Full Length Research Paper

An assessment of Turkish secondary school students' attitudes towards biotechnology in the perspective of genetically modified foods

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Modern biotechnology and genetically modified (GM) foods have aroused growing interest in the public and education sector throughout the world because the public perception of biotechnology and genetically modified foods are at the center of controversy. People's and students' attitudes towards biotechnological issues are the object of many quantitative and qualitative studies. At present, there is a need to assess Turkish students' attitudes towards biotechnology and genetically modified foods. This study aimed to explore these attitudes in secondary education. For this purpose, 916 senior year high school students within eight different provinces of Turkey were surveyed. Students were given seven statements to assess their opinions by choosing an agreement level about genetically modified foods and the development of biotechnology. Then, comparisons were made based on gender and study areas. The results suggested that more than half of the students supported the biotechnological studies being done throughout the world, but they want these studies to be tightly supervised. Additionally, 80% of them thought that GMOs may harm human health. The study also revealed that, the attitudes of boys and social sciences students were more positive than the other students, and science students supported the biotechnological studies more than the students studying in other areas.

Key words: Biotechnology, genetically modified (GM) foods, secondary schools, Turkey.

INTRODUCTION

The issue of people's attitudes towards modern genetics and biotechnology is arousing growing interest in many countries and is the object of many quantitative and qualitative studies (Massarani and Moreira, 2005). Studies have been carried out in many countries, including Australia, the United States, Brazil, Britain, the Netherlands and Slovakia. These studies investigated the knowledge level and perceptions of the public and students about biotechnological issues (Dawson and Schibeci, 2003a, b; Gunter et al., 1988; Hill et al., 1999; Massarani and Moreira, 2005; Klop and Severiens, 2007; Prokop et al., 2007; Moerbeek and Casimir, 2005).

Analogous studies have also been conducted in Turkey for the same purposes (Özdemir, 2005; Özel et al., 2009; Sürmeli and Şahin, 2010; Darçin and Turkmen, 2006;

Çelik and Erişen, 2010). However, the assessment of students' attitudes towards biotechnology regarding genetically modified foods by comparing the gender and study area of the students was an important research gap in the field. Therefore, the main motive behind this study was to investigate the students' attitudes focusing on gender and study area differences.

Many studies have been conducted to examine the perceptions and attitudes of the public towards biotechnology and genetically modified foods (GM foods) in different countries over the last 15 years. The results of these studies revealed that the perception and attitudes of the public to GM foods differs not only from country to country, but also from time to time even within the same country (Demirci, 2008). However, few studies have examined the attitudes of secondary school students towards biotechnology and GM foods. Moreover, most of these studies have focused on students' knowledge and understanding of biotechnology rather than on their attitudes.

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One study from a large sample (15 to 16 years old; 1,116 students) of students surveyed in Western Australia was performed to determine their understanding of recent advances in modern biotechnology. The results indicated that most students had little or no scientific understanding of biotechnology, genetic engineering, cloning or GM foods (Dawson and Schibeci, 2003a). In an extension of their examination of this understanding, students were surveyed on their attitudes towards a range of biotechnology processes. The results showed that the students held a wide range of beliefs about what is an acceptable use of biotechnology. Most students (>90%) approved the use of microorganisms for specific biotechnology processes. However, the support decreased from microorganisms to plants (71 to 82%), humans (42 to 45%) and animals (34 to 40%) (Dawson and Schibeci, 2003b).

Gunter et al. (1988) examined the understanding of teenagers and their opinions on biotechnology regarding food production in Britain. The results showed that teenagers considered genetic engineering of plants to be more acceptable than genetic engineering of food crops and animals. Similar results were found in a study conducted by Hill et al. (1999). They examined the attitudes of students (11 to 18 years old, 778 students) towards using engineered animals in medical research; 42% of the students felt it should not be allowed. In Brazil, Massarani and Moreira (2005) investigated the attitudes of high school students (n = 610) towards genetics. They observed that most of the students thought that transgenic food could be useful but that it also involves risks. Until the risks are better understood, they would prefer not to grow transgenic crops at all. Additionally, Klop and Severiens (2007) examined the attitudes of secondary school students (n = 574) towards biotechnology in the Netherlands. The results indicated that, out of all the students, 22% were confident supporters, 42% were not sure and 60% were not sure and concerned skeptics.

In a study conducted in Slovakia, the knowledge and attitudes of university students (n = 378) toward biotechnology were examined. It was revealed that Slovakian students had poor knowledge and numerous misunderstandings about biotechnology. Females showed poorer knowledge and lower acceptance of genetically engineered products than did males (Prokop et al., 2007). Another two studies showing a gender difference in the acceptance of genetically modified foods were conducted in the Netherlands (Moerbeek and Casimir, 2005) and the United States (Qin and Brown, 2007). These studies both showed that girls had fewer acceptances for genetically engineered products than boys.

In Turkey, little has been done to analyze students' attitudes towards genetics and biotechnology. One of the rare relevant studies was conducted by Özdemir (2005) to determine the misconceptions of primary school students regarding genetics and biotechnology. The results revealed that the students had little scientific understanding of biotechnology. As for high school students, Özel et al. (2009) conducted a study to determine the knowledge and perceptions of high school students (n = 352) about biotechnology. The study revealed that girls had fewer acceptances of biotechnological issues than boys, which is similar to the studies from Slovakia, the Netherlands and the United States.

Besides these, two important studies were conducted in the universities. In one study, 222 university students were surveyed in Turkey to determine their understanding of biotechnology. The results showed that the students had a very low level of understanding of biotechnology and they considered the use of microorganisms to be more acceptable than genetic engineering of foods and animals. Although, the students accepted genetic engineering for the production of medicine, they did not want it for food production (Sürmeli and Şahin, 2010). Another study conducted by Darçin and Türkmen (2006) revealed that science students (n = 194) had inadequate knowledge of biotechnological issues. Moreover, Çelik and Erişen (2010) assessed the biotechnology program that is being taught in biology courses in Turkey. By taking the opinions of the teachers, the study revealed that the program had some deficiencies and needed to be further developed.

METHODOLOGY

The main aim of this study was to explore the Turkish secondary school students' attitudes towards biotechnology from an agricultural perspective, in detail. For this purpose, a questionnaire was designed that measured the students' level of agreement in answering two specific research questions:

(1) What are students' opinions on biotechnology regarding GMOs?
(2) How do they assess biotechnological research in terms of support and supervision?

The main data collection tool was an assessment questionnaire. Based on the research questions of the study, 13-item questionnaires were prepared in two sections as follows:

(1) Demographic questions: This section included questions on gender and study area of the students (after finishing the 9th grade, all students must choose an area of study, including Turkish language-mathematics, science and social sciences).
(2) Statements: In this section, students were given seven statements about biotechnology, focusing on GMOs and the development of biotechnology. They were asked to assess their opinions based on a five-point Likert scale: 1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree.

The questionnaires were distributed to 916 senior year high school students within eight different provinces of Turkey. Nearly 80% of the respondents were from Istanbul, but others were from different regions of Turkey including east, west and south (the provinces of Erzurum, Adana, Antalya, İzmir, Aydın, Manisa and Bursa).

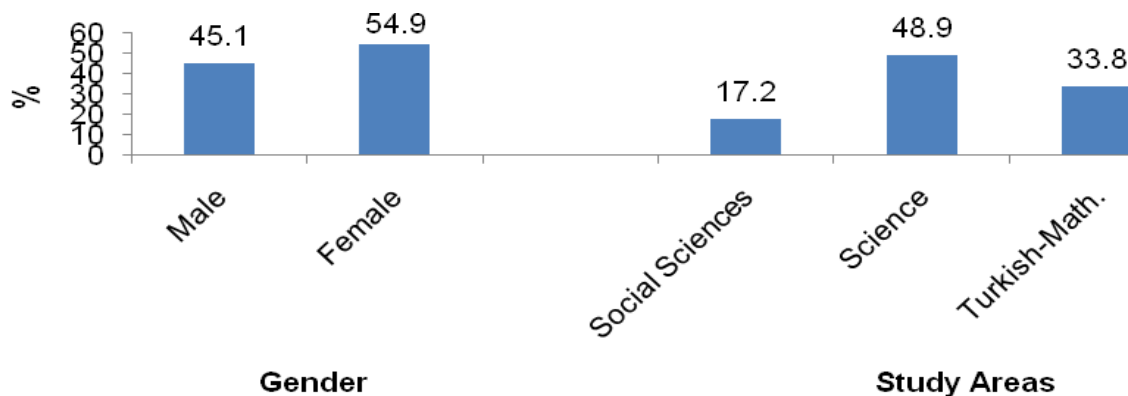The relationships between the demographic characteristics and

Figure 1. Distribution of respondents by gender and study areas.

answers of the students given to the statements were investigated in the study. The reliability coefficient was 64% based on the factor reliability analysis of dependent variables (Cronbach's alpha = 0.64). In this study, descriptive statistics were used for the demographic data, and nonparametric tests were used, including Mann-Whitney U and Kruskal-Wallis H, for the inferential statistics, as the data collected did not have a normal distributed interval variable ($p < 0.005$) based on the one-sample Kolmogorov-Smirnov Z test. Throughout the study, p values less than 0.05 were considered as significant level.

FINDINGS

According to demographic analysis of the respondents, out of 916 students, 54.9% were female (n = 503) and 45.1% were male (n = 413). Analysis of the students' study areas revealed that 33.8% of the students were studying Turkish language-mathematics (n = 310), 48.9% were studying science (n = 448) and the remaining 17.2% were studying social sciences (n = 158) (Figure 1).

In the survey, students were given seven statements to assess their opinions by choosing an agreement level about genetically modified foods and the development of biotechnology. According to the descriptive analysis of the answers given to the statements, the mean score for all statements was 3.07 out of 5, which corresponded to "neutral". The agreement level was highest on the seventh statement: "biotechnological studies should be tightly supervised throughout the world", with a score of 4.19. This was followed by the statement: "GMOs may be harmful to human health", with a score of 4.16 and the statement: "more funds should be given to biotechnological studies to support studies throughout the world", with a score of 3.56. However, the mean score levels for the statements 1 (high nutritious and quality improved agricultural foods should be grown by modifying the genetics of seeds), 2 (I consume agricultural foods (wheat and tomatoes) produced by modifying the genetics of seeds), 4 (highly productive and quality improved animal breeds should be grown by modifying

the genetics of their breeds) and 5 (I consume the meat of animals produced by modifying their genetics) were relatively low (Figure 2).

The results of the statements section, which was concerned with GMOs and biotechnological studies, revealed that 78.4% of the students agreed or strongly agreed that "GMOs may be harmful to human health". Of all the students, 30.6% thought that "genetically modified agricultural foods should be grown", 31.3% of them agreed or strongly agreed with the statement that "I consume agricultural foods (wheat and tomatoes) produced by modifying the genetics of seeds". On the statements about animals, the rates of agree and strongly agree were relatively low, as only 16.8% of the students wanted animal breeds to be genetically modified and 12.5% agreed or strongly agreed with the statement that "I consume the meat of animals produced by modifying their genetics". The statement that supported biotechnological studies was quite encouraging; 54% of the respondents agreed or strongly agreed that "more funds should be given to biotechnological studies to support studies throughout the world". However, 77.8% of the students wanted these studies to be supervised (Figure 3).

To determine whether boys and girls differed significantly in their agreement levels about biotechnological issues, Mann-Whitney U tests were performed. This was an appropriate procedure because the dependent variables were ordinal and variances were unequal. The p values refer to the statistically significant differences in the mean ranks of boys and girls on the first, second, third and fifth statements ($p < 0.05$). A greater difference was seen on the third statement. The 499 female students had a significantly higher mean (482.10) than the 411 male students (423.20) on the third statement ($p = 0.000$, $r = -0.12$). On the contrary, the male students had a significantly higher mean (489.14) than the female students (431.53) on the first statement ($p = 0.001$, $r = 0.001$). Moreover, male students had significantly higher means (479.31 and 475.64) than the
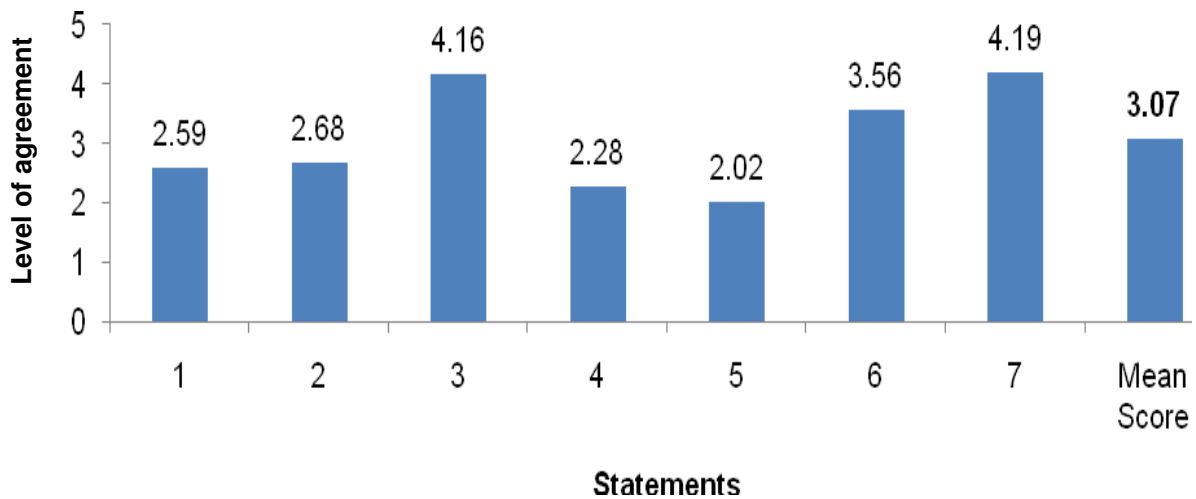
Figure 2. Students' agreement levels in biotechnological statements. The mean score of 3.07 out of 5 corresponds to "neutral".

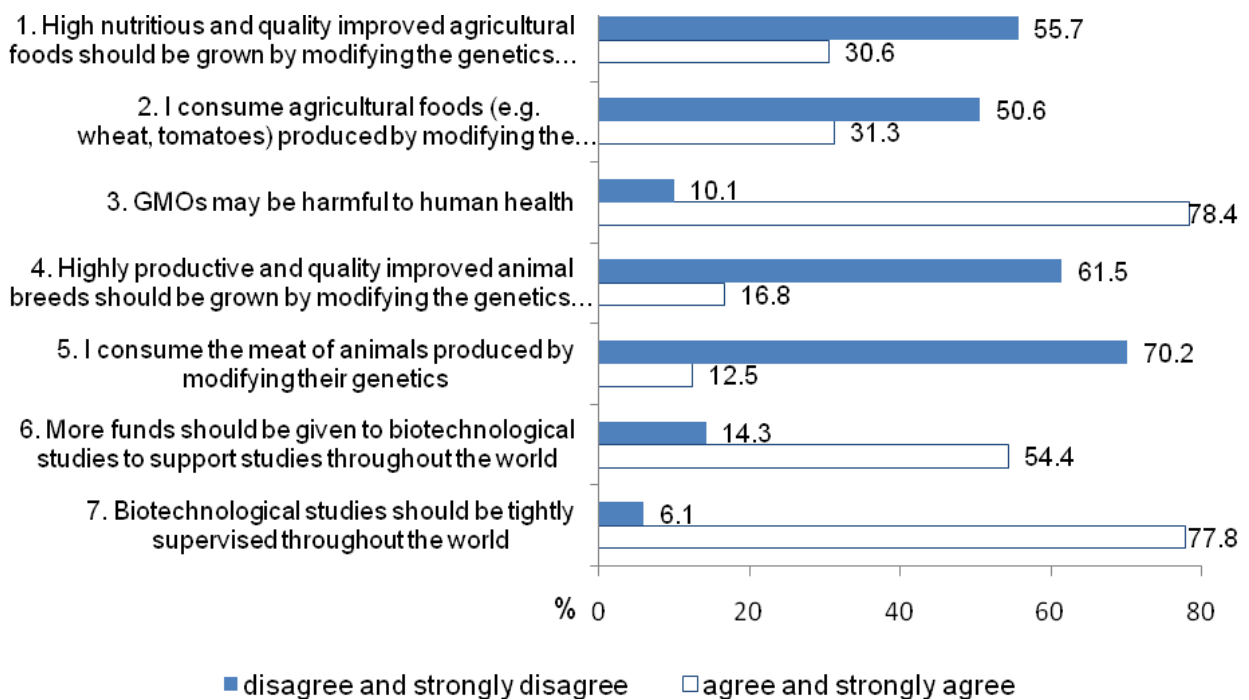■disagree and strongly disagree □agree and strongly agree

Figure 3. Agreement levels of students about statements.

female students (432.16 and 437.17) both on the fifth and second statements, respectively. However, male and female students did not differ on the other statements (p > 0.05). Moreover, according to Cohen (1988), the r-value (r = z / √n) indicated that the effect size was low in all statements (Table 1).

A Kruskal-Wallis analysis of variance indicated that there was a statistically significant difference among the three study areas (Turkish language-mathematics, science and social sciences) of the students with respect to students' agreement levels on the second, third, fifth and sixth statements due to the fact that the p value was smaller than 0.05 (Table 2). The differences were highest on the third and sixth statements, with the p values of 0.012 and 0.018, respectively. These were followed by the second (P = 0.030) and fifth statements (P = 0.044).

Table 1. Mann-Whitney U test results for male and female students' level of agreements.

Statement*	Gender	Number	Mean rank	Sum of ranks	U	Z	p	r
1	Male	12	489.14	201524.50	90377.500	3.376	0.001	0.11
	Female	02	431.53	216630.50				
2	Male	09	475.64	194537.50	93398.500	2.253	0.024	0.07
	Female	99	437.17	218148.50				
3	Male	11	423.20	173937.00	89271.000	3.675	0.000	0.12
	Female	99	482.10	240568.00				
5	Male	10	479.31	196517.50	91097.500	2.867	0.004	0.09
	Female	96	432.16	214353.50				

*See Figure 3 for statements.

Table 2. Kruskal-Wallis test results for level of agreement on statements based on study area.

Statement*	Study area	Number	Mean rank	Df	X^2	p
2	Social sciences	155	502.65			
	Science	444	439.65	2	7.017	0.030
	Turkish-mathematics	309	451.69			
3	Social sciences	155	411.94			
	Science	446	452.26	2	8.913	0.012
	Turkish-mathematics	309	482.02			
5	Social sciences	153	498.30			
	Science	444	441.39	2	6.249	0.044
	Turkish-mathematics	309	448.72			
6	Social sciences	155	449.19			
	Science	444	477.82	2	8.017	0.018
	Turkish- mathematics	310	425.22			

*See Figure 3 for statements.

To find which of the pairs of study area means were different on the second, third, fifth and sixth statements, post hoc Mann-Whitney tests were used to compare students' study areas on their agreement levels in order to indicate statistical difference. The outcomes suggested that there was a significant difference on statement 2 between students in social sciences (330.86, n = 155) and those in science (289.23, n = 444; Z = -2.642, p = 0.008). There was also a significant difference on statement 3 between students in social sciences (208.75, n = 155) and those in Turkish language-mathematics (244.41, n = 309; Z = -2.960, p = 0.003). Moreover, there was a significant difference on statement 6 between students in science (395.46, n = 444) and those in Turkish language-mathematics (351.75, n = 310; Z = -2.820, P = 0.005) (Table 3).

The mean rank of students in social sciences was higher (249.78, n = 155) for statement 2 than for those in Turkish language-mathematics (223.83, n = 309; Z = -2.013, P = 0.044). Moreover, for statement 5, the mean rank of students in social sciences was higher (326.87, n = 153) than for those in science (289.40, n = 444); Z = -2.460, P = 0.014 and the mean rank of students n social sciences was higher (248.43, n = 153) than those in Turkish language-mathematics (223.11, n = 309; Z = -2.025, P = 0.043). However, there were no differences found among the other groups on the statements.

DISCUSSION

Our survey of secondary school students' attitudes towards biotechnology from an agricultural perspective revealed that students had negative attitudes towards genetically modified foods. Only one third of the students wanted genetically modified agricultural products in their

Table 3. Post hoc Mann-Whitney U test results when comparing the three student study areas on statements 2, 3, 5 and 6.

Statement*	Study area	Number	Mean rank	U	Z	p
2	Social sciences	155	330.86	29626.500	-2.642	0.008
	Science	444	289.23			
	Social sciences	155	249.78	21268.500	-2.013	0.044
	Turkish-math.	309	223.83			
	Science	444	372.92	66786.000	-0.633	0.527
	Turkish-mathematics	309	382.86			
3	Social sciences	155	281.19	31494.500	-1.782	0.075
	Science	446	307.88			
	Social sciences	155	208.75	20266.500	-2.960	0.003
	Turkish-math.	309	244.41			
	Science	446	367.88	64393.500	-1.686	0.092
	Turkish-mathematics	309	392.61			
5	Social sciences	153	326.87	29702.000	-2.460	0.014
	Science	444	289.40			
	Social sciences	153	248.43	21047.500	-2.025	0.043
	Turkish-math.	309	223.11			
	Science	444	374.49	67483.500	-0.405	0.685
	Turkish-mathematics	309	380.61			
6	Social sciences	155	286.09	32254.000	-1.210	0.226
	Science	444	304.86			
	Social sciences	155	241.10	22769.000	-0.953	0.340
	Turkish-math.	310	228.95			
	Science	444	395.46	60845.000	-2.820	0.005
	Turkish-mathematics	310	351.75			

*See Figure 3 for statements.

life. Interestingly, for genetically modified animals, these rates fell below 20%. The results showed that majority of students thought that genetically modified foods were not necessary for life and did not want to consume genetically modified foods. Moreover, three students out of four thought that genetically modified foods may be harmful to human health. An encouraging finding of this study was that almost 55% of the students who were surveyed thought that biotechnological studies should be supported throughout the world, but the majority of them wanted the studies to be tightly supervised.

In addition to the results from the responses of the students, inferential statistics indicated that male students differed significantly from female students on the first, second, third and fifth statements. According to the statistics, male students had more positive attitudes than the female students towards genetically modified foods. Also, female students believed in the harms of GMOs more than male students. The mean ranks for males and females on each statement clearly showed higher negative attitudes of the females. Moreover, there was no statistical difference between boys and girls on the statements about supporting and supervising biotechnological studies.

Other analysis showed that there were statistically significant differences among students by study areas with regard to statements 2, 3, 5 and 6. Students in social sciences agreed with statement 2 ["I consume agricultural foods (wheat and tomatoes) produced by modifying the genetics of seeds"] and 5 ("I consume the meat of animals produced by modifying their genetics") more than those in other study areas. On both statements, the largest difference was between students in social sciences and students in sciences. However, there was no significant difference between students in science and Turkish language-mathematics on the same statements.

As for the third statement, students who believed in the probable harms of the GMOs more than others were the students in Turkish language-mathematics. The largest difference was between students in Turkish language-mathematics and students in social sciences.

Interestingly, our study revealed that students in science

agreed with supporting biotechnological studies more than those students in other study areas. The largest difference was between them and students in Turkish language-mathematics.

Conclusion

In conclusion, the following remarks can be underlined. More than half of the students surveyed in this study supported the biotechnological studies being done throughout the world, but they wanted these studies to be tightly supervised. The students also had significant negative attitudes towards genetically modified foods, and nearly 80% of them thought that GMOs maybe harmful to human health.

More specifically, boys and girls did not differ in supporting and supervising studies. However, boys' attitudes were more positive than girls' attitudes regarding genetically modified foods, which is similar to the findings of previous international studies. The results also revealed that, although students in sciences wanted studies to be supported more than the others, students in social sciences had more positive attitudes towards genetically modified foods as compared to students in other study areas.

Finally, some key steps taken by authorized institutions can help students to fully understand whether biotechnological studies focusing on genetically modified foods are harmful or not to human health. Organizing the related subjects in curriculums according to research findings may remove doubts from the students' minds and encourage the development of biotechnological studies.

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