

Agriculture faculty students' knowledge, attitude, and behaviors about genetically modified organisms (GMOs)

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Abstract

Aim: This study was conducted in order to collect information about current knowledge, attitudes, and beliefs of students studying at Bingöl University Faculty of Agriculture regarding genetically modified organisms (GMOs) and to determine problems regarding the subject if any.

Material and Methods: The population of this descriptive study consisted of students (146 students) studying at Bingol University Faculty of Agriculture. Data collection tool used in the study was the Questionnaire developed by the researchers based on literature information. Questionnaire consisted of 51 questions.

Results: It was found that answers of students to the information on GMO were usually correct and their knowledge score on GMO was 4.9 ± 1.2 out of 7. The rate of the students who found the production of genetically modified foods risky for all living creatures existing in the nature was 52.9% and 41.3% disapproved modifying genetics of foods to remedy hunger in the world.

Conclusion: It was observed that the students had knowledge about the subject but they did not deem themselves to have sufficient knowledge hereof.

Keywords: Genetically modified organisms; agriculture faculty; students; attitudes.

INTRODUCTION

Difficulties encountered in satisfying basic needs of the increasing world population and negativities in food chain reaching the people have driven scientists of our age to quests. Changing environmental conditions and rapidly increasing world population have made it compulsory to attain higher yield from a unit area and to get more quality products in agriculture (1). Even if it is possible to utilize natural resources that lessen day by day in the best way, it remains incapable against the rate of increase of the world population. In this case, as well as rational use of current potential, it has become inevitable to provide appropriate foodstuffs for a sufficient and balanced nutrition for the future of mankind (2).

Recent developments in technology, genetics and molecular biology have made it possible to process and shape genetic structures of organisms (3). Within this context, gene transfer can be made between species for which gene exchange is not possible with natural processes and gene structures can be modified in line with

the desired objective. By manipulating gene sequences of the living creatures, it is aimed to modify their features or add them new features. Thanks to biotechnology, it is possible to transfer suitable genes from a living creature to another. Products obtained through these methods are defined as transgenic or genetically modified organisms (GMOs) (4).

GMO is defined as the organism obtained by transfer of DNA piece (gene) received from any living creatures (plants, animals or microorganisms) to a different living creature, usually using recombinant DNA technology (5). Living creatures and products developed using recombinant DNA technology are also called with many different names in the literature such as genetically modified products, genetically modified organisms, genetically modified foods, genetically modified products, gene-transferred organisms, transgenic organisms, and bioengineering organisms (5,6).

GMOs are also applied in the fields of agriculture and animal husbandry. Placement of a DNA piece that carries the desired gene into chromosomes of the cells in the

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tissue, and then obtaining transgenic plants from these cells using tissue culture techniques form the basis for techniques used for transferring genes to plants (6). In order to form transgenic plants, specific DNA sequence is placed into the natural DNA of cultivated plant cells. Placement process is carried out randomly and scientists are not able to predict where the transgene is located in the genetic code of the cells or how it will function (7).

This study was conducted in order to collect information about current knowledge, attitudes, and beliefs of students studying at Bingöl University Faculty of Agriculture regarding genetically modified organisms (GMOs) and to determine problems regarding the subject if any.

MATERIAL and METHODS

The population of this descriptive study consisted of students (146 students) studying at Bingöl University Faculty of Agriculture. 122 of these students (male: 56.6%; female: 43.4%) were reached within the scope of the study (Rate of response; 84.7%). The study was performed in accordance with the principles of Declaration of Helsinki (16-20/10/2015). All participants gave verbal permission to participate in this study.

Data collection tool used in the study was the Questionnaire developed by the researchers based on literature information. Questionnaire consisted of 51 questions. The first part were concerning demographic characteristics of the students. It was tried to find out nutrition status of the students in the second part. Finally, last part, it was tried to determine the knowledge and opinions of the students on Genetically Modified Organisms (GMOs) together with the reasons.

After obtaining necessary permissions from the relevant institution before the study, field study was carried out between 10 November – 10 December 2016.

Statistical Analysis

Data were analyzed using a Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM, Armonk, NY). Error controls, tables, and statistical analyses were made by evaluating the obtained data with statistical package program. In statistical evaluations, percentage and mean were given and chi-square test was conducted. The averages were given with standard deviation and $p < 0.05$ was determined as significance level.

RESULTS

Table 1 shows general characteristics of the students who participated in the study. Accordingly, while 56.6% were male, 43.4% were female. The average age of the students was 23.1 ± 2.9 .

Table 2 shows information on dietary habits and characteristics of the students with regard to sleeping duration and the status of doing physical activities. 67.2% of the students considered that they did not have a healthy diet and they had 2-3 main meals a day. The rate of the students sleeping for 6-10 hours daily was 83.6%.

Table 1. Distribution of the students in terms of their general characteristics

| General Characteristics | Number | Percentage |
|--|--------|------------|
| Gender | | |
| Male | 69 | 56.6 |
| Female | 53 | 43.4 |
| Age (x±SD) | | 23.1±2.9 |
| Classes | | |
| 1 st class | 7 | 5.7 |
| 2 nd class | 22 | 18.0 |
| 3 rd class | 65 | 53.3 |
| 4 th class | 28 | 23.0 |
| Residential area | | |
| City center | 74 | 60.7 |
| District center | 26 | 21.3 |
| Village/ Town | 22 | 18.0 |
| Number of family members (x±SD) | | 7.5±3.2 |
| Number of siblings (x±SD) | | |
| Number of brothers | | 2.9±1.7 |
| Number of sisters | | 3.2±2.0 |
| Which child of the family (in order) (x±SD) | | 3.4±2.4 |

Table 2. Information on dietary and physical activity habits of the students

| Information on Dietary and Physical Activity Habits | Number | Percentage |
|---|------------|--------------|
| Idea of healthy dietary habits | | |
| Yes | 40 | 32.8 |
| No | 82 | 67.2 |
| Number of main meals (x±SD) | | 2.5±0.83 |
| Status of eating snacks | | |
| Yes | 54 | 44.3 |
| No | 68 | 55.7 |
| Status of skipping meals | | |
| Yes | 44 | 36.1 |
| Sometimes | 70 | 57.4 |
| No | 8 | 6.5 |
| Skipped meal | | |
| Breakfast | 71 | 58.2 |
| Lunch | 39 | 32.0 |
| Dinner | 12 | 9.9 |
| Daily sleeping duration | | |
| 3-5 hours | 13 | 10.7 |
| 6-10 hours | 102 | 83.6 |
| 11 hours and more | 7 | 5.7 |
| Time Spent Sitting on a Desk | | |
| 1-3 hours | 47 | 38.5 |
| 3-5 hours | 57 | 46.7 |
| 6-10 hours | 14 | 11.5 |
| 11 hours and more | 4 | 3.3 |
| Doing regular physical activity | | |
| Yes | 37 | 30.3 |
| No | 85 | 69.7 |
| Frequency of doing physical activity | | |
| 1-2 days in a week | 19 | 15.6 |
| 3-4 days in a week | 11 | 9.0 |
| 5-6 days in a week | 4 | 3.3 |
| Every day | 3 | 2.5 |
| Reason for not doing physical activity | | |
| Unavailability of economic conditions | 15 | 12.3 |
| Unavailability of time | 28 | 23.0 |
| Lack of adequate space for doing physical | 19 | 15.6 |
| Not having habit of doing physical activity | 18 | 14.8 |
| Other | 5 | 4.0 |
| TOTAL | 122 | 100.0 |

| Table 3. Distribution of answers of the students to information on Genetically Modified Organisms (GMO) | | |
|--|----------|------------|
| Information on Genetically Modified Organisms (GMO) | Number | Percentage |
| What are the organisms produced using genetic engineering are called? | | |
| Genetically Modified Organism (GMO) | 97 | 79.5 |
| Transgenic Organism | 3 | 2.5 |
| Gene-Transferred Organism | 10 | 8.2 |
| None | 5 | 4.1 |
| All | 7 | 5.7 |
| Do you have knowledge on GMO? | | |
| Yes | 106 | 86.9 |
| No | 16 | 13.1 |
| Where did you first hear the term GMO? | | |
| In the school courses | 44 | 36.1 |
| On Television and Radio | 67 | 54.9 |
| On the internet | 7 | 5.7 |
| From friends | 2 | 1.6 |
| In this questionnaire | 2 | 1.6 |
| What are the mostly planted Products within the Scope of GMO? | | |
| Soya-Corn-Cotton | 69 | 56.6 |
| Tomato-Pepper- Zucchini | 30 | 24.6 |
| Mango-Kiwi-Papaya | 2 | 1.6 |
| Mango-Kiwi-Papaya | 2 | 1.6 |
| All | 19 | 15.6 |
| In Which Country is the Most GMO Production realized? | | |
| USA | 91 | 74.6 |
| India | 3 | 2.5 |
| Brazil | 3 | 2.5 |
| China | 15 | 12.3 |
| Turkey | 10 | 7.4 |
| Which one of the followings does not represent the objectives of production of genetically modified organisms? | | |
| Increasing food quality and its benefits for health | 23 | 18.9 |
| Increasing shelf life of fruits and vegetables and their organoleptic quality | 31 | 25.4 |
| Increasing productivity of herbal and animal products | 25 | 20.5 |
| Production of edible vaccine and medicine | 12 | 9.8 |
| Ensuring genetic mutations in living creatures that consume | 31 | 25.4 |
| New gene used in GMO may cause allergic reactions and toxic effects for consuming individuals. | | |
| True | 101 | 82.8 |
| False | 21 | 17.2 |
| Although planting genetically modified plants may reduce usage of pesticides in the near future, it may cause emergence of resistant weed and insects in the long term. | | |
| True | 100 | 82.0 |
| False | 22 | 18.0 |
| Lack of labeling in products with GMO for distinguishing may cause breach of consumer rights. | | |
| True | 111 | 91.0 |
| False | 11 | 9.0 |
| Score of giving correct answers to the Information on Genetically Modified Organisms (GMOs) (mean ±SD) | | |
| | 4.9 ±1.2 | |

The time most of the students (46.7%) spent sitting at a desk was 3-5 hours.

Table 3 shows distribution of answers of the students to

questions on GMO. It was observed that majority of the students (86.9%) had knowledge about GMO and obtained this information usually (54.9%) from television and radio. It was found that answers of students to the information on GMO were usually correct and their knowledge score on GMO was 4.9 ±1.2 out of 7.

| Table 4. Knowledge, attitudes, and behaviors of the students concerning genetically modified organisms | | | |
|---|---------------|----------------------|------------------|
| Statements about GMO | I agree n (%) | I am undecided n (%) | I disagree n (%) |
| I approve production with genetically modified seeds in Turkey. | 40 (33.1) | 33 (27.3) | 48 (39.7) |
| Currently I think that there may be genetically modified products in the foods I buy. | 96 (79.3) | 9 (7.4) | 16 (13.2) |
| I think that the community is informed sufficiently about genetically modified products. | 27 (22.3) | 17 (14.0) | 77 (63.6) |
| Production of genetically modified foods is risky for all living creatures in the nature. | 64 (52.9) | 23 (19.0) | 34 (28.1) |
| I approve modification of genetics of foods in order to remedy hunger in the world. | 38 (31.4) | 33 (27.3) | 50 (41.3) |
| I approve modification of genetics of foods in order to enrich their ingredients. | 35 (28.9) | 27 (22.3) | 59 (48.8) |
| I approve modification of genetics of foods in order to extend their shelf lives and to get products that are more resistant to pesticides and insects. | 56 (46.3) | 30 (24.8) | 35 (28.9) |
| I think that it should be definitely stated on the labels of foods if they are genetically modified or not. | 87 (71.9) | 14 (11.6) | 20 (16.5) |
| I do not hesitate to consume a genetically modified food. | 29 (24.0) | 33 (27.3) | 59 (48.8) |
| I think that I have sufficient knowledge on genetically modified foods. | 30 (24.8) | 47 (38.8) | 44 (36.4) |
| As a candidate of agricultural engineer I support production of genetically modified foods. | 31 (25.6) | 29 (24.0) | 61 (50.4) |

Table 4 shows distribution of status of agreement of the students with the statements regarding GMO. Accordingly, 39.7% of the students disapproved making production with genetically modified seeds in Turkey, 79.3 % considered that there may be genetically modified products in the foods they bought, and 63.6% did not think that the community was informed about GMO sufficiently. The rate of the students who found the production of genetically modified foods risky for all living creatures existing in the nature was 52.9% and 41.3% disapproved modifying genetics of foods to remedy hunger in the world. While 48.8% of the students disapproved modification of genetics of foods in order to enrich ingredients thereof, 46.3% approved modification of genetics to extend shelf life. 71.9% of the students stated that they thought it should be definitely stated on the labels of foods whether

it is a genetically modified food or not. Furthermore, 48.8% of the students also stated that they would hesitate when consuming a genetically modified product. Most of the students (38.8%) were undecided about whether or not they had a sufficient level of knowledge on genetically modified foods, 50.4% stated that they, as an agricultural engineer candidates, did not support production of genetically modified foods.

Table 5. Comparison of attitudes and behaviors of the students towards genetically modified organisms with their classes

| Statements about GMO | Classes | | | | P value |
|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|---------|
| | 1 st Class n (%) | 2 nd Class n (%) | 3 rd Class n (%) | 4 th Class n (%) | |
| I approve production with genetically modified seeds in Turkey. | | | | | |
| I agree | 2 (5.0) | 6 (15.0) | 26 (65.0) | 6 (15.0) | 0.434 |
| I am undecided | 1 (3.0) | 5 (15.2) | 17 (51.5) | 10 (30.3) | |
| I disagree | 4 (8.3) | 11 (22.9) | 21 (43.8) | 12 (25.0) | |
| Currently I think that there may be genetically modified products in the foods I buy. | | | | | |
| I agree | 6 (6.3) | 15 (15.6) | 51 (53.1) | 24 (25.0) | 0.185 |
| I am undecided | 1 (11.1) | 2 (22.2) | 6 (66.7) | 0 (0.0) | |
| I disagree | 0 (0.0) | 5 (31.3) | 7 (43.8) | 4 (25.0) | |
| I think that the community is informed sufficiently about genetically modified products. | | | | | |
| I agree | 1 (3.7) | 3 (11.1) | 16 (59.3) | 7 (25.9) | 0.228 |
| I am undecided | 2 (11.8) | 2 (11.8) | 12 (70.6) | 1 (5.9) | |
| I disagree | 4 (5.2) | 17 (22.1) | 36 (46.8) | 20 (26.0) | |
| Production of genetically modified foods is risky for all living creatures in the nature. | | | | | |
| I agree | 5 (7.8) | 12 (18.8) | 34 (53.1) | 13 (20.3) | 0.181 |
| I am undecided | 0 (0.0) | 3 (13.0) | 10 (43.5) | 10 (43.5) | |
| I disagree | 2 (5.9) | 7 (20.6) | 20 (58.8) | 5 (14.7) | |
| I approve modification of genetics of foods in order to remedy hunger in the world. | | | | | |
| I agree | 2 (5.3) | 3 (7.9) | 23 (60.5) | 10 (26.3) | 0.018* |
| I am undecided | 0 (0.0) | 4 (12.1) | 19 (57.6) | 10 (30.3) | |
| I disagree | 5 (10.0) | 15 (30.0) | 22 (44.0) | 8 (16.0) | |
| I approve modification of genetics of foods in order to enrich their ingredients. | | | | | |
| I agree | 1 (2.9) | 7 (20.0) | 21 (60.0) | 6 (17.1) | 0.631 |
| I am undecided | 1 (3.7) | 3 (11.1) | 15 (55.6) | 8 (29.6) | |
| I disagree | 5 (8.5) | 12 (20.3) | 28 (47.5) | 14 (23.7) | |
| I approve modification of genetics of foods in order to extend their shelf lives and to get products that are more resistant to pesticides and insects. | | | | | |
| I agree | 1 (1.8) | 11 (19.6) | 31 (55.4) | 13 (23.2) | 0.015* |
| I am undecided | 3 (10.0) | 1 (3.3) | 21 (70.0) | 5 (16.7) | |
| I disagree | 3 (8.6) | 10 (28.6) | 12 (34.3) | 10 (28.6) | |
| I think that it should be definitely stated on the labels of foods if they are genetically modified or not. | | | | | |
| I agree | 4 (4.6) | 14 (16.1) | 51 (58.6) | 18 (20.7) | 0.455 |
| I am undecided | 2 (14.3) | 3 (21.4) | 6 (42.9) | 3 (21.4) | |
| I disagree | 1 (5.0) | 5 (25.0) | 7 (35.0) | 7 (35.0) | |
| I do not hesitate to consume a genetically modified food. | | | | | |
| I agree | 1 (3.4) | 6 (20.7) | 16 (55.2) | 6 (20.7) | 0.934 |
| I am undecided | 2 (6.1) | 4 (12.1) | 19 (57.6) | 8 (24.2) | |
| I disagree | 4 (6.8) | 12 (20.3) | 29 (49.2) | 14 (23.7) | |
| I think that I have sufficient knowledge on genetically modified foods. | | | | | |
| I agree | 0 (0.0) | 8 (26.7) | 17 (56.7) | 5 (16.7) | 0.016* |
| I am undecided | 1 (2.1) | 4 (8.5) | 28 (59.6) | 14 (29.8) | |
| I disagree | 6 (13.6) | 10 (22.7) | 19 (43.2) | 9 (20.5) | |
| As a candidate of agricultural engineer I support production of genetically modified foods. | | | | | |
| I agree | 2 (6.5) | 2 (6.5) | 21 (67.7) | 6 (19.4) | 0.214 |
| I am undecided | 1 (3.4) | 4 (13.8) | 16 (55.2) | 8 (27.6) | |
| I disagree | 4 (6.6) | 16 (26.2) | 27 (44.3) | 14 (23.0) | |

*Chi-square test was used. *P<0.05

When comparison of attitudes and behaviors of the students towards GMO with their years was examined, a statistically significant difference ($p < 0.05$; Table 5) was found between the years concerning distribution of answers of the students to propositions of 'I approve modification of genetics of foods in order to remedy hunger in the world', 'I approve modification of genetics of foods in order to extend their shelf lives and to get products that are more resistant to pesticides and insects' and 'I think that I have sufficient knowledge on genetically modified foods'.

DISCUSSION

In the study, the students who were studying at Bingöl University Faculty of Agriculture and participated in the study voluntarily were asked questions regarding GMO. It was found that a majority of the students (86.9%) had knowledge about GMO; answers of the students to information on GMO were usually correct and their score of knowledge on GMO was 4.9 ± 1.2 out of 7. It was also determined that the students obtained such information generally (54.9%) through television and radio. Similar to results of this study, in other related studies, Koçak et al, found in 2010 that 71.9% of Medical students thought that the community did not have sufficient knowledge on GMO and 67.8% heard about the term GMO firstly on radio/television (8). In another study, the participants were asked if they had knowledge about GMO and 97.5% of the participants stated to have information (9). In the study by Tekedere et al., on the other hand, it was found that 64.0% of the students did not have sufficient knowledge on GMO and 63.1% heard about the term GMO firstly on radio and television (10).

As a result of developments in genetics and molecular biology in recent years, genetically modified organisms, in short GMOs, have become an issue involving the overall community and subject of many discussions (11). In the studies, viewpoints of the consumers on the subject have been emphasized. Kaya et al., (12) who analyzed the viewpoints of the consumers living in cities on GMO across Turkey, found in their study that 42.7% of the participants thought all foodstuffs offered to their consumption could be including GMO and they did not want to consume these products (83.6%), and obesity was the main reason for this (69.1%). In their review article, by Ergin et al (13) compared results of studies conducted inside the country and abroad and stated that consumers did not know products with GMO much, they were substantially concerned about products with GMO that are obtained as a result of genetic modification and they showed negative attitude towards such products. Similarly in this study, in analysis of attitudes and behaviors of students of Faculty of Agriculture towards GMO, it was found that 79.3% of the students thought that there could be genetically modified products in the foods they bought, 39.7% disapproved production with seeds with GMO in Turkey, and 63.6% thought that the community was not given sufficient

information about GMO.

The rate of the students who thought that production of genetically modified foods pose risk for all living creatures in the nature was found to be 52.9%. While 41.3% of the students disapproved modification of genetics of foods for remedying hunger in the world and 48.8% disapproved the same for enriching ingredients of foods, 46.3% approved modification of genetics for extending shelf life. In a study conducted with university students, similarly, it was stated that most of the students thought that production of GMO was risky for all living creatures in the nature and they mostly disapproved modification of genetics of foods for resolving hunger, food enrichment or extension of shelf life (8,13). In their review article Celik and Turgut (14) stated that those supporting GMO were of the opinion that this technology would provide many benefits in increasing food quality and health benefits thereof, improving particularly shelf lives and organoleptic quality of fruits and vegetables, increasing productivity of herbal and animal products, production of edible vaccine and medicine and treatment of illnesses; on the other hand, those criticizing foods with GMO think that there would be change in food quality, labeling of products with GMO would not be exact, there may be important risks regarding food safety, allergic reactions and their toxic effects and there are/would be environmental concerns together with problems in various groups regards religious, cultural and ethical dimensions.

In this study, 71.9% of the students stated that it should absolutely be mentioned on the labels of foods whether they contained genetically modified foods and 48.8% stated that they would hesitate when consuming products with GMO. Similar results were reached in previous studies (8,9,13). In addition, it was found in the study that the students were mostly undecided about whether they had enough knowledge on genetically modified foods and 50.4% did not support production of genetically modified foods as candidates of agricultural engineers. When examining the comparison of attitudes and behaviors of students towards GMO with their years, a statistically significant difference was found between the years in terms of distribution of answers of the students to propositions of 'I approve modification of genetics of foods in order to remedy hunger in the world', 'I approve modification of genetics of foods in order to extend their shelf lives and to get products that are more resistant to pesticides and insects' and 'I think that I have sufficient knowledge on genetically modified foods' ($p < 0.05$). In a study in which views of different segments of the society on GMO were analyzed, it was found that the more the level of knowledge the more positive the perspective to GMO; the older the people the higher the rate of reading labels of products and also that women had a more suspicious approach to foods with GMO compared to men and in general, the reaction to modification of genetics of animals was stronger compared to that of plants (15).

Knowledge and risk perception of the community regarding GMO is changing. This has been a study which provides information about future viewpoints on GMO of

Agricultural Engineer candidates, a group in touch with genetically modified organisms. It was observed that the students had knowledge about the subject but they did not deem themselves to have sufficient knowledge hereof. It is considered that training activities that appease information starvation of students for information should be supported and the subject should be included in the education and training curriculum in a more comprehensive way. Although there are legal regulations on GMO in Turkey, it is observed that students have gained a perception, without being noticed, that products with GMO are added to foods and they consume such foods. Therefore, legal regulations on the subject should be monitored by relevant legal authorities in an effective and regular manner and the public should be relieved on this subject. In order to raise awareness of the community for consuming healthy and safe food, it is thought to be useful to organize activities concerning food safety and healthy nutrition under the leadership of healthcare professionals and experts and to deliver trainings and seminars.

CONCLUSION

As is seen in the study, since the subject is firstly learned through media organs such as television and radio, information pollution in media organs should be avoided, legal regulations and measures should be ensured for presentation of reliable and correct information about GMO. In this way, it would be possible to clear the doubts of the community about foods with GMO and to raise awareness.

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Ethical approval: The study was performed in accordance with the principles of Declaration of Helsinki. The ethical approvals were taken from Bingöl University Scientific Research Publications Ethics Committee(02.11.2015/ 14668).

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