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Research Article

Consumer Perception and Purchase Attitude towards Genetically Modified Foods during the Covid-19 Pandemic: the Case of Erzurum, Türkiye

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Abstract: The aim of the study was to determine consumers' perception and purchase attitudes towards foods with genetically modified organisms (GMOs) and the main factors impacting on their purchase decision in Erzurum province in Türkiye. The material of the research consisted of primary data obtained from face-to-face questionnaire fulfilled with 323 households residing in Erzurum in 2021 and intending to consume foods with GMOs during the Covid-19 pandemic, and then explanatory factor and cluster analyses were applied to determine the main factors affecting three homogenous consumer clusters' attitudes and beaviors towards foods with GMOs. The results of the study highlighted that high-income consumers were of willingness to buy foods with GMOs due to positive purchase motivation with orientation of media communication and product mixes, that middle-income consumers altered consciously their purchase models by preferring GMO-foods with lower price to traditional foods, and that low-income participants did not want to buy foods with GMOs owing to negative impacts on human health, environment safety and ethical issues. As a result, high and middle-income consumers attributed positive purchasing perception and attitudes toward foods with GMOs, but low-income those were of a negative perception for these.

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1. Introduction

The rapid increase in the world population and food supply security resulting from climate changes prevent people from reaching a balanced and healthy diet. Being able to reach to food products of people, it is possible with either to increase productivity in agricultural production or to expand useable agricultural fields. However, it is inevitable to increase the factor productivity per unit since it is not possible to expand potentially the cultivation areas. In order to obtain more products per unit area or to obtain more productive species with product diversity, organisms improving food attributes through genetic engineering, namely genetically modified organisms (GMOs), have taken over important missions for the last years (Gürbüzoğlu, 2016).

In USA, the first scientific studies conducted on GMOs started in 1980s (Uzogara, 2000), and the first genetically modified product in the world was obtained from tobacco plant applications. The

first plant with GMO to have been traded was tomato type called as Flavr Savr with a longer shelf life in the USA in 1994, and the number and variety of genetically modified plants has continued to increase dramatically until today.

Especially the production fields of products with GMO for the food industry have been expanded, and their production periods have been shorted and thus the product quality has been also improved through the enzyme and fermentation processes facilitated by gene technology in the last decades (Shetty, 2008). A large number of crops with GMO such as wheat, corn, rice, potatoes, soybeans, tomatoes, sunflowers, zucchini, pumpkins and peanuts, some fish species, rapeseed, cassava and papaya have survived in today. Moreover, it was also reported that agricultural food products with GMO such as melon, watermelon, banana, strawberry, raspberry, cherry, pineapple, pepper and canola were of a much more contribution to mitigate the impacts of climate change and then to accelerate the natural adaptation process (Cummins and Lilliston, 2000).

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA) 2019, it was reported that the expansion rates of biotech agricultural product areas versus those of other agricultural fields had dramatically increased in developing countries such as Vietnam, the Philippines and Colombia. On the other hand, it was stated that the top five countries with the largest biotech product areas were the USA, Brazil, Argentina, Canada and India. It was also declared that those who adopted basic biotech products in these countries were 1.95 billion people in 2019, which correspond to 26% of the world's population. Furthermore, with Malawi, Nigeria and Ethiopia from the African continent in 2019, the number of countries growing biotech products increased from 24 to 27 (ISAAA, 2019). As a result of all these development trends, the products with GMO have been accepted as technological products providing faster adaptation to agricultural fields and increasing productivity at agricultural production.

In parallel with developments in the world, trial fields have been expanded for agricultural products such as potato, cotton, corn and soybean with GMO in Türkiye since 1999. Especially, it was stated that soybean is at the highest level with a share of 50% among the others including in corn (22%), cotton (12%), canola (5%) and other agricultural products (11%) (Sahin et al., 2018).

As a result of the production of the products with GMOs and the spread of their usage areas, possible natural risks on human health and environment have begun to increase. However, some studies conducted on the effects of the products with GMOs on human health and environment declared a positive outlook (economic and environmental benefits), whereas the others were also focused on negative and irreversible impacts (environmental, biosafety and ethical concerns, and bioterrorism) (Kaya, 2020).

Nowadays, issues including in the previously mentioned positive and negative motivation items continue to spark debate marked by contrasting the ideas about the GMO-food production, marketing and consumption. Foods with GMOs, therefore, led to reveal the opposite approaches between those supporting the use of GMOs in agriculture and those supporting not (Palmieri et al., 2020).

In marketing literature, it was also highlighted that the negative emotional attitude about foods with GMOs was associated to the lack of knowledge dealing with core of GM and its impacts on human organism (Boccia et al., 2018, Palmieri et al., 2020, Russo et al., 2020, Turan et al., 2022). Consumers' concerns about GMO foods and suspicious feelings towards new food technologies could lead to unsuccessful food product innovation under marketing mix, and thus their possible uses and designs are strongly affected from the consumers' perception and preferences changing their expectation of core benefit via GM technology under product mix. The lack of consumers' knowledge about innovative food products being applied new technologies such as GMOs, in fact, could cause an important barrier to their acceptance.

Previous studies indicated how consumers' positive or negative attitudes towards foods with GMOs could be an indicator of their intention to purchase these foods, and thus they could affect food pricing with GMOs (Lackowski et al., 2017). It was stated that consumers, indeed, not only purchased food with GMOs at more affordable prices but contributed to expanding also innovative foods penetrating to the food markets since they were able to decrease negative environmental affects via good agricultural applications (Ghozzi et al., 2018, Palmieri et al., 2020, Russo et al., 2020, Turan et al., 2022). On the other hand, it was also reported that consumers concerned GM technologies being capable to alter the natural/ecological food attributes, and it could have caused dangerous impacts on human health and environment (Boccia et al., 2018, Pechlaner, 2020, Arani et al., 2021, Adalja et al., 2022).

Consumers have caused to exhibit their asymmetrical behavior patterns under these two opposite paradigms in the literature (Kaya, 2020). According to various researches focused on consumers' attitudes and behaviors towards foods with GMOs, thus, it was reported that American consumers were accepting of foods with GMOs than European consumers interesting extremely to traditional and local food products, but Chinese consumers were fairly willingness to buy these products (Perito et al., 2019, Palmieri et al., 2020).

In fact, societies' perspectives towards foods with GMOs have been differently evaluated globally. There are consumers' different perspectives towards these products in Türkiye as a research region, and it is of great importance to reveal these differences on regional basis to be able to create innovative approaches for these products. As a result of all those, changings at the consumers' attitude and behaviors towards foods with GMOs during Covid-19 could have very important effects on production and supply decisions based on food industry and market strategies. In current research, thus, it was planned to explore the approaches of consumers residing in Erzurum, Türkiye and their consumption awareness and attitudes towards foods with GMO during the Covid-19 pandemic, and to determine the main factors affecting the consumers' purchase attitudes and behaviors towards these.

2. Material and Methods

2.1. Material

The main material of the research consisted of primary data obtained from face-to-face surveys with consumers residing in Erzurum, Türkiye in 2021. The secondary data of the study were also collected from the paper results and project reports about biotechnological product consumption, as well as from data of various statistical institutions and organizations such as TUIK, OECD, EFDA and FAO.

2.2. Methods

2.2.1. Determination of sample size

The sample size taking into account the main mass and consumption tendency of food with GMOs of the population whose variance rate is known under Standard Normal Distribution probabilities at 95% confidence interval was calculated in Equation 1 and 2 by using the Simple Random Sampling Method based on Main Mass Ratios (Newbold, 1995).

$$n = \frac{Np(1-p)}{(N-1)\sigma_p^2 + p(1-p)} \tag{1}$$

Where;
n: Sample size,
N: Main population (417 784 persons),
σ^2_p: Main mass variance ratio,
r: Deviation from the mean (5%),
$Z_{\alpha/2}$: Z table value at 95% confidence interval (1.96),
p: The probability of those preferring foods with GMOs (0.70).

$$\sigma_p^2 = \frac{r}{Z_{\frac{\alpha}{2}}} \rightarrow \sigma_p^2 = \left(\frac{r}{Z_{\frac{\alpha}{2}}}\right)^2 = \left(\frac{0.05}{1.96}\right)^2 = (0.0225)^2 \tag{2}$$

$$n = \frac{417\,784 * 0.7 * 0.3}{(417784 * (0.0255)^2) + (0.7 * 0.3)} = 323 \tag{3}$$

It was determined that the population size of Erzurum province was 417 784 persons based on Address Based Population Registration System (ABPRS) in 2021 (TÜİK, 2021). In order to determine GMOs food consumption probability of the consumers representing the main mass, a pilot study was conducted at the research region and probability of willingness to consume the foods with GMOs was founded to be 70% (p = 0.70). The sample size was calculated as 323 persons by considering this probability level.

2.2.2. Method applied in the preparation of the questionnaire forms

In the study, it was applied face-to-face questionnaire technique due to the difficulty and complexity of the questions planned for the survey form used in data collection by taking into consideration the questionnaire form approved by Igdir University Ethics Committee with 2022/13 number. The variables based on consumers' attitude and behaviors towards foods with GMOs were determined by accounting the variables used in domestic and foreign consumption researches. It was asked consumers participated in the survey to mark each statement on attitude scale determined by Likert Scale with 5-point (1: not any important, 3: neutral/undecided, 5: very important) (Kotler and Armstrong, 2004). Product attributes being consumers' purchase attitude and behavior determinates involve in their cognitive and visual perspectives related to foods with GMOs such as GMO-born legal regulations and some components of marketing mix (Table 1).

Table 1. Variables used in the research model

Code	Variable idendification
M1:	GMO term refers to genetically modified organisms
M2:	Foods with GMOs are organisms obtained by transferring a gene or genes from plants, bacteria, viruses or any other living thing to products' genetic structure trough techniques interfering to genes
M5:	Food with GMOs could be recognized by their shape
M6:	Food with GMOs could be understood by their price
M8:	I know what foods with GMOs are
M9:	It is considered that tomato is a food with GMOs
M10:	It is considered that strawberry is a food with GMOs
M11:	It is considered that corn is a food with GMOs
M12:	It is considered that soybean is a food with GMOs
M13:	It is considered that potato is a food with GMOs
M14:	It is considered that eggplant is a food with GMOs
M17:	Consumption of foods with GMOs is harmful for human health
M18:	Products with GMOs are of a negative impact on the environment
M19:	Foods with GMOs are harmful for all age groups
M23:	Foods with GMOs are healthier than other products
M27:	Unit cost for foods with GMOs is lower than the others
M31:	When buying food, I pay more attention to its advertisements
M33:	When buying food, I pay more attention to its package knowledge and materials
M35:	If food with GMOs is sold at the real markets, I try to buy it
M36:	I buy by ignoring whether it with GMOs is or not, when any branded food is cheap
M37:	If the price of food with GMOs is more attractive, I buy it
M38:	I buy foods with GMOs if they are of higher quality than others
M39:	If foods with GMOs are of higher nutritional value than foods without GMOs, and are sold at the same price, I buy a food with GMOs
M41:	The reason why the price of food with GMOs is cheap is that its supply amount is high
M42:	The reason why the price of foods with GMOs is cheap is that the production cost is low
M43:	The reason why the price of food with GMOs is cheap is that its penetration rate at the market is high

Table 1. Variables used in the research model (continued)

Code	Variable idendification
M44:	The reason why the price of food with GMOs is cheap results from lower demand
M46:	Foods with GMOs are healthier
M47:	Foods with GMOs should be consumed in a wider concept
M49:	We consume by being not had information about foods with GMOs, if I find out that I consume food with GMOs, I stop immediately its consumption
M53:	The Covid-19 pandemic has changed considerably my purchase habits
M54:	During the Covid-19 pandemic, I have token care not to buy foods with GMOs
M56:	I have bought foods with GMOs during the Covid-19 pandemic
M58:	The Covid-19 pandemic has created a difference in my cognitive memory to purchase the foods with GMOs
M59:	Even though the foods with GMOs is known to be harmful for human health, I have purchased them for stock purposes during the Covid-19 pandemic
M60:	Since the foods with GMOs is known to be harmful for human health, I don't buy them for stock purposes during the Covid-19 pandemic

2.2.3. Method applied in statistical analyses

In the first step, Explanatory Factor Analysis (EFA) was especially used to determine the factors related to the attitude and behaviors influencing on consumers' GMOs food consumption preferences under Covid-19 pandemics. EFA is a multivariate statistical dimension reduction technique trying to create a small number of unrelated, but conceptually meaningful new factors by bringing together variables that are related to each other (Civelek, 2020).

Hierarchical steps for the EFA were followed to test the suitability of the data, to determine the main factor number, to perform the rotation (transformation) techniques, to identify main factors, to calculate the explained and cumulative variances for each factor dimension, respectively. In order to investigate the data suitability of the sample mass according to the main population for the EFA, Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity were used in the research. KMO, the adequacy criterion of the sample size should be in acceptable confidence interval (between 0.50 and 1.00). On the other hand, Correlation Matrix should be different from the Unit Matrix in Bartlett's test of Sphericity explaining the relationship among the variables depending on the correlation matrix calculated between each pair of variables.

Whereas determining the main factor number in the EFA, the factors with Eigenvalues greater than one or equal to one were taken into consideration statistically. Rotation technique was also used to be able to give easily the factor names, and to eliminate the variable overlaps in factor matrices. In the rotation process, the factors in the axes are rotated so that reducing the variable loads to optimal levels. Rotation could be applied in two groups as vertical (orthogonal) and oblique rotation. While it could be minimized the relationship among the factor dimensions in vertical rotation, it could be accepted the relative relations among them in oblique rotation. It could be used Varimax, Quartimax and Equamax Methods in vertical rotation techniques, but it could be used Direct Oblimin and Promax Methods in Oblique Rotation one. In this study, it was applied vertical rotation and Varimax Method by being assumed being minimal relationships among the factors. As a result, 60 variables impacting on the consumption perception and awareness of foods with GMOs in Erzurum were conducted by considering the hierarchical process steps explained for EFA.

In the second step, it was used Two-step Cluster Analysis, dividing a heterogeneous target mass into two or more homogeneous segments by taking into account their various characteristics such as socioeconomic, demographic and psychographic variables (Karagöz 2019). In the present study, two-step cluster analysis was used and target consumers were classified into three groups as low (less than ₺750), medium (₺750-₺1500) and high (over ₺1500) income groups. Low, middle and high income groups constituted 23.2% (75 households), 49.8% (161 households) and 26.9% (87 households) of the sample population, respectively.

3. Results

3.1. Consumers' cluster profiles and perceptions for foods with GMOs

The relationships between consumers' demographic and socioeconomic characteristics being tendency to consume foods with GMOs in Erzurum and three income segments were given in Table 2.

Table 2. Demographic and socioeconomic attributes of the participants in each cluster

Demographic and socioeconomic factors		Income groups			Total
		Low	Middle	High	
Gender	Men	27	80	57	164
	Women	48	81	30	159
Age	15-25 years	25	27	8	60
	25-35 years	31	101	39	171
	35-45 years	11	21	27	59
	45-85 years	8	12	13	33
Education	Primary school	6	1	2	9
	Middle school	4	4	2	10
	High school	21	31	14	66
	University	44	125	69	238
Marital status	Married	33	74	65	172
	Single	42	87	22	151
Number of children	0	46	93	23	162
	1-3	20	57	53	130
	3-5	8	8	10	26
	5-8	1	3	1	5
Occupation	Lawyer	0	5	4	9
	Teacher	1	10	8	19
	White collars	2	36	27	65
	Blue collars	33	40	11	84
	Retired	2	5	1	8
	Others	37	65	36	138
Where did you first hear about concept of GMOs?	Television	46	92	48	186
	Journal	1	3	1	5
	Newspaper	48	2	2	4
	Internet	18	43	23	84
	Other	9	21	13	44
Is it objectionable to buy foods with GMOs?	Yes	65	138	77	280
	No	10	23	10	43
Should foods with GMOs have a label?	Yes	72	157	86	315
	No	3	4	1	8
Do you inquire about GMOs while purchasing?	Yes	22	48	21	91
	No	53	113	66	232
Organic food budget	Yes	12	38	30	80
	No	63	123	57	243
Number of consumers in each group		*75*	*161*	*87*	*323*

In the sample population, men and women consisted of 50.77% and 49.23% of the participants. Although the rates of men and women at the middle-income group were almost equal to each other, they showed a higher density than the other segments. While 54% of the participants were in 25-35 age groups, this age group was mostly concentrated at the middle-income group. 74% of target mass and 78% of middle-income group graduated from any university.

On the other hand, whereas the marriage rate for sample mass was calculated as 53%, singles with 56% at the low-income group and marrieds with 75% at the high-income group were found a more intensive position. Although the ratio of childless families in total population was 50%, this density increased at low and middle-income groups. The density of households with 1-3 children at the high-income group was, however, determined as higher than the others. The occupational statuses of blue and white collars come to the fore in all consumers, but blue and white collars were of a higher rate at the low and high-income segments, respectively (Table 2).

It was found that 58% and %26 of the participants perceived GMO-food awareness from visual media and social media, respectively. Similarly, it was stated that the consumers at the middle and high-income groups were widely used the visual and social media communication channels, but those at the low-income group were mostly triggered by the newspapers and visual media. On the other hand, 87% of all consumers and 86-89% of the participants at each segment manifested that it was a legal obligation to be given information about the negative effects of foods with GMOs on human health and the environment. In addition, 96-99% of consumers considered that it was a necessary to be included GMOs information on the food labels. Furthermore, 72% of the target mass and those at each segment highlighted that they were of not any information about food with GMOs during purchasing at food markets, and 75% of those were not able to make a budget for organic foods, as well (Table 2).

The average monthly food and organic food expenditures of the participants were calculated as ₺1245.36 and ₺111.15. While the average monthly food and organic food expenditures were ₺886 and ₺52 at the low-income segment, it was determined as ₺1104 and ₺79.81 and ₺1815.52 and ₺220.11 at the middle and high-income groups (Table 3). As the income levels of the participants increased, a similar trend was observed for the conventional and organic food expenditures. In conclusion, it was analyzed that there was a positive relationship between consumers' income and food expenditure amounts.

Table 3. Monthly general and organic food expenditures under income groups

Expenditure types		Income groups						All consumers	
		Low		Middle		High			
		Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***
Food expenditure	+ < ₺750	513.64	159.35	532.76	146.47	616.67	229.49	529.63	156.93
	₺750-₺1500	1137.50	271.36	1148.21	247.57	1176.53	275.96	1154.97	259.40
	+ > ₺1500	4000.00	1732.05	2657.89	1364.76	3018.75	1369.59	2946.30	1392.39
	Total	*886.00*	*788.80*	*1104.66*	*809.34*	*1815.52*	*1262.27*	*1245.36*	*1010.85*
Organic food expenditure	+ < ₺150	100.00	0	83.33	28.86	2650	42.74	87.50	25.00
	₺150-₺250	200.00	28.86	213.89	0	265.38	0	228.95	55.30
	+ > ₺250	600.00	270.80	625.00	311.78	923.53	521.15	767.14	441.91
	Total	*52.00*	*153.87*	*79.81*	*203.28*	*220.11*	*425.45*	*111.15*	*280.77*

3.2. The EFA results related to consumers' consumption tendency toward foods with GMOs

Kaiser Normalization (KMO), sample adequacy criterion index comparing the observation and partial correlation coefficients, and explaining the consumers' attitude and behaviors toward foods with GMOs was calculated as 0.787 in Table 4. Bartlett's test of Sphericity statistics for the main factors related to consumers' attitude and behaviors, on the other hand, was calculated as $\chi^2_{630;\,0.05} = 4517.93$ ($p = 0.000$) and unit matrix hypotheses was rejected (p<0.001). These two statistics evaluating the sample data set indicated that the data set, therefore, on the factors affecting consumers' food consumption with GMO were at a good level for EFA.

Table 4. EFA results and fit statistics related to consumers' purchase perception and attitudes toward foods with GMOs

	F1	F2	F3	F4	F5	F6	F7	F8
Willingness to buy foods with GMOs during the Covid-19								
M39	0.771	0.117	0.111	0.165	0.088	0.014	0.112	0.150
M37	0.756	0.023	0.118	0.104	0.002	0.206	0.050	0.118
M59	0.729	0.086	0.104	0.038	0.134	0.099	0.143	0.024
M38	0.695	0.101	0.113	0.147	0.141	0.074	0.141	0.161
M35	0.695	0.073	0.007	0.130	0.106	0.133	0.015	0.099
M36	0.689	0.044	0.109	0.070	0.093	0.147	0.066	0.001
M46	0.671	0.018	0.165	0.025	0.045	0.162	0.092	0.080
M47	0.641	0.117	0.065	0.145	0.083	0.075	0.025	0.021
M27	0.618	0.045	0.188	0.044	0.038	0.035	0.044	0.001
M23	0.591	0.068	0.248	0.018	0.133	0.096	0.088	0.065
M56	0.508	0.058	0.097	0.084	0.138	0.304	0.200	0.139
Food preference with GMOs								
M10	0.108	0.812	0.017	0.030	0.114	0.092	0.027	0.081
M14	0.003	0.806	0.125	0.055	0.126	0.072	0.062	0.029
M9	0.007	0.800	0.015	0.028	0.042	0.078	0.011	0.155
M11	0.173	0.765	0.011	0.012	0.033	0.063	0.135	0.081
M13	0.008	0.765	0.011	0.121	0.122	0.027	0.028	0.092
M12	0.108	0.658	0.017	0.030	0.114	0.092	0.027	0,081
GMOs concern perception								
M17	0.195	0.093	0.859	0.077	0.043	0.034	0.035	0.065
M18	0.198	0.108	0.846	0.007	0.037	0.030	0.009	0.033
M19	0.251	0.009	0.844	0.026	0.008	0.000	0.026	0.009
Price mix for foods with GMOs								
M42	0.006	0.018	0.041	0.788	0.056	0.109	0.125	0.028
M43	0.083	0.044	0.141	0.781	0.035	0.038	0.025	0.020
M41	0.007	0.147	0.025	0.723	0.008	0.044	0.073	0.098
M44	0.193	0.081	0.064	0.573	0.142	0.357	0.059	0.080
Visual and cognitive GMOs perception								
M5	0.138	0.179	0.038	0.009	0.762	0.036	0.046	0.065
M8	0.049	0.160	0.000	0.130	0.715	0.192	0.155	0.064
M6	0.153	0.187	0.045	0.053	0.701	0.035	0.262	0.001
Change in favor of GMO food purchase during the Covid-19								
M54	0.057	0.113	0.109	0.135	0.023	0.666	0.202	0.075
M58	0.056	0.075	0.062	0.155	0.005	0.658	0.125	0.098
M53	0.018	0.083	0.088	0.051	0.176	0.588	0.063	0.043
***GMOs concern based on product* mix**								
M31	0.147	0.019	0.033	0.013	0.196	0.060	0.658	0.331
M33	0.069	0.049	0.043	0.003	0.075	0.260	0.640	0.123
M49	0.192	0.007	0.077	0.134	0.218	0.014	0.601	0.166
M60	0.296	0.014	0.063	0.083	0.050	0.236	0.515	0.179
GMOs concept awareness								
M2	0.086	0.063	0.099	0.117	0.099	0.014	0.007	0.814
M1	0.156	0.075	0.017	0.082	0.070	0.033	0.066	0.794
				Goodness of fit statistics				
Eigenvalues	6.060	4.369	2.416	2.061	1.785	1.583	1.513	1.468
Explained variance (%)	16.833	12.135	6.712	5.726	4.960	4.398	4.202	4.078
Cumulative variance (%	16.166	28.968	35.680	41.405	46.365	50.042	54.965	59.042
KMO (Kaiser-Meyer-Olkin) statistics								0.787
Bartlett's test of Sphericity								*[Chi-square ($\chi^2_{df:630}$) = 4517.926] (p = 0.000)*
Sample size (n)								323

In the present study, it was firstly tested whether or not 60 attributes presented at food attitude scale designed for the consumers' consumption tendencies toward foods with GMOs met the criteria assumed for EFA. The results of rotated component matrix showed that 24 variables were excluded from EFA due to the variable loads overlapped and the meaningless items in the component matrix under

each factor dimension. 36 variables impacting on the consumers' consumption tendencies towards foods with GMOs were then determined, and they were reduced to eight main factors explaining 59.04% of the total variance by taking into consideration the Eigenvalues greater than 1 for each factor (Table 4).

First factor explaining 15.14% of total variance was identified as willingness to buy foods with GMOs during the Covid-19, and this factor included the food attributes such as M23, M27, M35-M39, M46, M47, M56 and M59 (Table 4). Second factor responding to 10.54% of total variance was called as foods with GMOs, which contains agricultural products such as strawberry, eggplant, potato, tomato, corn and soybean. On the other hand, GMOs concern perception and price mix for foods with GMOs illustrating 6.85% and 6.47% of total variance were third and fourth factors being constructed by the food attributes with M17-M19 and M41-M44, respectively.

Fifth factor accounting for 5.32% of total variance referred to visual and cognitive GMOs perception covering the variables such as M5, M6 and M8. Change in consumers' purchase attitudes towards foods with GMOs during the Covid-19 with 5.04% explanatory rate consisted of sixth factor covering the variables such as M53, M54 and M58 in Table 4. Similarly, the factors related to GMOs concern based on product mix and GMOs concept awareness revealed seventh and eighth factors accounting for 5% and 4.65% of total variance, respectively. Indeed, there were much stringer relations among not only the variables integrating M31, M33, M49 and M60 for seventh factor, in turn, but also M1 and M2 for eighth factor.

3.3. Cluster analysis results for consumers' consumption tendency toward foods with GMOs

After exploring eight factors affecting the consumers' attitude and awareness towards foods with GMOs in Erzurum, and then cluster analysis was applied to these main factors. Target consumer mass was divided into three income groups consisting of low, middle and high-income segments according to their income levels, and then it was determined the main factors for each consumer mass toward foods with GMOs. The relative ratios of high, middle and low-income groups were calculated as 26.9%, 49.8% and 23.2%, respectively.

The results of cluster analysis highlighted that the consumers with low-income positioned with awareness of foods with GMOs by considering biotechnological processes concerns under the product mix. In the middle-income group, the consumers focused on their purchase behavior changings in favor of being bought foods with GMOs based on lower prices by being awareness of foods with GMOs during the Covid-19 pandemic. On the other hand, it was pointed out that high-income consumers espoused willingness to buy foods with GMOs during the Covid-19 despite product mixes designed or improved by being awareness of GMOs food concern via their visual and cognitive perception (Table 5).

Table 5. The results of two-step cluster analysis based on the EFA results for each income group

Main Factors	**Income groups**		
	Low	**Middle**	**High**
Willingness to buy foods with GMOs during the Covid-19	-0.23	-0.04	0.31
Food preference with GMOs	-0.02	0.04	-0.09
GMOs concern perception	0.10	-0.03	0.13
Price mix for foods with GMOs	-0.05	0.14	-0.05
Visual and cognitive GMOs perception	-0.01	-0.06	0.11
Change in favor of GMO food purchase during the Covid-19	-0.08	0.05	-0.03
GMOs concern based on product mix	0.10	-0.03	0.02
GMOs concept awareness	0.05	-0.07	0.13
Number of samples in each cluster (pieces)	*75*	*161*	*87*
The share of each cluster in the total sample (%)	*23.20*	*49.80*	*27.00*

4. Discussion

Consumers' perception toward foods with GMOs and their purchasing attitude and behaviors has always differed from society to society and from region to region. Although there were various studies conducted on foods with GMOs in Türkiye, they referred to the technical and statistical approaches being used to descriptive the current condition. In Türkiye and Erzurum, there has been

fairly little consumption studies conducted on consumers' attitudes and perceptions towards foods with GMOs considering the structural equation models.

In general, consumers' knowledge about foods with GMOs is low due to their similarity to non-GMO foods and a subjective knowledge of food production with GMOs (Wunderlich and Gatto, 2015). Indeed, the results of the study indicated that 72% of Turkish consumers in Erzurum knew nothing at all or a little knowledge about foods with GMOs. Their knowledge about foods with GMOs, moreover, received from television and the internet with 57.6% and 26%, respectively.

In similar studies, it was reported that 65 and 79% of US consumers (Hallman et al., 2013), 77.3% of Latvian consumers (Aleksejeva, 2014), 82.9% of Turkish nursing students (Turker et al., 2013), 81.4% of Polish students (Jurkiewicz et al., 2014) knew very little or nothing knowledge about foods with GMOs, but 28% of Italian consumers and 33.3% of Japanese consumers (McGarry et al., 2012) were moderately or very familiar with GMOs foods. On the other hand, Turker et al. (2013) and Aleksejeva (2014) highlighted that 77.3% and 63.6% of Latvian consumers and 21.7% and 74.3% of Turkish consumers, in turn, received information about foods with GMOs from the internet and television. Although consumers' primer and seconder knowledge sources about foods with GMOs at each country differed, their awareness knowledge levels depicted fairly similar rates.

By depending on consumers' knowledge about foods with GMOs, they have concerned about foods with GMOs on individual health and environmental impacts last decades, and thus consumers showing a negative attitude toward foods with GMOs have particularly concerned about safety, labelling, environmental impacts and ethical issues (Kadirhanoğullaru et al. 2021; Adalja et al., 2022). In fact, the results suggested that 87% of consumers in research area concerned from the negative impacts on human health and environment of foods with GMOs, and thus 97% of those agreed to be a legal necessity to be labelled with mandatory labels of foods with GMOs in contrary US and Japanese consumers.

High-income consumers gave bigger importance to willingness to buy innovative GMO foods in view of information provided from the food labels under their cognitive and visual perception through communication mix by trusting to knowledge sources related to GMO-foods, and thus they were of a positive purchasing motivation towards foods with GMOs during the Covid-19 pandemic due to accessible foods with augmented quality image, disruption at traditional food supply chain, differentiated foods at the markets, more resistant plants to pesticides, agricultural applications without hormone and antibiotics, solution expectations related to resource depletion and world hunger issues. The high-income consumers showed a positive trend towards GMO-foods during the Covid-19 period, moreover, because they believed that GMO-foods would not be at levels to be led to health concerns, and even if they do, they have easier access to health services. In fact, some studies conducted on this topic informed that consumers' cognitive and visual perception about biotechnological applications and foods with GMOs affected positively their awareness, attitude and purchase intention, and thus they accepted new genetic discoveries and progresses at food production (Pham and Mandel, 2019, Palmieri et al., 2020).

In the middle-income group, consumers changed directly their purchasing patterns in favor of food preference with GMOs during the Covid-19 pandemic. With the Covid-19 pandemic, there were very much important problems at food supply chain, and then target consumers gotten difficult to access to the conventional foods, and thus conventional food prices increased rapidly, but foods with GMOs decreased gradually at the agricultural food markets (Akay, 2021; Topcu, 2022a, Topcu, 2022b). In this case, middle-income consumers' food purchase models altered consciously from the conventional foods to foods with GMOs. In other words, due to the higher price sensitivity of middle-income consumers and their lack of health concerns, they changed their purchasing patterns in favour of GMO-foods. In the studies conducted by Palmieri et al (2020) and Pham and Mandel (2019), indeed, it was highlighted that the participants who were not concerned about foods with GMOs did not wanted to pay more for non-GMO foods, since consumer awareness of GMO-food labeling were fairly much low, and their GMOs knowledge was a considerably lack (Russo et al., 2020).

The low-income participants suffering from unknown food ingredients in product mix lacking GMO food labels, and being concerns about human health and environmental safety and ethical issues for GMOs food consumption resulting from biotechnological processes attributed strongly a negative attitude toward foods with GMOs. Unlike high and middle-income participants, low-income consumers were of a negative perception and attitudes toward foods with GMOs. The factors driving consumers to

negative perceptions determined to be adverse impacts on human health and environment, ethical issues, as well as lack of GMOs knowledge based on the information sources in similar various consumption studies. From authors conducted these scientifically researches, Giordano et al (2018), Palmeri et al (2020) and Arani et al (2021) highlighted that even if consumers in favor of pro-science expressed positive opinions for food with GMOs, they believed that when compared the benefits to be provided with the risks to be endured for these; there was a negative perception toward GMO-foods due to their possible long term risks.

In addition, Boccia et al (2018) and Russo et al (2020) reported that the lower consumers' scientific knowledge scores and trust to information sources, the lower their perception and intention to buy foods with GMOs. Furthermore, Bovay and Alston (2018) and Adalja et al (2022) pointed out that mandatory branding legislative process for foods with GMOs increased considerably consumer aware, and thus non-GMO foods sales increased fairly due to differences in consumer awareness tied to legislative activity. Similarly, Ghozzi et al (2018) and Saputri et al (2019) also indicated that the performance of non-GMO food chain was better than GMO ones, and GMO-free foods were more sustainable.

Conclusion

During the Covid-19 pandemic, in the research trying to determine consumers' perception and purchasing intention toward foods with GMOs, it was found that 72% of all consumers did not any research about foods with GMOs, that 86% of those were not willing to buy the foods designed with new discoveries in biotechnology field, that %99 of those were a mandatory requirement of GMO-food labeling.

On the other hand, it was also reached to interesting results with respect to the understanding of the main drivers of consumers' purchase intention and patterns in the cluster analysis. The results of the study indicated that high-income consumers were of willingness to purchase foods with GMOs under mandatory food labelling by being created cognitive perception and awareness through media communication tools. It was found that, moreover, the middle-income participants wanted to change their purchase patterns to prefer foods with GMOs with lower prices than conventional foods. By contrast with high and middle-income groups, low-income consumers declared to concern in view of human health, environment safety and ethical issues from food mix (especially core product) designed at biotechnology filed. High and middle-income consumers, therefore, attributed a positive purchase motivation toward foods with GMOs, but low-income consumers were of a negative buying perception for these. Consequently, it was determined that there were gradually the adverse relationships among consumers' income segments and their purchase perception and attitudes towards foods with GMOs.

Ethical Protocol

Ethical Protocol was approved by the Scientific Research and Publication Ethics Committee of Iğdır University with its session dated 23.08.2022 and decision numbered 2022/13.

Author's contributions

All authors included in this article contributed equally to each stage of the research.

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