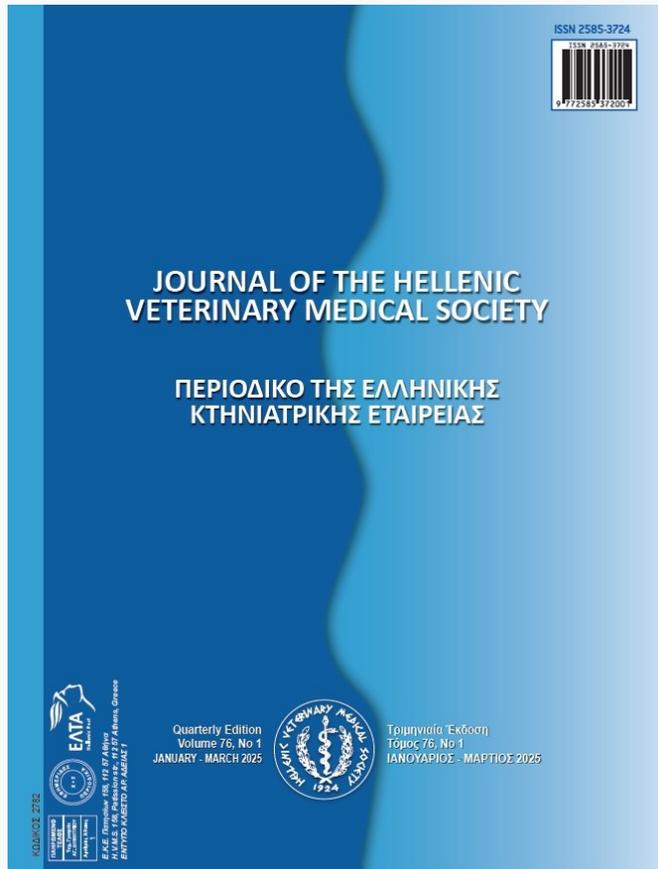


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## Using Genetically Modified Feedstocks in Broiler Diets; Risks, Perceptions and Facts

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**ABSTRACT:** Chicken meat has significantly contributed to people's access to animal protein sources in recent times. However, it fails to garner the same importance from experts in various sectors of public opinion. Therefore, the objective is to obtain expert opinions and present facts from their perspective, as opposed to consumer opinions typically collected in studies of broiler chickens that consume genetically modified feed raw materials. In some surveys, certain experts who were selected based on their fields of expertise have been found to make errors. The opinions or views of individuals lacking real knowledge on the subject can have negative impacts on both consumers and their environment, who require access to healthy sources of animal protein, as well as the industry and its employees, who rank among the top 11 worldwide.

**Key Words:** Broiler; corn; expert opinion; genetically modified raw feed material; soybean

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## INTRODUCTION

Since ancient times, animal protein has been a crucial component in human development (Kumar et al., 2023). However, the pandemic and recent global economic and military conflicts have led to a surge in demand for food, resulting in limited access (Kozielec et al., 2024; Miozzi and Powell, 2024). In recent months, a food supply crisis has made it challenging for many consumers to obtain healthy and safe food, while the quality and quantity of food have taken a backseat (Nadathur et al., 2024). However, chicken meat, which has received some criticism in our country, is the most popular meat due to its wide appeal and easy accessibility. According to 2019 data from BESDBİR, the per capita consumption of chicken in our country is around 21 kg, making it the most consumed meat (BESDBİR, 2019). Amongst animal protein sources, particularly the poultry sector in Türkiye, most of the feed is reliant on foreign production. Corn and soybean are vital components in the production of broiler feed. As per 2020 data, almost 3 million tonnes of soybean and 2.3 million tonnes of corn-based raw materials were imported to Türkiye (FAO, 2022). Despite the challenges posed by the pandemic and Türkiye's policies, which ranks among the top 11 global chicken meat producers and exports to key markets such as Iraq and Saudi Arabia, the sector achieved a record-breaking export figure of 476 thousand tons in 2020, according to Institute of Agricultural Economics and Policy Development, Türkiye (TEPGE, 2021) data. Despite the lack of permanent expertise within this significant and vital sector, the production models, adhering to global standards, have faced criticism from individuals who possess expertise in alternative fields and provide statements within the press. Criticisms and disinformation can sway consumer preferences. Currently, many consumers hold the belief that broiler chickens which have been fed a diet high in proportion to genetically modified

raw materials - such as corn and soybean - are considered genetically modified animals or that these chickens are the result of genetic differences due to the feed consumed. Numerous studies have gathered consumer perspectives on the consumption and willingness to purchase chicken meat, which accurately reflect their opinions (Karakaya and İnci, 2014; İskender et al., 2015; Tümer et al., 2016; Skunca et al., 2017; Zhang et al., 2018; Kaygisiz et al., 2019; Kop Bozbay, 2020; Escobedo del Bosque et al., 2021; Dewi et al., 2024; Kassoh et al., 2024). No improvement is needed as the text already adheres to the principles and lacks context. The current study was prepared by taking the opinions of subject experts rather than the opinions of consumers on the issues where there are critical approaches to broiler breeding fed using genetically modified feed raw materials. Because studies on the content of general chicken meat or feed raw materials used in feeding have been prepared in line with consumer behavior-opinions and demands. For this reason, the aim of our study was to determine whether experts, rather than consumers, think that chicken meat or feed raw materials that consumers are concerned about are GMO. Additionally, during the literature review, no study was found in which expert opinions were taken.

## MATERIAL AND METHODS

Consumers, can there be any changes caused and/or brought about using genetically modified feed raw materials while preparing broiler feeds? They are asking the question. General information about the experts selected because of their specialization in this problematic is related to genetics or biotechnology disciplines, is given in Table 1 below.

12 different questions were asked to the expert participants who participated in the survey, and they are given in Table 2. Using the SPSS statistical pack-

**Table 1.** Interview Group Using Genetically Modified Feed Raw Material in Ration (n:10)

Number	Area of Expertise	Worked Institution
1	Genetically Modified Organisms	University
2	Animal Nutrition	Ministry of Agriculture and Forestry
3	Forage Crops Meadow and Pasture	University
4	Farm Animal Genetics	University
5	Plant Biotechnology	University
6	Medical Biology	University
7	Medical Biology	University
8	Anesthesia and Reanimation	University
9	Medical	University
10	Poultry Breeding	Ministry of Agriculture and Forestry

**Table 2.** Question headings directed to experts.

1.	Do you find the industrial revolution and the developments in the livestock sector compatible?
2.	It is said that biotechnology is a necessity of our age. Do you find it correct?
3.	Can you mark the usage areas of biotechnology that you know?
4.	What do you think are the possible harms of genetically modified organism (GMO) technology, one of the biotechnological methods?
5.	Are genetically modified feed raw materials imported in Türkiye? (Other: If yes, please specify).
6.	Are any products used as genetically modified feed raw materials grown in Türkiye?
7.	Can you mark the products with GMOs developed by biotechnological methods in the agricultural sector, and can the products you marked be grown without GMOs?
8.	Can you mark the areas of use of GMO products you know in the food industry in order of priority?
9.	Can you mark the genetically modified feed raw materials used in animal feeds in order of priority?
10.	Can broiler feed be made without corn and soybean?
11.	Which GM feeds have the potential to disrupt the structure of proteins or GM when applied?
12.	Do you see any objections to consuming the meat of broiler chickens fed with genetically modified feeds?

age program for the quantitative evaluation of the answers, the records of the experts who completed the survey by clicking the link to participate in the survey in the e-mails sent according to the fields of expertise of the experts carried out through Google Forms were grouped and frequency of each group was calculated. Frequency, mean and standard deviation from descriptive statistics in SPSS 22 program were used to analyze the data obtained from the table. The data of the participants were described with descriptive statistics and the distribution of the group participating in the research was determined according to their responses (Büyüköztürk, 2017).

## RESULTS

Sixty percent of the participants stated that the Industrial Revolution had a positive impact on agricultural production, with particularly rapid advancements in the livestock sector. Regarding the applications of biotechnology, 90% highlighted its widespread use, especially in plant-based agriculture. When it comes to the perceived risks of genetically modified organisms (GMOs), 60% of participants cited increased allergenicity and antibiotic resistance, 50% pointed to hormonal abnormalities, 40% mentioned genetic modifications and environmental harm, 30% identified environmental pollution as a concern. When asked about Türkiye's importation of GMO-based feed raw materials, 60% confirmed that products such as corn and soy are imported. Additionally, there was a significant divergence in opinions regarding the cultivation of genetically modified feed crops in Türkiye, with 40% asserting that such crops are not grown domestically. However, 100% of participants acknowledged that corn and soy are utilized as GMO

feed crops. In terms of usage in the food industry, 50% indicated that GMO agricultural products are found in corn syrup and its derivatives, 40% identified their presence in vegetable oils and animal feeds, while 20% reported their use in the biscuit and cracker sectors. Regarding broiler feed composition, 50% of participants stated that production without corn and soy would be impossible. As for the impact of GMO feed on animal genetics, 60% of respondents argued that the genetic material does not transfer to animals. Moreover, 23.68% of participants expressed the belief that exposure to high temperatures could degrade the genetic structure of GMO feed. When it came to the consumption of meat from animals fed with genetically modified feed, 50% saw no health risks, whereas 40% felt that there was insufficient scientific research on the potential effects, citing concerns over disease transmission, hormonal influences, antibiotic resistance, allergies, and carcinogenic risks. From a consumer perception standpoint, 59% of respondents believed that GMO feed is used in livestock farming, 84% opposed its use, and 87% perceived meat from animals fed with GMO feed as harmful to human health.

## DISCUSSION

Sixty percent of the participants reported that there were improvements in all fields of activity in agricultural production with the effect of the industrial revolution and that the improvements were felt rapidly especially in the livestock sector. As a result of the reflections of the industrial revolution that took place, the number of agricultural workers working in the agricultural sector in Türkiye, especially since 2000, has led to the shift of agricultural workers to the service

sector, as the increase in industrialization in the agricultural sector has led to a decrease in the need for manpower (Görmüş, 2019). On the other hand, while the amount and quality obtained from the products produced with the effect of industrialization increased, a more profitable production was realized, and it took its share in animal husbandry. All the participants stated that technology has come to our rescue in almost every subject, especially in the age we live in, and that it is the best example of biotechnology in biological sciences (Güran, 2005). All the participants reported that biotechnology is a technology used in the production of insulin, or in the production of many health products, such as mRNA vaccines, which is a cure for the most devastating disease of recent years. 90% of it is used in herbal production, which is a part of agriculture, especially golden rice with high  $\beta$ -carotene can be given as an example, 80% in the field of fermentation technology in the pharmaceutical and pharmacy industry or in the identification of diseases (Covid-19), 70% in the identification of species (microorganisms, plant, and animal), 60% answered that it is used in bioremediation methods in environmental cleaning or in the production of salmon whose cold resistance gene is transferred in fisheries. From the first three questions, it is seen that the experts have detailed information about the science of biotechnology. Biotechnology is not only a necessity of our age, but also a product of the industrial revolution. Biotechnology: It is a science that has found serious uses in sectors such as health, agriculture, and environment, especially in the production of insulin, production of golden rice with high  $\beta$ -carotene, bioremediation environmental products, drug production in fermentation technology, identification of genetic diseases and species or product development. Possible harms of genetically modified organism (GMO) technology from biotechnological methods, 60% increase in allergenicity and 60% resistance to antibiotics, 50% hormonal anomalies (estrogen hormone increase, etc.), 40% damage to tissues, 40% genetic modifications in animal fauna, While the answers were given as 40% genetic modifications in plant flora, 30% environmental pollution, 20% changes in human gene sequence, 10% transmission or infection to people or animals, one participant said, "The above-mentioned are risks, but there is clear information about the possibility of these risks occurring. is not. There has been no negative impact on the genetically modified plants, which have been widely cultivated in the world for 23 years, so far." gave the answer. Ateş (2020) evaluated

the substances described above as possible harm of genetically modified organisms as potential risks. Unfortunately, there is no evidence about their harm and the fact that the realization of risks will differ from individual to individual. When the experts whose fields of study are genetics and biotechnology are asked whether the Republic of Türkiye imports genetically modified feed raw materials, they replied that they are soy, corn or derivative products from which 60% is imported. As it can be understood from the results, it is seen that even among the expert group, there are experts who do not have knowledge about whether genetically modified feed raw materials are imported to our country. This result does not show that you have knowledge about some specific subjects, even if you work in the field of genetics or biotechnology. In Türkiye, within the scope of the Biosafety Law enacted in 2010, transgenic corn and soybean imports are made especially for use as animal feed, with the permission of the Biosafety Board. While there are no GMO products approved for use as human food, the Biosafety Board made the necessary controls and allowed the import of 23 corn, 13 soybeans and 3 enzymes to be used only for animal feed purposes other than human food (TBBDM, 2021a). When asked whether any crops used as genetically modified feed raw material are grown in Türkiye, there is a serious difference in information among experts. While 40% of the participants answered no, 30% answered that they did not know, while the remaining 30% answered yes that soybean and corn were cultivated for research purposes. While there are no genetically modified feed raw material plants cultivated in Türkiye, their cultivation is also prohibited (TBBDM, 2021a). Many products, which are described as genetically modified feed raw materials, can be cultivated conventionally, as well as the agriculture of any plant with genetically modified feed raw material is not carried out in our country. It is thought that most consumers think that animals fed with soy and corn, which are genetically modified feed raw materials, have been genetically modified, and even some experts on this subject have made a mistake. For this reason, it was concluded that more of the public should be informed about genetically modified feed raw materials and the truth of what is known wrong should be taught. No genetically modified products or raw materials are used for food purposes in our country. Before being used as genetically modified feed raw material, especially soybean broiler feeds, it must be subjected to physical processes (heating, pressing, solvent removal, roasting, etc.) to

eliminate antinutritional factors and increase its usefulness. It is thought that the probability of being denatured may be high.

For this reason, no evidence of its effect has been found even in animals and humans consuming their products. In the regulation prepared by the Ministry of Agriculture and Forestry, there is no application requirement for research and development studies related to GMOs to be carried out in the country. However, it is obligatory to inform the Ministry about the subject and outcome of the activity to be carried out for research and development purposes. It is said that the Ministry's permission is obtained for GMOs and their products to be imported for research, development, and training purposes (OG: 13.08.2010, No.27671; OGRT, 2010). As can be understood from the above question, as the experts specialize in the subject, the number of experts who have knowledge about the subject decreases. When asked whether there are products that they know of that have been genetically modified by biotechnological methods in the agricultural sector, 100% of them are genetically modified fodder crops of corn and soybean, 80% cotton, 50% rice and sugar beet, 40% tobacco and chicken meat, a genetically modified agricultural product. declared that he saw it as a product. Hossain and Onyango (2004) reported in their study that the average consumer perception is that the animals are genetically modified rather than the feed or feed raw materials that the animals are fed with. Chern et al. (2002) reported that consumption of salmon fed with genetically modified feed from labeled products increased the purchasing preference in their study in which consumers' willingness to purchase was determined between genetically modified salmon and salmon fed with genetically modified feed. As can be understood from the studies above, it is seen that consumers have a high perception that animals are GMO, rather than whether or not feed or feed raw materials are GMO.

Fifty percent of the experts, whose opinions were taken about the usage areas of genetically modified agricultural products in the food sector, used corn syrup and its derivatives, 40% of them used corn, soy, canola etc. plant oils and animal feeds, and 20% in the biscuit and cracker sectors. However, in accordance with the Biosafety Board Decision, all the products mentioned above are not imported except for animal feed, and it is clearly stated that they cannot be used as human food if they are (TBBDM, 2021a). Corn, soybean, and canola answers were given according

to the priority order of use from genetically modified feed raw materials used in animal feeds. Among the feeds mentioned above, only corn and soybean are genetically modified forage crops that are allowed to be imported in our country. In addition, it is obligatory to provide information on the use of genetically modified feed raw materials on the labels of animal feeds (TBBDM, 2021a). When asked whether broiler feed can be made without corn and soybeans, 50% of them reported that broiler feed cannot be made without these two feed raw materials. While Şahin et al. (2019) reported that it is very difficult to create broiler feed without soy and corn, Filik et al. (2011) reported that it is possible to prepare a soy-free ration if necessary essential amino acids are provided, and it will be costly compared to the soy-prepared ration. They reported that 60% of the participants would not pass on the genetically modified gene to animals and animal products fed with genetically modified feed raw materials. On the contrary, Şengül and Zeybek (2020) reported in their study that 82% of consumers do not want to consume animals because they consider animals genetically modified and harmful for health. 20% of it is 2S albumin and 10% is "There are some research results that some transgenes in GMO products are passed on to the products of animals fed with these foods. For example, there are scientific articles on the possibility that some marker genes, such as antibiotic resistance in first generation transgenic plants, can be transferred to the animal's circulatory system and animal products. Contrary to the interpretive response, de Vos and Swanenburg (2018) and Swiatkiewicz et al. (2014) stated in their study that the transgenic DNA in GMO feeds does not pass into the tissues of animals and that reported that it does not pose a risk to human health". A portion of 20.00% answered this question as "I don't know". TBBDM (2021b) declared that no such finding has been encountered in scientific studies on the subject so far.

When applied to genetically modified feeds with technological processes, 23.68% of the participants answered yes to the Heating 103-111 °C 30' process, while 4.55% answered no to the potential to disrupt the proteins or genetically modified structure. For Pressing 95°C and Solvent Removal Roasting 105°C, 21.05% of the participants answered yes and 4.55% answered no. For the Crushing and Pressing 65°C processes, only 5.26% of the respondents said yes and 27.3% answered no. A temperature of 93-95°C is required for the DNA denaturation process (AUADM, 2021). During pressing at 95 °C, heating at 96-111

°C, or solvent removal roasting at 105 °C, genetically modified feed ingredients, like many nutrients, are likely to degrade the transgenic gene region. While 50% of the participants do not see any harm in consuming the meat of broilers fed with genetically modified feeds, 40% of the participants say that there is no sufficient scientific study on the possible effects on human health of the consumption of broiler chickens fed with genetically modified feeds, the disease can pass, additional hormone effects, antibiotic resistance, allergy may be carcinogenic". Except for the products determined by the Biosafety Board, the entry of genetically modified feed raw materials other than corn and soy, which are feed raw materials, is prohibited (TBBDM, 2021a), and no evidence has been found that affects the health of animals consuming genetically modified feeds or people consuming the products of animals consuming these feeds (Şahin et al. 2019). In addition, all DNA fragments, whether GMO or non-GMO, are broken down in the same way in the human digestive system. The amount of transgenic DNA in GMO products is extremely low compared to plant DNA consumed by humans and animals. The United Nations, the Food and Agriculture Organization and the World Health Organization have reported that sources of DNA ingested, including plants, are safe (Tufarelli et al., 2015). Studies have also reported that transgenic DNA in genetically modified feed raw materials does not pass into the tissues of animals and does not pose a risk to human health (Swiatkiewicz et al., 2014; de Vos and Swanenburg 2018). Şengül and Zeybek (2020), in their study, 59% of consumers believe that GMO feed is used, 84% are against GMO feed raw materials, and 87% of them say that chicken meat fed with GMO feed raw material is healthy. They stated that they thought it was harmful for them. Karasu and Ozturk (2020) reported that young and middle-aged individuals (18-59 years old) were less likely to purchase chicken meat due to the use of genetically modified feed raw materials in broiler breeding and the level of education was not effective in this regard.

It can be seen from the answers given to the questions that even people who experts in genetics or biotechnology are, let alone consumers, are wrong about some questions that contradict each other. Because

many people do not have detailed information about GMO technology, there has been resistance against the use of technology in the public. However, GMO technology has recently been used in the production of mRNA vaccine, which is used to prevent Covid-19 disease, and all countries have come a long way in the fight against the disease. For this reason, it should be explained that GMO technology should be better explained to the public and that many applications have potential risks as well as benefits. Currently, there is no genetically modified plant farming in our country, while almost all agricultural production is described as GMO. In our country, 23 corn and 13 soybean plants and 3 enzymes for the same purpose could be imported by the Biosafety Board if they are not used in human nutrition. The Biosafety Board needs to prepare a public service announcement or make more publications to inform the public, nutrition, and health experts correctly. In addition, the Ministry of Agriculture and Forestry is required to prepare public service announcements that inform the public that no genetically modified substance or component is used in GMO technology, produced products or any food used in human nutrition in our country.

## CONCLUSION

In conclusion, an important takeaway from the text is the necessity of educating the public accurately about the role of genetically modified organisms (GMOs) in agriculture and food production. This emphasizes the importance of both explaining the potential risks and benefits of the technology, enabling the public to make informed decisions and better understand the technology. In this regard, it is crucial for the authorities to undertake effective communication and educational activities to inform the public.

## CONFLICT OF INTEREST

No conflicts of interest to declare.

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