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Acceptance of Genetically Modified Foods among Maltese Youths: Can Exposure to Formal Knowledge Make a Difference?

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This article examines the perceptions and acceptance of GM foods in 217 Maltese youths and attempts to establish whether exposure to formal channels of knowledge—such as biology tuition—may act to predispose students to be GM-technology receptive. Regardless of gender or academic background, students were found to be supportive of creating GM plants but opposed to the creation of GM animals. However, this study showed that those who had been exposed to formal-based knowledge were generally more positively disposed to purchase plant-derived GM foods, while those who had been exposed to informal knowledge (minimum to no biology) were negatively disposed to the purchase of GM produce. These results have implications for companies producing GM products, as well as decision makers.

Key words: biology, genetically modified foods, perceptions.

Introduction

Genetically modified (GM) foods are those that have been produced by biotechnological techniques and involve the deliberate transfer of genes across species. Techniques that allow modification of almost all of the major food crops have been developed and most of the major food crops including maize, sugar-beet, rice, and soybean have now been modified to express traits such as resistance to common insect pests and tolerance to a spectrum of herbicides. Today, genetically modified agri-produce represents one of the fastest growing industries, and in 2008, the global area of GM crops registered an increase for the tenth consecutive year—reaching a total of 125 million hectares (James, 2008). That is more than a 60-fold increase over the corresponding 10-year period.

Despite the fact that GM crops have been largely accepted by the farming community, European consumers remain among the most staunchly opposed to GM-derived foods and regard them as 'not offering benefits, as unsafe, as unequitable and as worrying'(Gaskell et al., 2010). The most recent Eurobarometer survey on Europeans and biotechnology shows that although there is variation across Member States, the dimension that most differentiated supporters and opponents was the issue of safety, with 'opponents showing marked—almost extreme—concerns about safety, and proponents being marginally convinced of the safety' (*ibid*). Given the growing commercial and economic importance of the field and the embedded resistance of some European consumers, it is therefore pertinent to ask just how attitudes towards GM crop safety are influenced. An understanding of these factors could begin to mitigate consumer fears. The seminal paper by Frewer, Howard, and Shepherd (1997) showed that attitudes towards biotechnology are application-specific, with applications involving plants being viewed as more acceptable than those involving animals. For example, in the United States, where GM products enjoy relatively higher acceptance by consumers than in Europe, half of those interviewed supported plant-based genetic modifications; only a quarter approved of its use in animal agriculture (Halman, Hebden, Aquino, & Lang, 2003). Furthermore, data now shows that in the absence of a concrete understanding of complex issues such as gene technology, people rely on and turn to social trust to reduce the complexity of risk-management decisions (Earle & Cvetkovich, 1995; Luhmann, 1989). Therefore, confidence in social organizations such as government organizations, the laws controlling gene technology and trust in scientists and companies doing genetic modification has been shown to have a positive bearing on risk perception (Siegrist, 2000), while trust in environmental groups is correlated with a negative risk perception (Hoban, Woodrum, & Czaja, 1992). Additional research has shown that consumers' perceptions and attitudes are influenced by family, friends, class, and their culture (Fritz et al., 2009). A recurrent observation is that in the absence of an opinion, persons may be influenced by prevalent cultural views.

Likewise, it is now widely accepted that gender differences exist in the perceptions of gene technology. Repeated studies have shown that females perceive fewer benefits and demonstrate less acceptance of gene technology (Siegrist, 2000). This is in turn thought to be correlated with women's traditional role as nurturers

and care providers, which is thought to result in a greater concern with health and safety than men (Moerbeck & Casimir, 2005). Interestingly, the non-religious tend to be more optimistic about the contributions of technology (Gaskell et al., 2010), and hence would be expected to be more supportive of technology in general. Published data also shows that young adults are more accepting of technology and less likely to hold menacing views of GM food than older people. This higher level of acceptance was not found to be linked to a greater level of knowledge (Gaskell et al., 2006).

The relationship between previous knowledge and risk perception of GM products is more tenuous, and the amassed data appears contradictory. In a succession of papers on acceptance of genetically engineered produce in Dutch individuals, Hamstra (1995) and Hamstra and Smink (1996) failed to identify a link between prior knowledge and attitudes. Likewise, studies by Bredahl (1999); Bredahl, Grunert, and Frewer (1998); Frewer et al. (1995); and Grunert et al. (2000) failed to show a relationship between knowledge and acceptance of GM products. In contrast, Halman et al. (2003) showed that higher-educated individuals were more likely to choose GM products. In their study on a total of 2,039 Italians, Bucchi and Neresini (2002) showed that information that was media-derived did not guarantee a positive attitude towards biotechnology. Significantly, they concluded that attitudes toward scientific issues are often rooted at deeper cultural levels where 'values such as trust of institutions are heavily involved,' and they pointed out that level of education seems to be more important than other factors in explaining attitudes toward genetic transfer. They also concluded that 'as much attention should be directed to science education as to the mass-media communication of science.' However, most recently in a 2010 study of respondents from across all the EU member states, Gaskell et al. (2010) showed that 'awareness' of GM products was not associated with increased preference for GM products.

In our study, we focused on the issue of why conflicting results with respect to previous knowledge and perceptions risks have been reported. The question addressed was whether variations in the baseline knowledge of the respondents were in fact altering perceptions of GMOs. We therefore sought to establish the platform of formal knowledge claimed by respondents by distinguishing between persons who had benefited from a formal understanding (such as that derived from biology tuition) and those with a more informal background (derived from the media or independent study). To this end, clearly different groups were selected for this study: those who had been exposed to biology tuition and a control group who had been exposed to minimum-to-no levels of biology in their education.

The Maltese Islands

The Maltese Islands form a small land mass of just over 300 km^2 in the southernmost part of Europe, inhabited by slightly over 420,000 persons. Traditionally, the Maltese fall into a band of Mediterranean Member State countries that report moderate levels of support for GM products in Eurobarometer studies. More than 32% of the Maltese interviewed in these same studies consistently support statements such as 'agree or totally agree that GM food should be encouraged' (Gaskell et al., 2006, 2010). This is slightly lower than the raised levels of support reported for other Mediterranean countries such as Spain and Portugal and is similar to the levels reported for Italy; however, it is considerably higher than the strong opposition reported by respondents from Greece or Cyprus.

This study differed from other studies (such as the Eurobarometer studies) in that it used a cohort with uniform cultural background, level of education, and age; the participants only differed in background knowledge.

Materials and Methods

Students at the end of their first year of post-secondary education at Junior College, Malta, were invited to participate in the study. Junior College is the largest public institution offering post-secondary education prior to entry into the University of Malta. It receives almost 20% of all adolescents who finish secondary education (Vallejo & Dooly, 2008) and therefore offers a unique catchment facility, offering insight into the behavior of a static cohort of 16-18 year olds. The education system in Malta allowed the students within the study to be categorized into the two broad groups required in this study. Those that had been exposed to biology-based options (identified as Group B) and those that had been exposed to minimal-to-no biology during their secondary education (encompassing arts, economics, but including areas such as maths and physics fields) were identified as Group MB. This assumption was invariably supported by the individual student's own response to the questions 'have you ever benefited from formal training in biology' and 'have you heard of genetic modification before' (Table 1). Students were specifically selected in their first year of study as they would not yet have covered applications of agricultural biotechnology in their curriculum, allowing a distinction between the two

Table 1. Summary of students' understanding.

Students who had been exposed to biology (Group B)	
Percentage of students %	**Individual student's description of level of understanding of genetic modification**
13.0	A great deal (from school)
80.9	Some understanding (from school)
3.0	Not sure
3.0	Nothing
Students who had been exposed to minimal or no formal biology tuition (Group MB)	
Percentage of students %	**Student's description of level of understanding of genetic modification**
0	A great deal
7.0	Some knowledge (from TV)
18.0	Some knowledge (unspecified)
35.0	Not sure
40.0	Nothing

groups based on differences in *prior* exposure to biology.

Participation was on a voluntary basis and consisted of a short interview, during which each student was administered a questionnaire based on that developed by Halman and Metcalfe (1994). The modified questionnaire was built around three sections. In the first section, students were asked to describe terms associated with the fields of genetic modification and biotechnology. They were then asked if they had followed formal training in the field of biology, to rate their own understanding of genetic modification, and to list the sources of their knowledge.

The second part of the questionnaire contained questions that dealt with the students' level of approval of products of the biotechnology industry. This was followed by a third section that investigated the factors that could be influencing student perceptions. Students were given the option to select a positive (*approve/willing*) option, a negative option (*disapprove/not willing*), or a *not sure/no answer.*

A total of 217 persons took part in the study; 57.9% were females and 42.1% were males. As stated previously, the cohort did not have a uniform exposure to biology-based knowledge. A total of 51.6% reported having studied biology at the secondary-school level and were furthering their biology studies at the post-secondary level, while 48.4% reported minimal-to-no exposure to formal biology-taught programs.

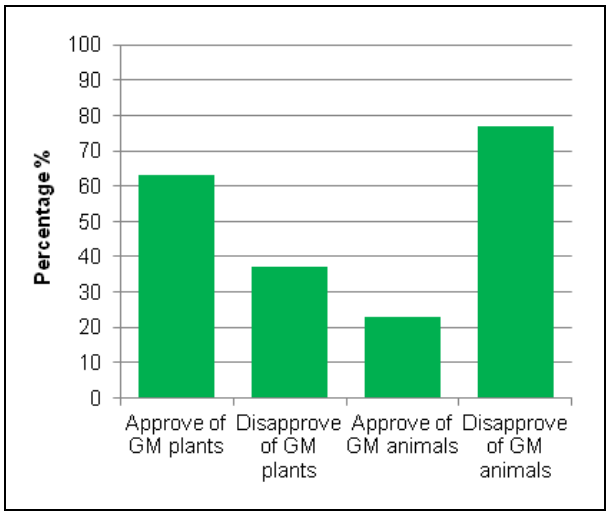

Figure 1. Percentage of students showing different attitudes to genetically modified organisms.

Attitudes Towards GM Products

As would be expected, the students claimed to have different levels of understanding of genetic modification, with 93.9% of Group B stating that they knew 'a great deal or some understanding' of genetic modification. The group overwhelmingly claimed that their knowledge was derived from school (Table 1). In Group MB, the reverse was true; almost 75% of students reported that they had no knowledge or were not sure if they had heard of the term genetic modification. The latter group had a by-far greater percentage of students who cited media as their knowledge source. This has implications because, as far back as 1998, Frewer, Howard, and Shepherd showed that television, radio, and newspapers tend to be the main sources of information on biotechnology among the general public and these sources tend to be associated with more negative perceptions of GM foods (Vilella-Vila & Costa-Font, 2008). Surprisingly both groups failed to mention the Internet as a source of knowledge about genetic modification.

Creation of GM Plants

Overall, the data shows that Maltese students have positive perceptions of gene technology, with 62.0% of the total cohort who expressed an opinion reporting that they 'approved of creating GM plants' (Figure 1).

These values are much higher than the EU average for the same age group; in a sample of adolescents across EU Member States, only 32% agreed that 'GM crop technology was to be encouraged' (Gaskell et al., 2006). Further analysis of the results (Table 3) showed

Table 2. Moral considerations of genetically modified organisms.

Statement		Minimal biology (MB) % n=106	Biology (B) % n=111
Do you believe that creating these plants is morally wrong?	**Morally wrong**	9.6	12.04
	Not wrong	32.6	21.0
	Depends	45.1	54.2
	Not sure	9.6	12.1
	No answer	3.1	0
Do you believe that creating these animals is morally wrong?	**Morally wrong**	51.9	46.9
	Not wrong	10.5	12.0
	Depends/ Not sure	37.5	41.1

that there was a positive correlation with gender, with males reporting higher levels of approval towards GM plants than females ($p<0.05$).

Despite the overall positive attitude towards GM plants, this approval was not extended towards GM animals. In fact, just 22.0% of the whole cohort who had expressed that they 'approved of the creation of GM animals' (Figure 1). This is consistent with published data that shows that among EU citizens, greater disapproval is reserved for GM animals. This reticence appears to be related to considerations of morality and fears of playing God (Gaskell et al., 2006). In fact, less than 13.0% of students from each stream thought that modifying plants was morally wrong; but, more than 49.0% from each group were concerned about the morality of modifying animals (Table 2). The opposition to modifying animals reflects a common perception among Maltese that organisms show a hierarchal arrangement whereby animals are perceived to be more worthy of protection than plants, with the latter relegated to the lowest rungs of the hierarchy. Of note, approximately 37.0% of students selected the '*not sure/ depends*' answer to the question of whether they thought creating GM animals was morally wrong; among these, several commented that their approval would be dependent on the intended end-use. The creation of a GM animal that expresses a vital chemical used in the treatment of a life-threatening disease may be justifiable to overcome their qualms over immorality. However, the creation of a GM organism for food purposes alone would not.

Willingness to Purchase GM Products

Students were then asked whether they would purchase various GM products if they retailed at the same price as their non-GM equivalents. The students were most willing to purchase GM apples (52.5%), followed by GM potatoes (51.7%) and GM tomatoes (47.3%). The latter are staples of the Mediterranean diet and affirm the positive attitudes towards plant-derived GM products. Conversely, students reserved high levels of rejection for GM animal-derived products such as baby food (24.2%), beef (25.5%), and milk (27.8%). The rejection of GM beef and milk appears to be linked to the students' unease with the creation of GM animals. This unease with the concept of purchasing GM-derived animal products has important implications to the industry. Even in a cohort with overall positive attitudes towards GM foods in general, attempts to introduce GM products that are derived from animals would be deeply unpopular.

Degree of Trust in Social Institutions

Students were then asked which institutions they would rely on for information on GM products. Most students (97.2%) reported great trust in University scientists, followed by government organizations (61.4%), farmers (56.7%), biotech companies (49.7%), and ultimately representatives of the Catholic Church (42.9%). As has been shown in other studies, University scientists enjoy the benefit of being seen as independent experts, and the great faith placed in this sector is consistent with the results seen in other studies in the United States and Japan (Hoban, 2001), in American youth (Knight, 2006), in EU studies (Gaskell et al., 2010), as well that reported in a pilot study of a group of Maltese adolescents by Zammit-Mangion (2010).

Correlation with Biology in Educational Background and Gender

In order to determine which variables were influencing student attitudes towards GM foods, the chi-squared test was applied to all the data collected, and the numbers were analyzed in terms of gender and then by background knowledge. The results are presented in Tables 3 and 4. Gender was found to affect certain choices, with

Table 3. Data analyzed by gender (* statistically significant at p<0.05).

		Male		Female			
		Willing	Not willing	Willing	Not willing	n	Chi square
1	Do you approve or disapprove of creating GE plants using genetically engineered techniques?	49	19	51	42	161	4.94**
2	Do you approve or disapprove of creating GE animals using genetically engineered techniques?	23	51	15	80	169	0.35
3	How willing would you be to buy the following GE products if they were available at the same price as non GM products?						
	Apple	41	44	70	56	211	0.05
	Corn	36	48	51	66	201	0.43
	Milk	31	52	26	96	205	1.64
	Tomatoes	43	43	57	68	211	0.39
	Beef	32	58	22	99	211	8.18**
	Baby food	12	50	40	112	214	1.16
	Potatoes	42	46	63	52	203	3.22
4	How much faith would you have in statements about GE produce made by the following institutions?	Faith	Little/ no faith	Faith	Little/ no faith		
	University scientists	89	1	118	5	213	1.65
	Local farmer	45	36	65	48	194	0.07
	Companies	44	42	58	61	205	0.24
	Government organizations	52	33	66	41	192	1.74
	Catholic church	41	43	32	54	170	2.33

*Calculations are based on those who expressed an opinion. *Statistically significant at p<0.05, **Statistically significant at p<0.01*

females being significantly less likely to approve of GM plants and less willing to buy GM beef than males ($p < 0.01$). This recurring pattern reflects the conservative views of females with respect to new technologies, their greater concern with safety, and low perceptions of benefits (Siegrist, 2000).

However, the variable that was found to correlate most strongly with student choice was the level of biology in the educational background. Exposure to biology was found to be correlated with greater students' willingness to purchase the following GM-derived products: GM apples ($p<0.05$), GM corn ($p<0.01$), GM tomatoes ($p<0.01$), and GM potatoes ($p<0.01$). Trust in institutions was not found to be correlated with gender or levels of biology in the educational background.

Discussion

This cohort is characterized by higher levels of approval for GM crops than their European counterparts. Several factors could be contributing to these positive attitudes. Due to restrictions of land size and the difficulty of complying with the EU obligations required when cultivating GM crops in a heavily built-up and densely populated area, GM crops have not been cultivated nor have GM trials been carried out locally. Thus, like many Americans, Maltese are largely unaware of the extent to which biotechnology has become part of the food supply (Fritz et al., 2009), and for the immediate future genetic modification is likely to remain perceived by the Maltese population as involving largely theoretical issues.

Faced with largely abstract dilemmas, it is interesting to study the attitudes of Maltese youths with respect to GM products. The results establish that they are characterized by positive attitudes towards GM crops, and this is in agreement with previous studies on the behavior of Maltese adults by Gaskell et al. (2006, 2010). Furthermore, this study showed that Maltese youth would be prepared to select certain GM produce if it retailed at exactly the same price as the non-GM product. It may

Table 4. Data analyzed by the level of biology reported in their educational background.

		Biology (B)		Minimal biology (MB)			
		Willing	Not willing	Willing	Not willing	n	Chi square
1	Do you approve or disapprove of creating GE plants using genetically engineered techniques?	56	25	44	36	161	3.41
2	Do you approve or disapprove of creating GE animals using genetically engineered techniques?	21	61	17	70	169	0.89
3	How willing would you be to buy the following GE products if they were available at the same price as non GM products?						
	Apple	69	42	42	58	211	8.57**
	Corn	52	49	35	65	201	5.56**
	Milk	33	74	24	74	205	1.02
	Tomatoes	60	49	40	62	211	5.29**
	Beef	30	77	24	80	211	0.68
	Baby food	14	91	13	96	214	0.09
	Potatoes	64	41	41	57	203	7.4**
4	How much faith would you have in statements about GE produce made by the following institutions?	Faith	Little/ no faith	Faith	Little/ no faith		
	University scientist	110	2	97	4	213	0.91
	Local farmer	58	44	52	40	194	0.002
	Companies	54	54	48	49	205	0.005
	Government organizations	68	34	50	40	192	2.49
	Catholic church	38	51	35	46	170	0.004

*Calculations are based on those who expressed an opinion. *Statistically significant at p<0.05. **Statistically significant at p<0.01*

well be that in the absence of a clear understanding of what constitutes genetic modification, the perceived levels of risk are diminished due to cultural attitudes inherent in Maltese society. As a Mediterranean society, these include the value of conformity and high trust in social organizations. Overall positive perceptions and low pessimism related to science (Gaskell et al., 2010), as well as positive media influences, may also play a part. It is also possible that for an island community, food availability and related issues may be perceived as more serious an issue and related issues may be perceived differently. In these respects, Maltese appear to share a lot in common with countries of the developing world (Curtis, McCluskey, & Wahl, 2004).

At the same time it should be acknowledged that Malta has invested a great deal of financial resources and energy into implementing a regulatory system concerning genetically modified organisms (GMOs) based on the rigorous requirements of the EU Acquis, in particular Directive 2001/18EC and Regulation 1829/2003EC. As far back as 2002, a Maltese Biosafety Coordinating Committee became responsible for the potential release of GMOs (including processed GM foods and feeds) into the environment; in 2006, a National Biosafety Framework outlining the responsibilities of all stakeholders within the country was placed in the public domain for engagement with the public. Following this, Malta became party to the Cartagena Biosafety Protocol. To date, a largely cautious approach towards GM crop introduction has been adopted by the regulatory bodies, and this approach seems to have paid off in terms of non-alarmist media-attention from NGOs, consumer groups, and the general press (Camilleri, 2010; Zammit, 2010). Furthermore, in a country that is still predominantly Catholic (98% of the population is reportedly Catholic, although not all are practicing), the role of the Catholic Church cannot be ignored. Recent press reports that the Vatican has recognized the role of transgenic plants in food security has also contributed to the absence of a pessimistic culture (Pontifical Academy of Sciences, 2009).

Where does this leave Maltese youth on issues concerning governance and ultimately decisions concerning GMOs? Ultimately, who could be trusted as the gatekeepers locally? The results of this study imply that the one-path scientific decisive process so favored by regulatory bodies globally may not be the ideal. In fact, where GM plants and their products are concerned the results imply that Maltese would be satisfied with a decision process involving scientific delegation. This term was used by Gaskell et al. (2010) to indicate a situation where decisions would be made by experts on the basis of scientific evidence (i.e., the Maltese *Biosafety Coordinating Committee*). However, this article shows that rejection of GM animals for food purposes is firmly rejected by moral concerns in the psyche of Maltese youths regardless of gender and education. Therefore, a decision process based on moral deliberation would be regarded more favorably. This could be of relevance to other European consumers and politicians.

As has been described elsewhere in the literature, gender was found to play a part in influencing students' opinions; females had generally more conservative views, and higher percentages reported that they would reject the GM product. First, this could be due to women tending to be more concerned about health and safety than men, and secondly, they also tend to perceive fewer benefits in gene technologies (Siegrist, 2000). In the eventuality that higher levels of GM products reach the local market, the gender difference is likely to be important in the final acceptance of GM products by a household, since females tend to be involved in selection and purchase of household products. Even if males do end up shopping, they tend to shop according to a list made by their partners (Moerbeck & Casimir, 2005).

Most importantly, while this study certainly confirms the general pro-GM stance of Maltese youths, it indicates that even for such a cohort, choice differences could be identified based on cognitive factors. Exposure to formal knowledge (as provided by biology tuition) was found to be strongly correlated with greater willingness to purchase certain GM products. It may be that when faced with a situation that requires assessment followed by choice, these students rely on more objective information at their disposal. This objective knowledge serves to reduce the perceptions of psychological risk associated with GM foods (Klerck & Sweeney 2007). The present study also repeats the recommendation by Bucchi and Neresini (2002) that attention should be directed toward science education and reiterates the critical importance of science literacy in today's world for understanding new knowledge and technologies (Alberts & Labov, 2003). Without this scientific framework, people will rely on culture and family-based influences, which are likely to be subjective sources of information.

The question of the extent to which these results would be replicated by general Maltese society is of course a legitimate one. A logical progression for this study will therefore be to carry out the same study using adults and to identify whether the effect of formal training is dampened with time or rather is maintained.

Ultimately, this study offers insight that certain types of formal knowledge can reduce the perceived risks in using certain GM products and offers support for the earlier suggestion by Zechendorf (1998) that knowledge is linked to greater acceptance of biotechnology, hence the positive trends shown in countries such as Netherlands and Finland. However, the knowledge must be factual, objective, and rooted in the foundations of biology; 'self or media-derived awareness' alone is not sufficient. This study offers a way out of the current deadlock where GM products are concerned. Manufacturers, politicians, and decision-making bodies such as the European Food Safety Authority (EFSA) could consider looking towards improving formal knowledge as a means of counteracting the disparate messages generated by media.

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