was prepared by the researchers, the first section includes descriptive characteristics, the second section includes questions about the level of knowledge and awareness about food nanotechnology, and the third section includes propositions about the level of knowledge and awareness about food nanotechnology. A 24-question food nanotechnology knowledge and awareness level scale was prepared based on the literature (Chaudhry & Castle 2011; Grobe et al., 2008). The propositions are arranged on a 6-point Likert scale as "Don't know / No opinion (0), Strongly disagree (1), Disagree (2), Neither agree nor disagree (3), Agree (4), Strongly agree (5)". A minimum score of 0 and a maximum score of 120 can be obtained from the scale. High scores indicate a high level of knowledge and awareness about food nanotechnology. In the reliability analysis in this study, the Cronbach's Alpha coefficient of the list of propositions was calculated as 0.953. In factor analysis, Kaiser-Meyer-Olkin Measure value was 0.937 (p=0.000).

2.3. Analysis of the Data

Number (n), percentage (%), mean and standard deviation (SD) were used in the analysis. The normality of the distribution was tested with the Kolmogorov-Smirnov test. Reliability analysis was done for the reliability of the data and the results were analyzed with Cronbach's alpha coefficient. Mann-Whiytney U test was used for the comparison of two independent group means and Kruskal-Wallis analysis of variance was used for the comparison of three or more independent group means. Data were analyzed in SPSS 26.0 statistical package program and significance level was accepted as $p<0.05$.

3. Results

Table 1 shows the descriptive characteristics of the participants. 52.1% of the participants were 22 years of age or older, 91.7% were female, 31.8% were fourth grade students.

Table 1. Distribution of descriptive characteristics of participants

Descriptive characteristics		*n*	*%*
Age	≤ 21	116	47.9
	≥ 22	126	52.1
Gender	Female	222	91.7
	Male	20	8.3
Class level	1st grade	59	24.4
	2nd grade	65	26.9
	3rd grade	41	16.9
	4th grade	77	31.8

Table 2 shows the characteristics of the level of food nanotechnology knowledge and awareness of the participants. 66.9% of the students had heard the concept of food nanotechnology (nano food) before. They mostly obtained this information from the internet, visual or written media (44.6%). 81.8% of the participants said that they had some knowledge about food nanotechnology (nano food). Students stated that nanotechnology in the field of food can be used mostly in food processing (63.6%) and development of packaging systems (57.0%). When asked "Do you think smart packaging systems that provide information about the quality of packaged food during storage and transportation would be useful?" 88.4% of the students answered yes. 78.9% of the students think that with the development of nanotechnology, smart packaging methods will be preferred instead of traditional packaging techniques. 44.2% of the research group stated that they did not know whether there were any ethical problems with the use of nanotechnology in the field of food. 36.8% of the group stated that they did not know the risk level of the use of nanotechnology in food. The highest response to the risk level was that the high area/volume ratio of nanomaterials makes them more reactive and more toxic (38.0%). 86.8% of the students expect safety criteria to be determined for food products containing nanomaterials. 86.0% of the participants expressed that they would like to receive training on food nanotechnology. 73.6% of the students think that developments in food nanotechnology will be beneficial for their profession and 73.6% of the students think that courses on food nanotechnology should be included in the Nutrition and Dietetics curriculum.

Table 3 shows the distribution of the mean scores of the responses to the statements regarding the level of knowledge and awareness of the participants about food nanotechnology. Based on this, the highest mean scores are "It can maintain the desired flavor and color of foods and beverages (3.38±1.45)" and "Nanosensors can be used for the detection of animal and plant pathogens (3.17±1.66)". The lowest scores were for the statements "It can improve the bioavailability of nutraceuticals (2.16±1.90)" and "Better absorption and absorption of nutraceuticals can be achieved (2.22±1.93)".

Table 4 shows the relationship between some features of the participants and the scale of knowledge and awareness level about food nanotechnology. It was found in the study that those who had heard the concept of food nanotechnology (nano food) before (p=0.017) and those who had knowledge of food nanotechnology (nano food) (p=0.000) had a high level of knowledge and awareness about food nanotechnology. Among those who think that smart packaging systems that provide information about the quality of packaged food during storage and transportation will not be useful (p=0.001), those who think that smart packaging methods will be preferred instead of traditional packaging techniques with the development of nanotechnology (p=0.000), The level of knowledge and awareness about food nanotechnology was found to be statistically higher in those who thought that there was no ethical objection to the use of nanotechnology in food (p=0.000) and those who stated that the perceived risk level in the use of nanotechnology in food was very low (p=0.000).

Table 2. Characteristics related to the level of participants' knowledge and awareness of food nanotechnology

	n	%
Have you heard of Food Nanotechnology (Nano food) before?		
Yes	162	66.9
No.	80	33.1
Where did you first hear about Food Nanotechnology?		
Internet, visual or written media	108	44.6
Scientific publications such as articles and reviews	17	7.0
Events such as panels, conferences	7	2.9
During my education	42	17.4
Are you familiar with Food Nanotechnology (Nano food)?		
Yes	11	4.5
A little bit	198	81.8
No.	33	13.6
Which applications in food can nanotechnology be used for?		
Food processing	154	63.6
Development of packaging systems	138	57.0
Development of functional products	132	54.5
Increasing the nutritional value of foods	115	47.5
Detection of pathogens and improving food safety	109	45.0
New product development	88	36.4
Transport and controlled release of bioactive substances	87	36.0
Use as an additive	69	28.5
Do you think smart packaging systems that provide information about the quality of packaged food during storage and transportation		
Yes	214	88.4
No.	6	2.5
I don't know	22	9.1
Do you think that with the development of nanotechnology, smart packaging methods will be preferred over traditional packaging tech-		
Yes	191	78.9
No.	14	5.8
I don't know	37	15.3
Do you think there are any ethical problems with the use of nanotechnology in food?		
Yes	31	12.8
No.	104	43.0
I don't know	107	44.2
What do you think is the level of risk of using nanotechnology in food?		
Too much	3	1.2
More	9	3.7
Medium level	80	33.1
Low	51	21.1
Very low	10	4.1
I don't know / no idea	89	36.8
*Which one(s) pose a risk in the use of nanotechnology in food?**		
Maximum limits not known	65	26.9
Use in food processing and packaging	50	20.7
No labeling requirement to identify the nanomaterials in the product	62	25.6
Lack of particle size range information	60	24.8
The high area/volume ratio of nanomaterials makes them more reactive and toxic	92	38.0
Nanoparticles can easily react with other components because they are more reactive	90	37.2
Nanoparticles released into the environment and indirectly contaminated food	81	33.5
Positively charged and hydrophilic nanoparticles increase circulation time in the body	52	21.5
The large surface areas of nanoparticles provide surfaces to which toxic chemical contaminants can bind and be transported	83	34.3
The ability of nanoparticles to enter the body and cells can cause toxic substances to spread inside the body, resulting in cell and tissue damage and defects in defense mechanisms	88	36.4
Inhalation of nanoscale substances can cause lung diseases	18	7.4
*What do you expect from food products containing nano materials?**		
Being labeled	177	73.1
Determination of safety criteria	210	86.8
Laboratory protocols have been established	171	70.7
Approval of organizations such as international food authorities (FDA, FAO, etc.)	195	80.6
Would you like to receive training in food nanotechnology?		
Yes	208	86.0
No.	34	14.0
Do you think that developments in food nanotechnology will benefit your profession?		
Yes	178	73.6
No.	7	2.9
Not sure/don't know	57	23.6
Do you think that courses on food nanotechnology should be included in the Nutrition and Dietetics curriculum?		
Yes	178	73.6
No.	12	5.0
Not sure/don't know	52	21.5

*Multiple options are selected.

Table 3. Distribution of responses to the propositions regarding the level of knowledge and awareness of participants about food nanotechnology

Proposals	Don't know/ No idea	Strongly disagree	Disagree	Undecided	Agree	Fully agree
Pesticides, fertilizers and other agricultural chemicals can be used more efficiently (Item mean score; 2.93±1.61)	20.2	0.4	3.7	23.1	46.3	6.2
It can ensure controlled use of growth hormones (Item mean score; 2.59±1.62)	24.0	1.2	7.9	28.9	34.7	3.3
Nanosensors can be used to monitor soil conditions and crop growth (Item mean score; 3.02±1.72)	21.9	0.4	2.9	12.8	52.1	9.9
Nanosensors can be used for the detection of animal and plant pathogens (Item mean score; 3.17±1.66)	19.0	0.8	2.9	10.7	55.0	11.6
Nanocapsules can be used to distribute vaccines (Item mean score; 2.62±1.87)	30.6	1.2	2.9	16.5	38.8	9.9
May play a role in the delivery of DNA and chemicals to plant tissues/cells (Item mean score; 2.72±1.74)	25.6	1.2	5.0	18.6	43.0	6.6
Can improve bioavailability of nutraceuticals (Item mean score; 2.16±1.90)	41.3	0.4	3.3	16.5	33.1	5.4
Can be used to enhance flavor (Item mean score; 3.01±1.57)	16.5	1.7	9.1	17.8	46.7	8.3
It can maintain the desired flavor and color of foods and beverages (Item mean score; 3.38±1.45)	12.4	0.8	5.0	11.6	59.1	11.2
Can be used as a gelling and viscosity enhancer (Item mean score; 3.00±1.67)	20.2	1.7	5.0	12.4	52.9	7.9
Plant-based steroid nanocapsules can be used instead of meat cholesterol (Item mean score; 2.76±1.66)	21.5	2.9	7.4	21.5	39.7	7.0
It can be used to remove pathogens or chemicals detected in foods (Item mean score; 3.25±1.56)	16.1	0.8	2.5	13.6	56.2	10.7
Food components can provide a more homogeneous and better distribution (Item mean score; 3.07±1.68)	20.2	0.8	2.5	14.5	51.7	10.3
May mask unpleasant tastes (Item mean score; 2.97±1.64)	18.6	2.9	6.6	16.1	46.7	9.1
Can be used to detect chemicals or foodborne pathogens (Item mean score; 3.17±1.64)	18.6	0.4	3.7	10.3	56.2	10.7
Biodegradable nanosensors can be used for temperature, humidity and time monitoring (Item mean score; 3.07±1.73)	21.5	0.8	2.5	11.2	52.1	12.0
Nanoclays and nanofilms can be used as barrier materials to prevent degradation and oxygen absorption (Item mean score; 2.73±1.86)	29.3	0.4	2.1	14.5	43.4	10.3
Nanoparticles containing antimicrobial and antifungal can be used for surface coatings (Item mean score; 2.57±1.86)	30.6	1.7	5.0	16.1	36.4	10.3
Lighter, stronger and heat resistant films made of silicate nanoparticles can be used (Item mean score; 2.42±1.90)	35.5	1.2	2.1	14.5	40.1	6.6
The permeability of the packaging material can be modified (Item mean score; 3.10±1.64)	19.0	0.8	4.1	12.0	55.0	9.1
Nanoscale transforming technologies can be used to increase the absorption of nutrients (Item mean score; 2.79±1.77)	24.8	1.7	6.2	14.0	44.2	9.1
Nanoparticles can be used as drug carriers (Item mean score; 2.69±1.85)	28.5	2.1	3.7	13.6	41.7	10.3
Better absorption and absorption of nutraceuticals can be achieved (Item mean score; 2.22±1.93)	40.5	0.8	3.3	14.0	34.3	7.0
Nanoclays and nanofilms can be used as barrier materials to prevent degradation and oxygen absorption (Item mean score; 2.73±1.86)	29.3	0.4	2.1	14.5	43.4	10.3
Nanoparticles containing antimicrobial and antifungal can be used for surface coatings (Item mean score; 2.57±1.86)	30.6	1.7	5.0	16.1	36.4	10.3
Lighter, stronger and heat resistant films made of silicate nanoparticles can be used (Item mean score; 2.42±1.90)	35.5	1.2	2.1	14.5	40.1	6.6
The permeability of the packaging material can be modified (Item mean score; 3.10±1.64)	19.0	0.8	4.1	12.0	55.0	9.1
Nanoscale transforming technologies can be used to increase the absorption of nutrients (Item mean score; 2.79±1.77)	24.8	1.7	6.2	14.0	44.2	9.1
Nanoparticles can be used as drug carriers (Item mean score; 2.69±1.85)	28.5	2.1	3.7	13.6	41.7	10.3
Better absorption and absorption of nutraceuticals can be achieved (Item mean score; 2.22±1.93)	40.5	0.8	3.3	14.0	34.3	7.0
It can be used for more efficient delivery of nutrients to body cells without affecting the color or taste of food (Item mean score; 2.89±1.73)	22.7	1.2	5.0	16.5	44.6	9.9

Table 4. The relationship between some characteristics of the participants and knowledge and awareness level scale about food nanotechnology

Proposals		*Mean*	*Std. Dev.*	*p-value*
Age	≤ 21	65.84	28.33	0.803
	≥ 22	64.87	27.11	
Gender	Female	65.79	27.76	0.277
	Male	60.30	26.58	
Class level	1st grade	64.07	29.37	0.824
	2nd grade	66.60	27.90	
	3rd grade	63.85	27.68	
	4th grade	66.03	26.51	
Previous knowledge of the concept of food nanotechnology (nano food)	Yes	68.80	25.10	0.017
	No	58.33	31.20	
State of knowledge about food nanotechnology (nano food)	Yes	74.55	31.40	0.000
	A little bit	68.67	24.50	
	No	42.24	33.26	
Do you think smart packaging systems that provide information about the quality of packaged food during storage and transportation would be useful?	Yes	67.67	26.15	0.001
	No	68.33	27.13	
	I don't know	41.77	31.99	
Do you think that with the development of nanotechnology, smart packaging methods will be preferred over traditional packaging techniques?	Yes	69.84	24.57	0.000
	No	61.79	33.53	
	I don't know	43.41	30.29	
Ethical concerns about the use of nanotechnology in food	Yes	71.03	20.91	0.000
	No	75.88	21.77	
	I don't know	53.43	29.87	
Perceived level of risk in the use of nanotechnology in food	Too much	56.67	29.26	0.000
	More	77.33	16.78	
	Medium level	76.96	16.88	
	Low	74.25	23.00	
	Very low	83.40	25.52	
	I don't know / no idea	46.82	29.25	
Willingness to receive training on food nanotechnology	Yes	66.11	27.39	0.334
	No	60.62	29.17	

4. Discussion

In this study, the level of knowledge and awareness of food nanotechnology was found to be high in those who had heard the concept of food nanotechnology (nano food) before and those who had knowledge of food nanotechnology (nano food). On the other hand, in a study conducted with Western University students,nanotechnology awareness and familiarity with nanotechnology were found to be low. Students in the field of nutrition were found to have stronger knowledge about nanotechnology and its applications in food than non-nutrition students. One third of nutrition students stated that "technology should not be associated with food" (Hekmat & Dawson, 2019).

It was found that those who thought that smart packaging systems that provide information about the quality of packaged food during storage and transportation would not be useful, and those who thought that smart packaging methods would be preferred instead of traditional packaging techniques with the development of nanotechnology had a high level of knowledge and awareness about food nanotechnology. Furthermore, as a result of the study, it was seen that the participants evaluated the development of nanotechnology as beneficial, but were aware that the use of nanotechnology carries certain risks. The participants of the study are hesitant towards the use of nanotechnology in the field of food due to lack of knowledge on the subject. A study by Ho et al. (2011) suggested that the more people know about nanotechnology, the more likely they are to have positive attitudes towards it (Ho et al., 2011). Another study reported that university students expressed some positive opinions towards the development of nanotechnology-based foods that provide beneficial effects but were concerned about the risks associated with it (Kim & Kim, 2013).

The knowledge and awareness level about food nanotechnology was found to be high among those who thought that there were no ethical concerns about the

use of nanotechnology in food and those who stated that the perceived level of risk in the use of nanotechnology in food was very low. It has been shown that ethical and moral concerns affect public acceptance of new food technologies and nanotechnology is no exception (Frewer et al., 2014). Optimism regarding the application of nanotechnology in Iran in general has been reported (Farshchi et al., 2011). Similar results have been reported for high school students and adults in Turkey (Sahin & Ekli 2013; Senocak, 2014).

In the study, nutrition and dietetics students reported that the biggest risk groups in the use of nanotechnology in food are nanoparticles being more reactive and toxic and entering the body and cells. In a similar study conducted at the University of North Carolina, engineering students stated that there may be toxicological risks of nanoparticles entering the body barriers and that nano food packaging particles can enter the food and then into the body (Gardner et al., 2010).

Nanotechnology is not a term or concept that people often encounter. As nanotechnology is a very new field, most people have limited knowledge about it, except for scientists in the field (van Giesen et al., 2018; Ho et al., 2020). Results show that nutrition and dietetics students have limited knowledge about the broad application of food nanotechnology. The participants seem to have different levels of awareness on this issue, despite receiving information from basically the same source (internet, visual or written media).

The absence of the concept of nanotechnology in the curriculum is a disadvantage. Students obtain partial information during their research for the assignments given in the courses and this information is thought to be insufficient. The reason for this limited knowledge about nanotechnology is estimated to be that it is learned through extra-curricular sources such as the internet, visual or written media (Aydın Sayılan & Mercan, 2016). However, students were found to be eager to learn more about nanotechnology. A number of studies among students have shown that participants are very enthusiastic about nanotechnology (Elmarzugi et al., 2014) and have a critical view of the potential risks and benefits of its applications (Gardner et al., 2010; Nerlich et al., 2007).

The increase in knowledge also increases the curiosity to learn. For this reason, students' scientific knowledge is expected to increase as the grade level increases. In the study, no significant difference was found between the grade levels in terms of awareness towards nanotechnology. In a study conducted by Baybek et al. (2017), it was found that nanotechnology attitudes did not differ between classes.

Three quarters of the students think that developments in food nanotechnology will benefit their profession and that courses on food nanotechnology should be included in the Nutrition and Dietetics curriculum. Nanotechnology is fast becoming a leading interdisciplinary field with broad implications for society. Advances in nanoproducts have the potential to change areas of food management such as purchasing, storage and preparation, as well as management systems such as hazard analysis critical control point (HACCP). Nanotechnology products may also reduce energy and personnel costs by changing food, preparation and cooking methods and equipment requirements. Moreover, this developing technology increases the number of functional food products and has the potential to change nutrient intakes accordingly. From this perspective, nutrient intakes and their possible toxic effects on individuals need to be closely examined. Possible imbalances in micronutrient intake, nutrient-drug interactions, changes in digestion and absorption of nutrients need to be monitored more closely. Likewise, advances in food nanotechnology will change medical diagnostics and nutritional therapy delivery, and metabolic changes need to be well understood by nutritionists. Since nanotechnology has not fully penetrated the nutrition and dietetics profession, nutrition and dietetics professionals need to educate themselves on this emerging science (Nickols Richardson, 2007). Activities for consumer education and the development of legislation on nano food applications should be intensified in the future. In particular, nutritionists need to develop themselves in food safety and consumer education. Nanotechnology education is offered in Bachelor's, Master's and PhD degrees by many universities worldwide (Schummer, 2004). As a result of the stated reasons and the study, food nanotechnology should take its rightful place in undergraduate, graduate and doctoral curricula in the field of nutrition and dietetics, and it is beneficial for the department to be open to new technological developments.

5. Conclusions and Recommendations

Two-thirds of the students had heard of the concept of food nanotechnology (nano food) before; four-fifths expressed that they had some knowledge about food nanotechnology (nano food). Three-quarters of the students think that improvements in food nanotechnology will benefit their profession and that

courses on food nanotechnology should be included in the Nutrition and Dietetics curriculum. It was found in the study that those who had heard the concept of food nanotechnology (nano food) before and those who had knowledge of food nanotechnology (nano food) had a high level of knowledge and awareness about food nanotechnology. Statistically high levels of knowledge and awareness about food nanotechnology were found in those who thought that smart packaging systems that provide information about the quality of packaged food during storage and transportation would not be useful, those who thought that smart packaging methods would be preferred instead of traditional packaging techniques with the development of nanotechnology, those who thought that there were no ethical problems with the use of nanotechnology in the field of food, and those who stated that the perceived risk level in the use of nanotechnology in the field of food was very low. In conclusion, it shows that nutrition and dietetics students have limited knowledge about the wide application of food nanotechnology.

It is expected that the knowledge and awareness levels of students will increase with the inclusion of courses on food nanotechnology in the Nutrition and Dietetics curriculum.

Limitations of the study

It is difficult to generalize the results of the study to the students studying in Nutrition and Dietetics Departments due to the risk of not reaching individuals without internet access in this online study. It is considered as a limitation that the participants of the study consisted only of nutrition and dietetics students of the university, except for students in other health fields. As the results are limited to the university where the study was conducted, they cannot be generalized to all universities.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Author's Contributions

M.A. Çakır (0000-0001-5066-1956): *Idea/Concept, Literature Review, Writing*.
Y. Mercan (0000-0002-7099-4536): *Idea/Concept, Supervision/Consultancy, Analysis and/or Interpretation, Critical Review*.

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