Awareness and Knowledge Levels Regarding Genetically Modified Organisms Among Students of Çukurova Unıversıty Imamoğlu Vocational School

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Abstract. This cross-sectional study aimed to assess knowledge levels, attitudes, and consumption behaviors regarding genetically modified organisms (GMOs) among students of Çukurova University İmamoğlu Vocational School. Data were collected in May–June 2025 using a structured 21-item questionnaire administered online to 211 students. The survey comprised three sections covering sociodemographic characteristics, knowledge about GMOs, and attitude items. Data were summarized with percentage and frequency distributions. The findings indicate that while many students had heard the term "GMO," they lacked detailed knowledge; moreover, the vast majority favored mandatory labeling of GMO-containing products, viewing it as a matter of consumer rights. Concerns about potential health and environmental impacts were prominent. The predominance of social media and other online platforms as information sources points to gaps in access to trustworthy scientific information, which may foster misconceptions about GMOs. In conclusion, the study underscores the need to strengthen GMO-related educational content at the university level and to support policies that ensure clear and visible product labeling.

Keywords: Genetically modified organisms, knowledge level, university students, GMOs, consumer attitudes, Çukurova University

1 Introduction

Following the Second World War, accelerated population growth accentuated global concerns about food security and prompted countries to seek solutions capable of rapidly increasing agricultural output. In this context, the dissemination of high-yielding varieties (HYVs) under the leadership of Dr. Norman Borlaug in Mexico during the 1940s combined with intensive irrigation, chemical fertilizers, and pesticides triggered the transformation known as the "Green Revolution," yielding striking increases in cereal yields across many countries [1,2]. By the 1970s, however, the implications of

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environmental conditions for human health became more apparent, and evidence accumulated that incorrect or excessive use of chemical inputs entailed risks for ecosystems and public health. The literature underscores that, alongside the production gains delivered by the Green Revolution, lasting adverse effects such as soil and water pollution, biodiversity loss, and groundwater depletion may occur, indicating the need to reconsider agricultural growth from the perspective of its "environmental and social costs" [3].

Against this backdrop, genetically modified organisms (GMOs) have emerged as a suite of technologies aimed at improving traits such as productivity, resistance to pests and diseases, tolerance to abiotic stresses (e.g., drought, salinity, cold), and postharvest/shelf life. Global adoption has concentrated primarily in soybean, maize, cotton, and canola, with approximately 190 million hectares planted worldwide in 2019 [4]. Recent assessments indicate that the global area increased to around 210 million hectares in the 2024 growing season [5]. By contrast, GM wheat remains limited: it was first approved in Argentina in 2020, and Brazil authorized commercial planting in 2023 [6,7]. Taken together, these patterns suggest rapid uptake of GM technologies in certain crops and geographies, while a more cautious approach persists for others.

In Turkey, the regulatory framework is shaped by the Biosafety Law No. 5977 (2010) and its secondary legislation. Commercial cultivation is prohibited, and no GMO is approved for food use. A limited number of events are permitted for feed; according to recent reports, 21 maize and 15 soybean events are authorized for feed use. In addition, a 0.9% threshold is applied for labeling and "low-level presence" practices [8,9,10]. While consistent with consumer-rights and traceability principles, this framework operates amid persistent public risk perceptions and trust debates.

GMOs are frequently covered in the Turkish media and strongly shape public perceptions. In this context, university students constitute a strategic sample, as they are both future decision-makers and a young consumer group. Students' levels of knowledge about GMOs, their information channels (academic sources, the internet, and social media), and their attitudes reflect a multidimensional risk-communication problem that intersects with ethical, environmental, and health-related arguments. This study aims, with respect to students at Çukurova University İmamoğlu Vocational School, to determine (i) their level of knowledge regarding GMOs, (ii) the sources from which they obtain this knowledge, and (iii) their attitudes toward GMOs, and to evaluate the findings within a statistical and interpretive framework. Accordingly, the study addresses the following questions: (1) What is the level of students' basic conceptual knowledge of GMOs? (2) How are the quality of information sources and perceived credibility related to attitudes? (3) What are the perceptions of labeling and consumer rights in relation to GMOs? (4) Are there significant associations between demographic characteristics (e.g., gender, age, parental education) and knowledge/attitude indicators? The findings are expected to inform the design of evidence-based communication and targeted educational interventions on GMOs.

2 Materials and Methods

This cross-sectional study was conducted between May and June 2025 among students of Çukurova University İmamoğlu Vocational School. Participants were asked to complete a Google Forms questionnaire developed by the researchers following a literature review, with the aim of assessing knowledge, attitudes, and behaviors regarding genetically modified organisms (GMOs). The instrument comprised 21 items in total: five questions on sociodemographic characteristics and 16 questions designed to elicit participants' knowledge, attitudes, and behaviors related to GMOs.

The required sample size was determined using the Raosoft Sample Size Calculator [11] assuming a 95% confidence level, a 5% margin of error, and a 50% response distribution. The population size was N=465, and the minimum required sample size was calculated as n=211. Data were collected from 211 students, fully meeting this requirement.

All data were transferred to a computer environment, and descriptive statistics were presented as frequencies and percentages.

3 Findings and Discussion

Of the total student population of 465, a subset of 211 students who adequately completed the questionnaire was included in the analysis. The majority of participants were female (75.8%), and the age distribution was heavily concentrated in the 18–24 range (89.6%). A substantial proportion reported that their families reside in provincial centers (58.1%). Parental education was predominantly in the "high school or lower" categories specifically, relatively high shares at the **primary school** and **high school** levels for mothers, and at the **high school** and **primary school** levels for fathers characterizing the sociodemographic profile of the sample. This composition warrants discussion of the potential influence of pre-university educational background and household socioeconomic indicators on perceptions of GMOs. Selected sociodemographic characteristics of the participants are presented in Table 1.

Table 1. Sociodemographic Characteristics of Participants

	n	%
Gender of Students		
Female	160	75.8
Male	50	23.7
Prefer not to say	1	0.5
Age of Students		
18–24	189	89.6
25–35	11	5.2
35 and above	11	5.2
Place of Residence of Family		
Village/Town	22	10.5
District	66	31.4
Province	122	58.1
Mother's Educational Level		
Illiterate or below	35	16.6
Primary school graduate	73	34.6
Secondary school graduate	36	17.1
High school graduate	53	25.1
College/University graduate	14	6.6
Father's Educational Level		
Illiterate or below	14	6.6
Primary school graduate	55	26.1
Secondary school graduate	52	24.6
High school graduate	69	32.7
College/University graduate	21	10

The findings on knowledge indicate that while students are familiar with the term GMO, their self-efficacy does not rise to the same level: 82.4% reported that they "know what the term GMO means," yet only 42.7% stated they "have sufficient knowledge about GMOs." Consistently, 59.2% said they "need more information" about GMO-containing products. Initial exposure to the term most commonly occurs via courses (43.8%) and the internet (33.3%). This pattern suggests that both formal (courses) and informal (internet) learning channels are influential; however, the lower self-efficacy rates may indicate that knowledge is being acquired superficially. Targeted deepening of curricular content and directing students to reliable digital resources could help close this gap. Details are provided in Table 2.

Table 2. Participants' Knowledge About Genetically Modified Organisms (GMOs)

	n	%
Do you know what the term Genetically Modified Organism (GMO) means?		
Yes	17	82.4
	3	
No	13	6.2
Not sure	24	11.4
Do you think you have sufficient knowledge about GMOs?		
Yes	90	42.7
No	66	31.3
Undecided	55	26.1
Do you think you need more information about GMO products?		
Yes	12	59.2
	5	
No	47	22.3
Undecided	39	18.5
Where did you first hear the term GMO?		
Internet	70	33.3
TV/Radio	40	19.0
Newspaper	3	1.4
Friend	5	2.4
Course/Class	92	43.8

The results on attitudes and behaviors indicate a pronounced risk perception toward GMO-containing products. While 66.8% of participants stated that they "see consumption of GMO-containing products as problematic," 73.5% reported that they "believe they consume products containing GMOs." This coexistence suggests that, despite risk perception, GMO-containing products may be viewed as invisible/inescapable in everyday consumption. A clear "attitude–behavior gap" is also observed in label-reading practices: although an overwhelming majority believe that GMO content should be indicated on food labels (97.2%), only 30.3% "always" examine labels during purchase (with 40.3% "never" examining them). This finding points to the need to strengthen label-reading skills and habits, and underscores the importance of interventions to improve the visibility/clarity of labels and enhance consumer literacy.

There is a marked information gap regarding regulations: 68.4% of participants believe that the "production, sale, and consumption of GMO-containing products in Türkiye are completely unrestricted." This misconception highlights the necessity of integrating up-to-date, reliable information on the scope of regulations and their practical implementation into course content and institution-wide awareness activities.

Perceptions of technological benefits and application areas are more nuanced. More than half of the students (52.1%) believe that GMOs can enable the production of foods

more resilient to environmental conditions; however, only 9% approve of genetic modification to increase nutrient content. This contrast reflects the tension between acceptance of technological possibilities and ethics/health-oriented concerns. Meanwhile, agreement is high with the statement that "GMO-containing foods may have a longer shelf life" (76.1%). This triad (relative acceptance for durability and shelf life; low approval for enhancing nutritional content) suggests that students' benefit perceptions are positioned more along a "logistics/shelf-life and adaptation" axis, while they remain cautious about "nutritional" interventions.

Indecision appears common on practical issues that require factual certainty: responses to "distinguishing GMO-containing products by external appearance" were split three ways (yes 32.9%; no 35.2%; don't know 31.9%); although most disagreed with the statement "GMOs are found only in imported foods" (64.3% no), the "don't know" rate was also high (31.4%). Regarding the claim that "GMOs are typically used in countries with high economic returns," nearly half were uncertain (46.4% "don't know"). These findings indicate a need for concrete, evidence-based information on product identification, supply chains, and global usage patterns.

On the societal benefit dimension, the rate of those who approve of "genetically modifying foods to combat hunger" is about half (approximately 51.7% "yes"). This suggests that, in the context of global food security, students can view GMOs as an instrumental solution; however, reservations about the risk–benefit balance have not fully dissipated. In communication strategies, presenting solution-oriented examples together with risk-mitigation mechanisms (assessment, monitoring, labeling) may help ground this ambivalent stance in a more productive discussion.

Overall, the findings reveal the coexistence of high awareness (familiarity with the term), limited self-efficacy (comprehensive knowledge), and a strong demand for information (desire for additional knowledge). Although risk perception and ethical concerns are pronounced, conditional acceptance is observed in certain benefit areas (shelf life, environmental resilience). In line with these results, (i) integrating clear, evidence-based content on regulatory and inspection processes into coursework, (ii) strengthening practical trainings aimed at improving label literacy, and (iii) curating pathways to reliable digital resources may be effective in closing students' knowledge gaps.

Table 3. Participants' knowledge, attitudes, and behaviors about genetically modified organisms

	n	%
Do you think you consume products containing GMOs?		
Yes	155	73.5
No	7	3.3

	n	%
Sometimes	49	23.2
Do you think there is any harm in consuming GMO products?		
Yes	141	66.8
No	12	5.7
Undecided	58	27.5
Do you check labels when purchasing products that may contain GMOs?		
Yes	64	30.3
No	85	40.3
Sometimes	62	29.4
Do you think GMO content should be indicated on food labels?		
Yes	205	97.2
No	6	2.8
Is the production, sale, and consumption of GMO products completely free in Türkiye?		
Yes	143	68.4
No	66	31.6
Can more environmentally resistant foods be produced through GMOs?		
Yes	110	52.1
No	37	17.5
Undecided	64	30.3
Do you think genetic modification to increase nutritional content is acceptable?		
Yes	9	9.0
No	144	68.2
Undecided	48	22.7
Do you think GMO foods have a longer shelf life than traditional ones?		
Yes	159	76.1
No	16	7.7
I don’t know	34	16.3
Can GMO-containing products be distinguished by their appearance?		
Yes	69	32.9
No	74	35.2
I don’t know	67	31.9
Are GMOs found only in imported foods?		
Yes	9	4.3
No	135	64.3

	n	%
I don't know	66	31.4
Are GMOs mostly used in economically developed countries?		
Yes	37	17.5
No	76	36.0
I don't know	98	46.4
Do you think genetic modification of foods is acceptable to fight hunger?		
Yes	37	17.7
No	108	51.7
I don't know	64	30.6

4 Conclusion

This study indicates that students are generally familiar with the concept of GMOs; however, detailed and practice-oriented knowledge is lacking. Although courses and the internet stand out as primary information sources, the accuracy and depth of content are not always sufficient.

Caution characterizes students' attitudes. While they keep a distance from GMO-containing products, they also consider encounters with such products in daily life to be unavoidable. Mandatory labeling enjoys broad support; nevertheless, the habit of routinely reading labels during purchase is not widespread. This pattern suggests a gap between affirmative responses to "what should be done" and translating those responses into everyday behavior.

Misconceptions or gaps regarding regulations are noteworthy. Students often fail to accurately recall the scope and operation of national regulations and are uncertain about how and which products are monitored.

With respect to potential benefits, there is greater openness to practical domains such as resilience and shelf life, whereas interventions aimed at enhancing nutritional content are approached more cautiously. Uncertainty also persists on practical issues, including identifying products by appearance, whether GMOs are found only in imported goods, and in which countries they are more commonly used.

Overall, while students are familiar with the concept, they need supportive instruction in practice-oriented areas such as regulatory literacy, label-reading literacy, and supply-chain/traceability awareness. Targeted short trainings enriched with concrete examples, together with guidance toward reliable information sources, can promote informed consumer behavior and strengthen scientific literacy.

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