

MISCELLANEOUS

Emotional attitudes of young people completing secondary schools towards genetic modification of organisms (GMO) and genetically modified foods (GMF)

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Abstract

Objective. The objective of the study was recognition of the opinions of adolescents completing secondary schools concerning genetically modified organisms and genetically modified food, especially the respondents' emotional attitude towards scientific achievements in the area of live genetically modified organisms.

Material and method. The study covered a group of 500 school adolescents completing secondary school at the level of maturity examination. The study was conducted by the method of a diagnostic survey using a self-designed questionnaire form.

Results. Knowledge concerning the possible health effects of consumption of food containing GMO among adolescents competing secondary schools is on a relatively low level; the adolescents examined 'know rather little' or 'very little know' about this problem. In respondents' opinions the results of reliable studies pertaining to the health effects of consumption of GMO 'rather do not exist'. The respondents are against the cultivation of GM plants and breeding of GM animals on own farm in the future. Secondary school adolescents considered that the production of genetically modified food means primarily the enrichment of biotechnological companies, higher income for food producers, and not the elimination of hunger in the world or elimination of many diseases haunting humans.

Key words

Adolescents, GMO, GMF, attitudes

INTRODUCTION

Agriculture based on genetically modified organisms plays an increasingly important role in the alimentation of the world population, which is evidenced by a considerable increase in the area under cultivation by GM plants. According to the biotechnological lobby from the ISAAA organization (International Service for the Acquisition of Agri-biotech Applications), from 1996–2012 the cultivated area of GM plants increased by as many as 100 times, from 1.7 mln ha to 170 mln ha [1, 2, 3].

In 2012, the number of farmers worldwide who cultivate genetically modified plants increased up to 17.3 mln, compared to 16.7 mln in 2011. GMO plants are cultivated in 29 countries worldwide, including 10 developed and 19 developing countries [4, 5, 6, 7, 8].

Considering much controversy evoked by the commercial application of biotechnology there are still many countries which have decided not to cultivate GM plants, and some of them limit such crops (Germany, France) [9].

Increasingly more often we consume food products without being aware that they contain in their composition genetically modified organisms (e.g. soya, maize, olive from GM rapeseed, fruits, vegetables, fish, poultry). Transgenic food, in contrast to traditional food, may possess new characteristics,

change nutritional values, health, technological and sensor properties [10].

The dynamic development of biotechnology which has been observed in recent years evokes serious social concerns about risks created due to uncontrolled penetration of dangerous transgenes into the natural environment. These concerns also pertain to the health consequences of the consumption of GM food, which are unknown from the generation perspective. Studies on species which produce several generations within a short time (e.g. mice, rats) lead to hardly optimistic conclusions. According to a study by Dr. Gilles-Eric at the University of Caen shows that 50% of males and females fed NK 603 maize varieties suffered premature death. Consuming trace amounts of chemical fertilizer Monsanto Roundup caused a frightening development in the rat tumors, extensive damage to the internal organs and premature death [6, 10, 11, 12, 13, 14].

In the developed countries, where the problem of malnutrition does not occur, the level of social acceptance of GM products plays an important role which, in turn, creates the problem of the provision of reliable knowledge concerning biotechnology and the possibilities of the practical use of its achievements. Public opinion, to a large degree, may either facilitate the development of biotechnology or considerably inhibit this development [15].

Due to the lack of studies concerning the effects of implementation of GMO on the natural environment and health effects of the consumption feed from GM plants by breeding animals and food GM by humans, this problem is

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rather of a psychosocial than medical nature. The views of society towards genetic modification of organisms (GMOs) and genetically modified food (GMF) is different in each country. The reasons for these differences can be traced to economic conditions, political and legislation. The population living in North America and Asia is a positive attitude towards GMOs, while the Europeans, including Poles present a more skeptical attitude [4].

Concerns related with genetically modified food are associated with the lack of elementary knowledge pertaining to its production, as well lack of reliable information about the effect of GMO on the natural environment and human health [16, 17, 18]. On the other hand, there is no trust concerning information provided by mass media, and even the information in professional journals.

Agricultural producers and consumers more aware of our health conditions are very suspicious of the modern crop varieties and breeding new species of animals and food production based on these organisms, and the placing on the market of food containing GMO.

The subject of the study were opinions, attitudes towards genetic modification of organisms (GMOs) and genetically modified foods surveyed graduates of secondary schools. The research tool was a questionnaire consisting of open and closed questions. Questions pertained to the intellectual realm (knowledge), behavior (behavior) and emotional (review), so included all dimensions that make up the attitude [19]. However, for purposes of this study were selected questions about the emotional aspect of the respondents to the advancements in the field of genetic modification of living organisms, production of GMO-based foods, the health effects of consuming GMOs, etc.

Knowledge of consumer attitudes towards GMOs and GMF is a valuable source of information necessary for manufacturers when developing marketing strategies related to the design and marketing of new products represent a new generation of food.

OBJECTIVE

The objective of the study was recognition of the opinions of adolescents completing secondary schools concerning genetically modified organisms and genetically modified food, especially the respondents' emotional attitude towards scientific achievements in the area of genetically modified live organisms.

MATERIAL AND METHOD

The study involved 500 – a group of students from Lublin region, completing secondary schools on the level of maturity examination in the school year 2010/2011.

The study was conducted using a diagnostic survey, using a standard questionnaire in classes at school – preceded by the hand of anonymous questionnaires, brief information on the purpose, object, place, and manner of conducting research and the possibility acquainted with their results.

The collected research material coded and entered into the computer by analyzing the statistical program SPSS. The test compound was based on the use of Chi² test, assuming that the level of $p < 0.05$. Among the surveyed students leaving

secondary schools 58.4% were girls, the remaining 41.6% of the respondents were boys. Most of the students surveyed were rural residents – 73.4%, only 26.6% of students are urban dwellers. Group analysis based on the origin indicates that more than half of the students (51.8%) is the origin of agriculture, the rest of the group – 48.2% of non-agricultural origin (Tab. 1).

Table 1. Characteristics of the examined adolescents completing secondary schools

	Characteristics	N	%
Gender	Girls	292	58.4
	Boys	208	41.6
	Total	500	100.0
Place of residence	Urban area	133	26.6
	Rural area	367	73.4
	Total	500	100.0
Origin*	Agricultural	253	51.8
	Non-agricultural	235	48.2
	Total	488	100.0
Type of school	General Secondary School	250	50.0
	Secondary Agricultural Technical School	250	50.0
	Total	500	100.0

* lack of data not considered; N – number of respondents.

RESULTS

The study shows that more than 81.4% of surveyed students assess their knowledge as a slight 'Unlikely I know' and 'I know very little about it.' (Fig. 1).

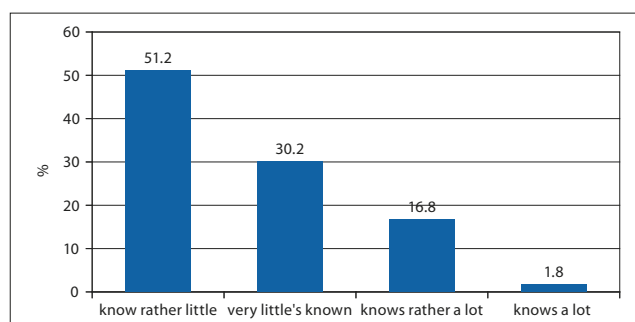


Figure 1. Level of adolescents' knowledge concerning possible health effects of the consumption of food containing GMO

According to the respondents' opinions, this low level of their knowledge there is no evidence base and may result from, among other things, lack of reliable studies of health effects of the consumption of GMO (57.4% of respondents "definitely not" and "there is little reliable research") (Fig. 2).

Despite the lack of reliable knowledge, the adolescents in the study possess (subjective) convictions based on an emotional attitude to the achievements of biotechnology companies and food produced on the basis of GMOs.

For the majority of adolescents, the production of genetically modified food means primarily the enrichment of biotechnological enterprises, risk of development of new health disorders in humans, higher profits for food producers, higher risk of unfavourable genetic changes in humans, and elimination of hunger in the world.

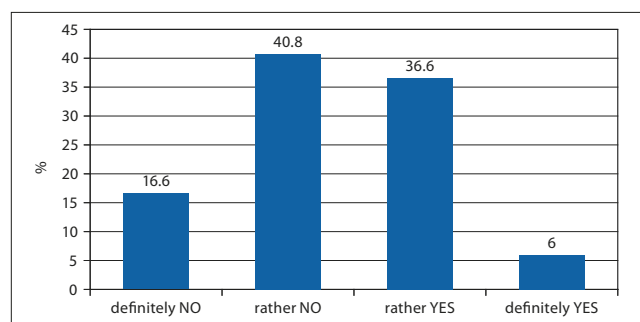


Figure 2. Reliability of the results of studies concerning health effects of the consumption of food containing GMO in opinions of adolescents attending secondary schools

Significantly more rarely statistically, the schoolchildren expressed the opinion that the production of modified food is associated with: improvement of the health situation of humanity, elimination of diseases plaguing humans, better quality of food, progress and blessing for humanity.

Despite the prevailing negative attitudes towards GM foods and biotechnology companies surveyed achievements can not make rational choices as consumers, as food products are generally available in Polish stores, and containing in its composition GMOs are not specially marked (Fig. 3).

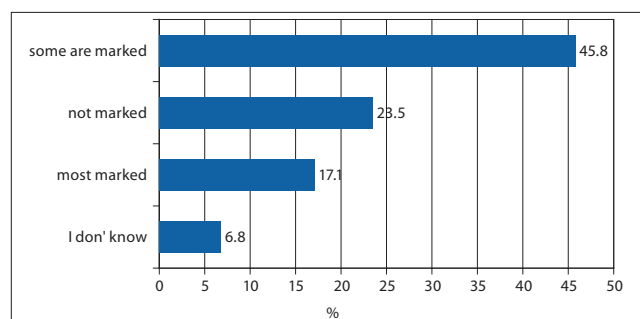


Figure 3. Labelling of food products containing GMO in opinions of secondary school adolescents

The production of GM crops in the majority of the students evaluate the “negative or rather negative” (Fig. 4). Opinions on this subject are the most diverse gender of the respondents ($\chi^2 = 19.771$; $p < 0.001$). Almost two thirds of girls (63.8%) is critical of the production plants, and this opinion is shared by 54.4% of boys. The differences were not statistically significant given the origin of the respondents (agricultural and non-agricultural), as well as in subgroups of people who attend different schools (High School, Technical School of Agriculture) (Fig. 4, Tab. 2).

In respondents' opinions, genetic modifications of plants may be the cause of both positive and negative phenomena in nature. Among the positive effects of genetically modified crops students most frequently mentioned: higher yield (89%), higher productivity of crops (81.9%), higher resistance of plants to diseases (79.2%), decrease in the use of mineral fertilizers (74.4%), decreased use of herbicides (68.5%), possibility to cultivate marginal soils (68.1%), decreased dependence of cultivation on weather conditions and climatic changes (64.4%), and lower contamination of the natural environment (51.7%).

Among phenomena unfavourable for the natural environment the respondents mentioned superseding

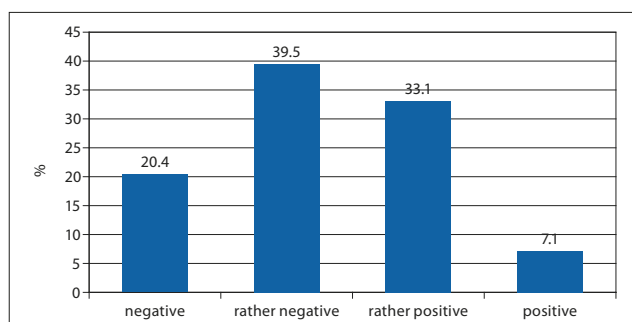


Figure 4. Evaluation of production of genetically modified plants by secondary school adolescents

Table 2. Evaluation of production of genetically modified plants and respondents' socio-demographic characteristics

Variables	Categories of replies								
	Negatively		Rather negatively		Rather positively		Positively		
	N	%	N	%	N	%	N	%	
Gender*	Girls	52	17.9	133	45.9	94	32.4	11	3.8
	Boys	49	23.8	63	30.6	70	34	24	11.7
Total		101	20.4	196	39.5	164	33.1	35	7.1
Origin*	Agricultural	48	19.2	91	36.3	97	38.6	15	5.9
	Non-agricultural	49	20.9	101	43.2	65	27.8	19	8.1
Total		97	20	192	39.6	162	33.4	34	7
Type of school*	General Secondary	46	18.5	104	41.9	78	31.5	20	8.1
	Secondary Technical	55	22.2	92	37.1	86	34.7	15	6
Total		101	20.4	196	39.5	164	33.1	35	7.1

* – lack of data not considered; N – number of replies.

¹ – $\chi^2 = 19.771$; $p < 0.001$

² – $\chi^2 = 6.735$; $p < 0.081$

³ – $\chi^2 = 2.641$; $p < 0.450$

traditional plants (71%), disappearance of biodiversity by cross-pollination of traditional and modified plants (68.6%), occurrence of weeds resistant to herbicides applied to-date (63.7%) and loss of control over the expansion of genetically modified plants (59.7%).

Most students are critical of GM animal husbandry. More than two thirds of the young people (66.7%), animal husbandry GM estimates “rather negative and negative.” The most significant differences were found according to the respondents' gender ($\chi^2 = 18.456$; $p < 0.001$). The percentage of people have a negative attitude towards GM animal husbandry is much higher in girls (71.7%) than among boys (59.8%). Differences were not statistically significant and in subgroups defined according to the origin and type of school (Fig. 5, Tab. 3).

Genetic modifications of animals, in the respondents' opinions, may be the cause of both negative and positive phenomena in nature, agricultural economy and animal breeding.

Among the negative consequences the respondents most frequently reported the occurrence of new diseases in the animal world (77.3%), occurrence in an uncontrolled way of new animal species, breeds (71.2%), disappearance of traditional species (70.9%), and loss of control over expansion of genetically modified species (61.6%).

In the case of positive effects of genetically modified animals the respondents indicated: higher productivity

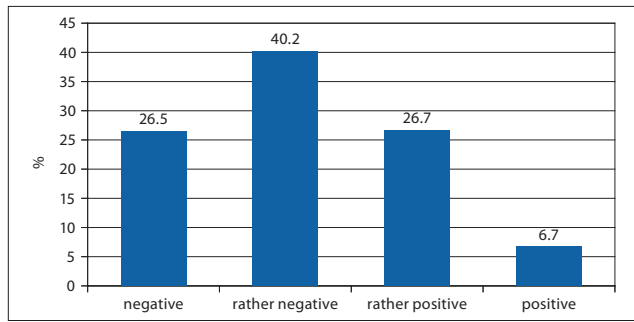


Figure 5. Evaluation of breeding of genetically modified animals by secondary school adolescents

Table 3. Evaluation of breeding of genetically modified animals according to respondents' socio-demographic characteristics

Variables	Categories of replies								
	Negatively		Rather negatively		Rather positively		Positively		
	N	%	N	%	N	%	N	%	
Gender*	Girls	73	25.3	134	46.4	72	24.9	10	3.5
	Boys	58	28.2	65	31.6	60	29.1	23	11.2
Total		131	26.5	199	40.2	132	26.7	33	6.7
Origin*	Agricultural	64	25.6	92	36.8	78	31.2	16	6.4
	Non-agricultural	64	27.4	103	44	51	21.8	16	6.8
Total		128	26.4	195	40.3	129	26.7	32	6.6
Type of school*	General Secondary	61	24.7	104	42.1	62	25.1	20	8.1
	Secondary Technical	70	28.2	95	38.3	70	28.2	13	5.2
Total		131	26.5	199	40.2	132	26.7	33	6.7

* – lack of data was not considered; N – number of replies.

¹ – $\chi^2 = 18.456$; $p < 0.001$

² – $\chi^2 = 5.749$; $p < 0.124$

³ – $\chi^2 = 2.993$; $p < 0.393$

of animal breeding (75.2%), production of new medicinal products (73.4%), higher resistance of animals to diseases (72.7%), and the possibility of providing organs for human transplantation (64.3%).

More than a half (54.8%) of the adolescents in the study evaluated the achievements of genetic engineering in negative terms. Highly statistically significant differences occurred in relation to the gender of students surveyed ($\chi^2 = 10.291$; $p < 0.016$). Girls (56.6% of replies 'rather negatively' and 'very negatively') significantly more often evaluated the achievements of genetic engineering in the area of genetic modification of living organisms in negative terms, compared to boys (52.5% of replies 'rather negatively' and 'very negatively'). Slightly less statistically significant differences were found in subgroups of people who attend different schools (Secondary schools, the Agricultural Technical) ($\chi^2 = 8.774$; $p < 0.032$), while in the case of the origin of the respondents (agricultural and non-agricultural) found no statistically significant differences (Tab. 4).

Also, nearly 2/3 of the adolescents examined (64.9%) negatively evaluated the use of genetically modified organisms for the production of food products. Gender exerted the most significant effect on the evaluation of the use of genetically modified organisms for the production of food products ($\chi^2 = 33.012$; $p < 0.001$). Girls (69.3% of replies 'rather negative' and 'negative') significantly more negative opinion about the use of genetically modified organisms for food production than boys (58.8%). The differences were not

Table 4. Evaluation of achievements of genetic engineering in the area of genetic modification of living organisms, according to respondents' socio-demographic characteristics

Variables	Categories of replies								
	Very negatively		Rather negatively		Rather positively		Very positively		
	N	%	N	%	N	%	N	%	
Gender*	Girls	37	12.8	127	43.8	117	40.3	9	3.1
	Boys	36	17.5	72	35	81	39.3	17	8.3
Total		73	14.7	199	40.1	198	39.9	26	5.2
Origin*	Agricultural	39	15.5	94	37.5	108	43	10	4
	Non-agricultural	33	14.1	100	42.7	86	36.8	15	6.4
Total		72	14.8	194	40	194	40	25	5.2
Type of school*	General Secondary	32	12.9	97	39.1	99	39.9	20	8.1
	Secondary Technical	41	16.5	102	41.1	99	39.9	6	2.4
Total		73	14.7	199	40.1	198	39.9	26	5.2

* – lack of data was not considered; N – number of replies.

¹ – $\chi^2 = 10.291$; $p < 0.016$

² – $\chi^2 = 3.589$; $p < 0.309$

³ – $\chi^2 = 8.774$; $p < 0.032$

statistically significant given the origin of the respondents (agricultural and non-agricultural) as well as in subgroups of people who attend different schools (High School, Technical School of Agriculture) (Tab. 5).

Table 5. Evaluation of use of genetically modified organisms for production of food products, according to respondents' socio-demographic characteristics

Variables	Categories of replies								
	Very negative		Rather negative		Rather positive		Very positive		
	N	%	N	%	N	%	N	%	
Gender*	Girls	34	11.7	167	57.6	86	29.7	3	1
	Boys	50	24.3	71	34.5	75	36.4	10	4.9
Total		84	16.9	238	48	161	32.5	13	2.6
Origin*	Agricultural	42	16.8	110	43.9	92	36.6	7	2.7
	Non-agricultural	38	16.2	123	52.6	67	28.6	6	2.6
Total		80	16.5	233	48	159	32.8	13	2.7
Type of school*	General Secondary	36	14.5	131	52.8	73	29.4	8	3.2
	Secondary Technical	48	19.4	107	43.1	88	35.5	5	2
Total		84	16.9	238	48	161	32.5	13	2.6

* – lack of data was not considered; N – number of replies.

¹ – $\chi^2 = 33.012$; $p < 0.001$

² – $\chi^2 = 4.343$; $p < 0.227$

³ – $\chi^2 = 6.224$; $p < 0.101$

In the opinion of the respondents (64.1%), information provided in the media about the benefits of GM crops are untrustworthy and unreliable. With respect to this question, statistically significant differences were noted according to gender ($\chi^2 = 10.742$; $p < 0.013$), while no significant differences were found according to origin and type of school (Tab. 6)

Based on the analysis performed, the respondents (61.6%) would not wish to be subject to treatment with the use of genetically modified organisms. The greatest statistical differences were observed according to gender ($\chi^2 = 16.058$; $p < 0.001$). Girls (67.1% of replies 'rather No' and 'definitely No') were more often against treatment with the use of achievements of genetic engineering than boys (53.9% of replies 'rather No' and 'definitely No'). Slightly

Table 6. Evaluation of information concerning benefits from cultivation of genetically modified plants provided by the mass media, according to respondents' socio-demographic characteristics

Variables	Categories of replies								
	Very negative		Rather negative		Rather positive		Very positive		
	N	%	N	%	N	%	N	%	
Gender*	Girls	37	12.8	150	51.9	94	32.5	8	2.8
	Boys	47	22.8	83	40.3	69	33.5	7	3.4
Total		84	17	233	47.1	163	32.9	15	3
Origin*	Agricultural	40	16	111	44.2	92	36.7	8	3.1
	Non-agricultural	42	18	118	50.6	67	28.8	6	2.6
Total		82	16.9	229	47.3	159	32.9	14	2.9
Type of school*	General Secondary	41	16.5	127	51.2	72	29	8	3.2
	Secondary Technical	43	17.4	106	42.9	91	36.8	7	2.8
Total		84	17	233	47.1	163	32.9	15	3

* - lack of data was not considered; N - number of replies.

¹ - $\chi^2 = 10.742$; $p < 0.013$ ² - $\chi^2 = 3.815$; $p < 0.282$ ³ - $\chi^2 = 4.220$; $p < 0.239$

smaller statistical differences were found according to the type of school ($\chi^2 = 11.727$; $p < 0.008$). Adolescents attending Secondary Technical School (57.3%) were more often against treatment, compared to those from General Secondary School (56.0%). The differences according to origin were statistically insignificant ($\chi^2 = 1.859$; $p < 0.602$), although schoolchildren from agricultural families were slightly more frequently against treatment with the use of genetic engineering than those from non-agricultural families (Tab. 7).

Table 7. Treatment using achievements of genetic engineering and respondents' socio-demographic characteristics

Variables	Categories of replies								
	Definitely No		Rather No		Rather Yes		Definitely Yes		
	N	%	N	%	N	%	N	%	
Gender*	Girls	90	30.8	106	36.3	85	29.1	11	3.8
	Boys	51	24.8	60	39.1	70	34	25	12.1
Total		141	28.3	166	33.3	155	31.1	36	7.2
Origin*	Agricultural	73	28.9	88	34.9	76	30.2	15	6
	Non-agricultural	66	28.1	72	30.6	78	33.2	19	8.1
Total		139	28.5	160	32.9	154	31.6	34	7
Type of school*	General Secondary	69	27.6	71	28.4	84	33.6	26	10.4
	Secondary Technical	72	29	95	28.3	71	28.6	10	4
Total		141	28.3	166	33.3	155	31.1	36	7.2

* - lack of data was not considered; N - number of replies.

¹ - $\chi^2 = 16.058$; $p < 0.001$ ² - $\chi^2 = 1.859$; $p < 0.602$ ³ - $\chi^2 = 11.727$; $p < 0.008$

More than a half of the respondents (60.1%) evaluated food produced from genetically modified organisms as dangerous and unfavourable for health. Gender exerted the most significant effect on the evaluation of food produced from genetically modified organisms ($\chi^2 = 11.489$; $p < 0.009$), whereas the effect of origin and type of school was insignificant (Tab. 8).

The adolescents examined (68.6%) rather did not trust food produced on the basis of genetically modified organisms

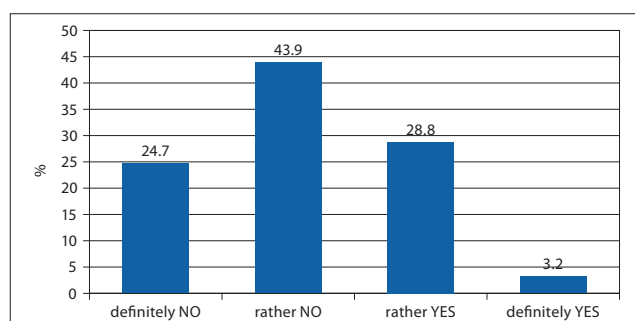
Table 8. Evaluation of food from genetically modified organisms according to respondents' socio-demographic characteristics

Variables	Categories of replies								
	It is dangerous and unfavourable for health		It is rather dangerous and unfavourable for health		It is rather safe and beneficial for health		It is totally safe and beneficial for health		
	N	%	N	%	N	%	N	%	
Gender*	Girls	44	15.1	140	48.1	105	36.1	2	0.7
	Boys	43	20.7	73	35.1	86	41.3	6	2.9
Total		87	17.4	213	42.7	191	38.3	8	1.6
Origin*	Agricultural	46	18.2	104	41.3	99	39.3	3	1.2
	Non-agricultural	39	16.6	102	43.4	89	37.9	5	2.1
Total		85	17.5	206	42.3	188	38.6	8	1.6
Type of school*	General Secondary	36	14.4	115	46	95	38	4	1.6
	Secondary Technical	51	20.5	98	39.4	96	38.6	4	1.6
Total		87	17.4	213	42.7	191	38.3	8	1.6

* - lack of data was not considered; N - number of replies.

¹ - $\chi^2 = 11.489$; $p < 0.009$ ² - $\chi^2 = 1.036$; $p < 0.0793$ ³ - $\chi^2 = 3.946$; $p < 0.267$

(Fig. 6). The most statistically significant differences were noted according to gender ($\chi^2 = 20.248$; $p < 0.001$), while the differences according to origin and type of school were insignificant statistically.

**Figure 6.** Trust in food produced based on GMO

According to the respondents, biotechnological companies should be supervised by governments and regulated by law (the differences insignificant statistically), because they do not conduct reliable research on the effect of GMO on human health (statistically significant differences were observed by gender, whereas the differences by the type of school and origin were insignificant statistically), do not pay attention to the protection of the natural environment (the differences statistically insignificant), while functioning are not guided by ethics and morality (statistically significant differences were observed according to the type of school, while the differences by gender and origin were insignificant), and are oriented only to the profit from selling seeds (statistically significant differences were noted only according to gender, the differences by origin and type of school being insignificant statistically).

DISCUSSION

Apart from the behavioural intellectual component in our attitudes towards the surrounding phenomena, the emotional component is of great importance, i.e. what emotions and feeling accompany behaviours and knowledge concerning these phenomena. In the presented study, the point is: what emotional experiences accompanied the respondents' thoughts and behaviours in association with achievement of genetic engineering in the area of creation of genetically modified organisms, production of food based on GMO, and health effects of the consumption of GMO?

Increasingly more frequently we consume food products without being aware that they contain GM organisms. Transgenic food, opposite to traditional food, may possess new characteristics, e.g. changed nutritional value, health, technological and sensor properties.

According to adolescents' opinions, only some products containing GMO available in shops are specially labelled. The respondents considered that there are no reliable studies concerning health effects of the consumption of GMO. The adolescents in the study reported that they had poor knowledge pertaining to health effects of consumption of food containing GMO.

When asked about the consequences of the cultivation of GM plants, the schoolchildren emphasized more benefits than hazards. As positive effects of the cultivation of these plants they mentioned: higher yield, higher productivity of crops, higher resistance of plants to diseases, decrease in the use of mineral fertilizers, decreased use of herbicides, possibility to cultivate marginal soils, decreased dependence of cultivation on weather conditions and climatic changes, and lower contamination of the natural environment. Among the negative phenomena related to the cultivation of GM plants the respondents indicated: superseding traditional plants varieties of GM plants are advertised as more productive than the traditional species) [20], disappearance of biodiversity by cross-pollination of traditional and modified plants, occurrence of weeds resistant to herbicides applied to-date, and loss of control over the expansion of genetically modified plants. Legal trials taking place in America, Europe and Asia against so-called 'theft of intellectual property' of biotechnological companies as a result of pollination of traditional plants with pollen of modified plants which are sometimes sown in very distant fields, are an evidence for the lack of control over the expansion of GM plants. Tests of the volatile properties of pollen showed that the pollen of rape, considerably finer and still more volatile, remain in the air for 3 – 6 hours, and during this time may travel very long distances [21, 22, 23].

With respect to the breeding of GM animals, the adolescents in the study perceived both the negative and positive consequences. Among the negative effects they emphasized the occurrence of new diseases in the animal world, occurrence in an uncontrolled way of new animal species/breeds, disappearance of traditional species, and loss of control over expansion of genetically modified species. As positive effects of breeding GM animals, the respondents mentioned higher productivity of breeding, production of new medicinal products for humans (in Poland, the techniques of genetic engineering used in many scientific centres have found their application for the production of some drugs, human insulin is produced from genetically

modified organisms, also research efforts to obtain other pharmaceuticals and vaccines are very advanced) [24], higher immunity of animals to diseases, and possibilities to produce organs for human transplantations. In respondents' opinions, the information provided by the media concerning benefits from GM plants are unreliable and untrustworthy, because investigations are most often sponsored by biotechnological enterprises. According to ecologic organizations, GMO is supported by the interests of large corporations. The larger the size of areas sown with GMO, the greater the scope of the corporation power [25]. In recent years, research centres have been created which are independent from biotechnological enterprises, financed, among others, by the EU, which are focused on studies of the effects of GM on health and the environment.

Genetically modified food evokes controversy in Polish society, and the introduction of GMO crops on a wide scale would be associated with the State acting against the will of its citizens. It is recommended that society should be provided with reliable information based on the latest scientific studies. Such activities should be undertaken by independent centres, which would pass on information in an objective way. However, the effect of various groups of interest should be excluded, both producers of modified organisms and ecology farmers [26].

The schoolchildren examined relatively sceptically approached the achievements of biotechnology in the area of genetic modification of plants and animals, which is confirmed by low interest in the possibility of cultivation of GM plants or breeding GM animals on own farm in the future. The results of the presented study are consistent with the attitude of societies worldwide towards GM crops, characterized by an increasing caution of producers and consumers with respect to transgenic food. Studies of the public opinion in the European Community of 2010 showed that the social protest against genetically modified food is 61%. Also, in the study ordered by the European Commission, 87% respondents did not believe that GM food could be better than natural traditional products. Approximately 70–75% of Poles are against GMF [27].

The respondents rather do not trust food produced based on GM organisms. Consumers increasingly more often pay attention to the composition and nutritional values of the food products they buy in the shops. Adolescents evaluate food containing GM components as dangerous and harmful for health, and they are ready to pay more for food products without genetically modified components. Young people are increasingly more often aware that an adequate and good quality food, so-called health food, is a precondition of a good state of health, the span and quality of life.

To the majority of adolescents the production of GM food means primarily enrichment of biotechnical enterprises, risk of occurrence of new human health disorders, higher profits for food producers and higher risk of unfavourable genetic changes in humans, more rarely elimination of many diseases haunting humans, improvement of health situation of humanity or elimination of hunger in the world.

In the opinions of adolescents attending secondary schools biotechnological enterprises which carry out research concerning GMO should be supervised by governments and regulated by law, because in their functioning they are not guided by ethics and morality, and do not conduct reliable studies of the effects of GMO on human health, do not pay

attention to the protection of the natural environment and are oriented only to profit from the sale of seeds.

CONCLUSIONS

1. Knowledge concerning the possible health effects of consumption of food containing GMO among adolescents completing secondary schools is on a relatively low level; the adolescents examined know 'rather little' or 'very little know' concerning this problem.
2. According to the respondents' opinions, the results of reliable studies concerning the health effects of the consumption of GMO 'rather do not' exist.
3. The respondents are against the cultivation of plants and breeding of GM animals on their own farms in the future.
4. In opinions of the adolescents in the study, the production of genetically modified food means primarily the enrichment of biotechnological enterprises, higher income for food producers, and not the elimination of hunger in the world or elimination of many diseases haunting humans.

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