Research Article
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A survey study on the Genetically Modified Organism (GMO) knowledge levels and attitudes of the consumers

Abstract

This research was conducted in the form of a survey study to determine the knowledge levels and attitudes of consumers towards genetically modified organism (GMO). The study was carried out in a 4-month period between September and December 2022. As a data collection tool in the research, questions were asked to determine the knowledge level and attitudes of consumers towards GMO products. The findings of the study revealed that the participants were aware of genetically modified products and the majority of them thought that genetically modified foods were harmful. As a result of the data obtained, it is understood that consumers have some misconceptions about GMO and that important awareness trainings are needed to eliminate these misconceptions. In other words, it has been understood that consumers confuse issues such as GMO, pesticide and antibiotic residue from hormone application, and they have wrong information or prejudice on the subject. Another important issue that consumers will face in the future and somehow need to be informed about the features of the products offered for sale in the market.

Keywords: Genetically Modified Organism (GMO), Consumer, Attitudes toward GMO, Knowledge Level of GMO

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Introduction

Rapid growth worldwide puts serious pressure on production systems. In addition, climate change and diseases, the effects of which are increasingly being felt in human nutrition, also highlighted the need for nutrition. Because people's nutrition is a basic need, it is a priority to meet their nutritional needs instantly, on the spot, and as needed. Already, the way people eat around the world changed significantly from the past to the present. With the transition of people from foraging to hunter-gatherer, agricultural and settled life, important changes have occurred in the nutritional structure and the food items they consume. The industrial revolution and technological developments have also changed the healthy structure and habits of human societies. While some are of the opinion that the use of technology in matters such as increasing the nutritional quality and health benefits, improving the shelf life and organoleptic quality of the products, increasing the number of products, producing vaccines and drugs, and treating diseases, some are suggest the opposite.[1] The production of modified living organisms for plant and animal breeding for traditional breeding methods and for some special purposes is also on the agenda. Today, modern biotechnology includes genetic engineering and genome editing tools. Genetically modified organisms or transgenetic products are new products that are formed by changing the gene sequence of the organism or transferring a new gene to the organism.[1–4] Gene transfer from one living thing to another is a kind of cutting, pasting, and duplication process. In this process, the gene to be transferred is first cut from the DNA of the living thing in which it is found; Then, the carrier gene, called a vector, is attached to the DNA molecule of the living thing to be transferred. The term genetically modified organisms (GMO) is used to describe organisms whose genetic makeup has been altered in nature other than through crossover or natural recombination. In other words, living organisms obtained by changing the gene sequence of a living thing or giving it a completely different character that is not in its own nature are called "Genetically Modified Organisms" (shortly GMO) or "Transgenic Organisms". Products produced in this way are called genetically modified crops or transgenic crops. Genetically modified organisms or transgenetic products have been used for many years in fields such as vaccines, drugs and prevention of plant pests as well as nutrients (Gözü Kırmızı, N., 2005; Soller, et al. 2021).[5] In addition, the use of GMOs in vaccine and drug production, organ transplantation, and the treatment of diseases, providing resistance to pests, long shelf life, and increasing food quality, as well as allergic reactions, toxic effects, and damage to ecological diversity are among its negative effects.[3,4] With GMO technology, benefits such as increased meat and milk yield in livestock, increasing the amount of milk casein or removing lactose from milk, and low cholesterol egg production can be achieved. (Kyyak, 2004). In addition, it is expected to provide significant advantages with the research of genes that provide resistance to diseases and pests, heat, and cold. However, GMO products have aroused great public interest since the first day they were produced and have been discussed on various grounds. There are still different target consumer reactions to GMO products.[1,6] Some groups believe in the importance of such technologies and consider this necessary for the development of new and modified products. However, some groups prefer to take care in terms of environmental security, food security, nutrition, morality, and belief, effects on social structure and economy, and deficiencies in the legal infrastructure. However, the presence and distribution of GMO products is gradually increasing.[2,7] In general, it is known that consumers do not fully know the subject of GMOs. Mostly, they are found uncomfortable with the use of GMOs and exhibit a negative attitude. Reactions are varying according to the place and conditions of people. The short and long-term effects of GMO products, especially on human health, are not known enough, and the possibility of an irreversible process in case these products threaten genetic diversity is also an important reason for reservations. However, the shrinking agricultural areas due to the rapidly increasing population and the increase in construction necessitate new searches for human nutrition. Today, hunger is a serious threat in the world and the majority of children under the threat of hunger live in developing countries.[6] Urbanization speed, product variety, increase in mass media, advertisements, age, occupation, education level, women's

participation in working life affect consumers' perspectives on food products.[8,9]

This research was conducted as a survey study in order to determine the knowledge levels and attitudes of consumers in Turkey about genetically modified organisms (GMOs).

Material and methods

This research was carried out in the form of a survey study between September and December 2022 in Adana. In order to determine the perception of GMOs in consumers, a literature study was conducted and survey questions were prepared. In determining the main population of the research, first of all, people who are university graduates and still working in Adana Province and its districts were determined on a voluntary basis. Questionnaires prepared for this purpose were through face-to-face, telephone, and online interviews. It was understood that the employees were reluctant to participate in a survey on GMOs, and they agreed to participate after the interviews and after being informed that their names would not be included. In the interviews, "designed questionnaires" were prepared with a literature review and sample applications and applied by the researchers. The results of 134 respondents who responded to the questionnaires were evaluated. The research questionnaire forms were formed from the questions in the sub-headings of the GMO knowledge level and the view on GMOs, which were prepared to meet the research objectives. The prepared questions were first applied with a group of volunteers and after the clarity of the questions was determined, necessary corrections were made and then applied to the target people.

In the evaluation of the survey results, cross tables were created using SPSS (for Windows 6.01) statistical program and MS Excel program.

Research findings and discussion

68.0% of the participants are female, 72% are from the 22-42 age group, 90% are university graduates, 30% are public employees, 10.8% are private sector, average family size is 4 people, socioeconomic status - their economic status; indicated as above-average. The distribution of the answers given to the questions on the level of knowledge about the GMO product in the research is summarized in Table 1.

When Table 1. is examined, do the participants know what GMOs mean? It is understood that he answered the question "Yes, I know" with a rate of 98.5%. It is understood that while 47.0% of the participants stated that they heard it from television, and school and 14.9% from the internet, 1 (0,7%) person said that they did not hear it. Product appearance is a very important factor for consumers.[10] In case the foods included in the Regulation on Genetically Modified Organisms and Their Products are obtained from approved GMOs above the threshold value determined by the Ministry (0.9%), or contain ingredients obtained from approved GMOs, or contain GMOs, or consist of GMOs, Turkish in addition to the requirements in the Food Codex, matters related to how to label are explained. However, since there is no gene approved for food purposes in Turkey, it is not considered appropriate to include a statement stating that there are no GMOs on the labels of foods (Anonymous, 2010).[11,12] Gezginç and Gök[13] stated that 46.7% of consumers use TV as a news source, 17.8% newspaper, and magazine publications, 32.1% school internet, 11.1% health workers, and 8.9% their close circles. Ozdemir et al.[14] in their study on the concept of functional food, 36% stated that they were informed through print media, 28% sales point promotions and 19% advertisements. Gezginç and Gök[13] stated that 50.7% of the individuals surveyed stated that they knew these foods but did not know that they were called functional food, 30.4% of them knew functional food, and 18.9% of them did not know functional food. Doğan et al., (2011) stated in their study that 47.2% of them know functional foods and 4.4% of them have the wrong information. Koç[15] states that as the income level of consumers increases, the share they allocate to food expenditures decreases proportionally, consumers are open to innovations in consuming new food products, the labels of food products are generally read carefully by consumers with middle and higher income, and they are in the high-income group regarding the safety of food products. It has been determined that consumers in the middle and upper-income groups are worried, but they do not give up on their purchasing behavior and habits. Miran et al.[16] stated that 84% of the respondents know what organic agriculture is, but 79.4% of those who say yes can define organic agriculture correctly. Genetically modified products cannot be recognized from the outside; however, if the producer wishes, he can change the phenotype as in the example of GOLDEN RICE.[11] Whether a product is GMO or not can only be understood through laboratory analysis. Analysis of GMOs; It is based on the detection of a new molecule (DNA, RNA, or protein) formed as a result of genetic modification.

The distribution of answers to questions such as consumption of Genetically Modified Agricultural Products and the disadvantages of these products is summarized in Table 2.

When Table 2 is examined, 62% of the participants answered that there may be a problem with GMO products and 55.2% answered that they would not consume GMO products. Since there is no gene approved for food purposes so far, the use of GMOs and their products for food purposes is prohibited, and the import of GMO products for food purposes is not allowed. Within the framework of the Biosafety Law No. 5977 in force in our country and the base regulations and the decisions of the Biosafety Board, 32 types of genes are allowed in soy and corn only to be used in animal feed. 15 soybean varieties and 21 corn varieties were approved for feed use by evaluating the reports prepared by the Scientific Risk Evaluation Committee and the Socio-Economic Evaluation Committee. In order to ensure the inspection and traceability of GMO feeds, which are allowed to be imported, in accordance with the Biosafety legislation, necessary inspections are carried out during their circulation, processing, and storage within the country. All relevant persons who import, process, and use GMO feeds are obliged to notify the Ministry of the entry and circulation of the products into the country, to keep the necessary records up-to-date, and to submit them to the Ministry when necessary. If soy and corn varieties approved for use as feed contain more than 0.9% GMOs, they must be indicated on the label. Turkiye'de, as in the EU, products obtained from farm animals fed with GMO feed do not need to be labeled in terms of GMO. According to the statement made by the European Food Safety Authority (EFSA), it has been stated that no GMO DNA or proteins have been found in the tissues, fluids, and products of animals fed with GMO feeds.

GMO plants are grown on 12% of 1.5 billion hectares of arable land globally. Soy, corn, rapeseed, and cotton constitute 99% of the plants produced as GMOs in the world. In addition, in some countries, potatoes, tomatoes, rice, wheat, pumpkin, sunflower, peanuts, some fish species, cassava, and papaya are also produced as GMOs. These plants are 47% herbicide tolerant, 12% insect tolerant, and 41% heap characteristics in terms of species; soybean (50%), corn (22%), cotton (12%), canola (5%), and other types (11%).

In the near future; It is planned to produce species that are more suitable for industrial production, that can produce important inputs for

the pharmaceutical industry, that have enriched nutritional properties, that have increased resistance to harsh climatic conditions such as drought, environmental stress factors such as salinity, pH level, and pests.[17] However, it is not possible to say that GMOs are accepted by consumers due to ignorance, prejudices, and concerns about possible risk factors. In the European Union, all GM products that have been accepted for various purposes until today have been proven to be safe.[18] Again, publications on farm-level benefits and socio-economic impacts of GM crop production in the EU are extremely restricted as production is limited in these countries. Research on these products in Europe has mostly focused on public acceptance and environmental impacts.[19]

The distribution of answers given to the question "Why is genetic change needed in the research?" is summarized in Table 3.

When we look at the distribution of answers regarding the reasons for the need for genetic modification, it is understood that 29.9% marked all, 29.8% chose to increase the productivity of agricultural products and 3% chose none. The distribution of the answers given by the respondents to the question of what are the reasons for the need for genetic modification is summarized below :

a. To increase the amount of products in existing types,
b. To reduce post-harvest losses
c. To make the products more tolerant to factors such as cold, heat, drought and salinity
d. To prevent products from reducing soil fertility
e. To increase the nutritional value of food
f. To reduce pesticide use with pest resistant crops

The answers given to the GMO contamination limit question in the study are summarized in Table 4. In the first paragraph of Article 4 of the Regulation on Genetically Modified Organisms and Their Products published in the Official Gazette dated 13/8/2010 and numbered 27671, the definition of GMO contaminant is defined as "Production, manufacturing, GMOs that are technically unavoidable, unavoidable or incidentally transmitted during processing, preparation, processing, packaging, packaging, transportation or storage or by environmental factors" were added. The contamination limit for GMO water-modified products is 0.9% (Anonymous, 2010.).

When asked if they know the contamination limit of GMO-modified products, 87.4% of the respondents do not know; 11.9% answered I know. Contagion is inevitable. For example, when a non-GMO soy or wheat, etc. product is stored in the area where the soybean containing GMOs, which are imported and permitted for animal feed, is stored, there will be contamination of the GMO from the previous storage.

95% of products such as corn, soybean, flax, and cotton in the USA are now produced as GMOs and exported all over the world. Since non-GMO products are kept in the same silos and transported by the same ships, they are also contaminated. The title of article 23 of the regulation was changed to "Sampling, analysis and evaluation", and paragraph (4) If a GMO of 0.9% or less is detected in the product as a result of the analysis, this situation is considered as GMO contaminant.

Not only the USA but also Argentina and Brazil, the world's largest soybean-producing countriesare now producing GMOs. Soybean is the biggest additive of animal and chicken feed. Therefore, the whole world mostly has to import GMO products from these three countries. Otherwise, the prices of meat, chicken, milk, and eggs will skyrocket. There is no more nutritious product for feed than soybeans. Therefore, the largest soybean-producing countries are active in the world market in terms of feed. Involved in the research, the answers given to the questions on the freedom of GMO production in Turkey and the legal regulations on the import of GMO products are summarized in Table 5.

Table 1 The level of knowledge about the GMO product in the research

	What does GMO mean?		Where did you hear the term GMO?			Can GMO be understood from its external appearance?		
Answers	**Number**	**Ratio (%)**	**Answers**	**Number**	**Ratio (%)**	**Answers**	**Number**	**Ratio (%)**
I know	132	98,5	Family	2	1,4	Understandable	43	32,1
I don't know	2	1,5	I did not hear	1	0,7	Incomprehensible	66	49,3
			I can't remember	1	0,7	No idea	24	17,9
			Internet	20	14,9	Everything can happen	1	0,7
			School	43	32,1			
			Television	63	47,0			
			at university	1	0,7			
			Other	3	2,2			

Table 2 The distribution of answers to questions such as consumption of Genetically Modified Agricultural Products and the disadvantages of these products

Which of the following is a GMO product?			Is GMO product harmful?			Do you consume GMO product?		
Answers	**Number**	**Ratio (%)**	**Answers**	**Number**	**Ratio (%)**	**Answers**	**Number**	**Ratio (%)**
Wheat	2	1,5	I don't know	8	6,0	Unanswered	1	0,7
All	83	61,9	Biological problem	16	11,9	Yes	59	44,0
None	7	5,2	Ethic problem	15	11,2	No	74	55,2
Sweetcorn	14	10,4	Health problem	84	62,7			
Corn, Wheat	22	16,4	No problem	11	8,2			
Egypt, All	1	0,7						
Corn, Cotton	4	3,0						
Cotton	1	0,7						

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Table 3 The distribution of answers given to the question "Why is genetic change needed in the research?"

Answers	Number	Ratio (%)
All	40	29,85
None	4	2,98
Protecting Agricultural Products Against Pests	5	3,73
Protecting Agricultural Products Against Pests, Monopoly Desire of Seed Companies	1	0,74
Increasing the Efficiency of Agricultural Products	40	29,85
Increasing the Efficiency of Agricultural Products, Protecting Agricultural Products Against Pests	20	14,92
Increasing the Efficiency of Agricultural Products, Monopolization Desire of Seed Companies	1	0,74
Monopoly Desire of Seed Companies	23	17,16

Table 4 Distribution of answers given to the question of GMO contamination limit

Cevaplar	Number	Ratio (%)
Unanswered	1	0,7
I don't know	117	87,4
Yes I know	16	11,9

Table 5 Distribution of the answers given to the questions on GMO production freedom and legal regulations on the import of GMO products in Turkey

Is GMO production allowed in Turkey?			Is there a legal regulation on the Import of GMO products?		
Answers	Number	Ratio (%)	Answers	Number	Ratio (%)
I don't know	56	41,8	I don't know	73	54,5
Yes	46	34,3	Yes	44	32,8
No	32	23,9	No	17	12,7

Is there a legal regulation on the Import of Genetically Modified products? 32.8% of the participants answered the question that they knew about legal regulations, and 54.5% of them did not know about legal regulations. It was understood that 12.7% of the participants had wrong information on this subject. It is not allowed to be imported as seeds and foodstuffs. There are legal regulations on the import of Genetically Modified Products (Anonymous, 2010). Import of Genetically Modified Products is permitted only if they are to be used as approved gene and animal feed. As in the EU, Turkey has adopted the principle of cautious approach to GMOs. Transactions related to GMO products; It is carried out in accordance with the provisions of the "Biosafety Law", which came into force on September 26, 2010, and the "Regulation on Genetically Modified Organisms and Their Products", which entered into force on the same date. Production of genetically modified plants and animals is PROHIBITED in Turkey (Anonymous, 2010). Regarding products covered by the Biosafety Law;

i. Placing GMOs and their products on the market without approval,
ii. The use of GMOs and their products in violation of the Board's decisions,
iii. Production of genetically modified plants and animals,
iv. Use of GMOs and their products outside the purpose and area determined by the Board within the scope of placing on the market,
v. It is forbidden to use GMOs and their products in baby foods and infant formulas, follow-on foods and follow-on formulas, and supplementary foods for infants and young children.

Since there is no gene approved for food purposes so far, the use of GMOs and their products for food purposes is prohibited, and the import of GMO products for food purposes is not allowed.[20,21]

Conclusion

As a result of the study on genetically modified organisms (GMO) knowledge levels and attitudes of consumers, it has been understood that consumers do not have enough knowledge about GMOs. The findings of the study revealed that, in general, the participants were aware of genetically modified products and the majority of them thought that genetically modified foods were harmful. As a result of the data obtained, it is understood that consumers have some misconceptions about GMOs and that important awareness training is needed to eliminate these misconceptions. In other words, it has been understood that consumers confuse issues such as GMO, pesticide, and antibiotic residue with hormone application, and they have wrong information or prejudice on the subject. Another important issue that consumers will face in the future and somehow the need to be informed about the features of the products offered for sale in the market.

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Conflicts of interest

The author declared that there is no conflict of interest.

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