

**Attitudes of the general public towards genetically modified organisms
(GMOs): The paradoxical relationship between knowledge and attitudes**

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Abstract

Biotechnology can be subdivided into application domains such as green (plant), red (medical), and white (industrial) biotechnology. In the context of green biotechnology, GMOs are a central theme. The application of GMOs is controversial and public opinion is rather negative towards GMOs. According to the Eurobarometer survey the general attitude towards green biotechnology is negative in Europe, although attitude differs between countries and over time. In Flanders (the Dutch speaking part of Belgium), there was a revival of the GMO-debate as the result of the destruction of a potato field experiment in 2011. Apart from the limited info available from the Eurobarometer study, no empirical research has thus far been set up about attitudes towards biotechnology in the Flemish context, especially in relation to green biotechnology, e.g., the case of GMOs.

Our present study evaluated the attitude towards green biotechnology in a randomly stratified sample of 4363 adult Flemish citizens (stratification variables: age and educational background). Secondly, their knowledge was measured and linked to their attitudes. A subjective (what people think they know), as well as an objective (what they actually know) knowledge score was calculated. The latter was based on a test consisting of true/false and short answer questions regarding genetics, biotechnology and commercialization of GM food. Attitudes towards green biotechnology were tested on the base of reactions towards green biotech applications (5-point Likert scale).

The results point at a rather positive attitude of Flemish citizens towards plant biotechnology ($M= 3.80$, $SD=.76$, max 5). In contrast, the knowledge of Flemish citizens about biotechnology seems very poor ($M=9.69$, $SD=3.95$, max 20). Knowledge hardly predicts attitudes ($F(1,4360)= 90,58$, $p< 0.01$; $R^2= .020$). These findings are not in line with current literature where a positive relationship between knowledge and attitudes is stressed. Our paradoxical findings can be explained by the fact that in Flanders, the overall attitude towards green biotechnology is positive. Although the media suggest a clear opposition against GMOs, our data show that the general audience is rather indifferent and even supportive of GMOs. This implies that at a theoretical level, knowledge might be important, but might not be considered as the only factor affecting attitudes. This has clear implications for GMO related campaigns.

Introduction

Genetic modification (GM) technology in food production is a contested subject. Genetically modified organisms (GMOs) are defined as organisms whose DNA has been altered using recombinant DNA technology to improve specific characteristics. Unless stated otherwise, the term 'GM' or 'GMO' refers in this article to plant related applications and can also be interpreted as plant or green biotechnology.

The continuous contest between proponents and opponents makes the study of attitude towards GMOs important especially when this debate creates a problematic situation for the endorsement of new genetically modified food products (for cultivation) in Europe. The approval procedure of GMOs itself is based on an anti-GMO thought as it erroneously assumes that GM crops inherently differ from conventional crops (Ammann,

2014). Since the introduction of the GM technology, scientists have conducted studies to measure perception and attitude towards or acceptance of GMOs and concluded that Europeans had a rather negative attitude towards them (Bredahl, 2001; Costa-Font, Gil, & Traill, 2008). The Eurobarometer on biotechnology is the most recent GM-attitude study conducted in Europe (Gaskell et al., 2010). This triennial study – set up since 1991 – concluded that European citizens find GM food to be unsafe, inequitable, worrying and to offer no benefits. In Belgium, only 28% (totally) agreed with the question “Should GM food be encouraged?”. Compared to results of earlier Eurobarometer studies, there are differences in attitude between countries and also fluctuations within countries. Regularly re-assessing GM-related attitude seems therefore necessary to develop a clear and updated picture on citizen’s attitude.

The present study focuses on GM-related attitude in Flanders, the Dutch speaking part of Belgium, where pioneering research in the field of GM was initially set up (Herrera-Estrella, Depicker, Van Montagu, & Schell, 1983). But, due to persistent protest, a moratorium on GM crops from 1998 to 2004 and increasing negative public attitude, it was – up to this date - impossible to valorize any of the research findings into commercially grown crops in Flanders. In 2011 there was a revival of the GMO-debate due to the destruction of a GM potato field trial in Flanders.

Apart from the limited information available from the Eurobarometer study, no empirical research has thus far been set up to assess attitude towards GMOs in the Flemish context.

Attitude is a broad concept being defined in many ways. Eagly & Chaiken (1993) define attitude as a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor. Looking at the Eurobarometer results, it can be concluded that attitudes are not stable. Albarracín, Johnson, & Zanna (2005) therefore put forward that attitude can be reflected in a temporary state of consciousness or in permanent memory. People will often form judgments based on information that quickly changes in time (Albarracín et al., 2005). This implies that events such as protest actions, media-hypes as well as the spreading of wrong/misleading information influence people’s attitude. When measuring attitude it is therefore important to monitor attitude-related events and to study the related impact. In the present study, we could consider as an

example of such an attitude-related event the recent destruction of a GM potato field trial that was widely discussed in the media during a long period of time near before the start of our analysis (De Krom, 2012; Krom, Dessein, & Erbout, 2013; Kuntz, 2012).

Knowledge influences attitude formation or change. Literature suggests that increasing knowledge about GM is related to a positive attitude towards (plant) biotechnology (Boccaletti & Moro, 2000; Costa-Font et al., 2008; Hossain, Onyango, Schilling, Hallman, & Adelaja, 2003; Knight, 2006; Moerbeek & Casimir, 2005; Moon & Balasubramanian, 2001, 2004). But House et al. (2005) put forward studies contradicting this positive relationship. They criticize the way knowledge is measured and distinguish between subjective knowledge (what people think they know) and objective knowledge (what people actually know). These authors concluded that subjective knowledge was more strongly related with the acceptance of GMOs as compared to objective knowledge. In the present study, we will include both types of knowledge.

Other variables like gender, age and educational level can also have an influence on attitude. For example, several studies show that females on average have a more negative attitude towards GM food (Chen, 2011; Legge Jr & Durant, 2010). These variables were included in this study.

Research Aims

The first aim of this study was to explore the attitude towards GM plants in Flanders (Belgium). Second, subjective and objective knowledge were measured. Thirdly, the relationship between knowledge and attitude towards genetically modified plants was explored. At the same time, the potential interaction with background variables was studied.

We questioned whether there is a positive linear relationship between a positive attitude towards GM plants and higher knowledge levels. We expect that more highly educated people will be more positive towards GMOs because of their more advanced knowledge of the subject and their scientific interest in it.

Methodology

Research Design

A paper version of a questionnaire was administered to people from Flanders (Belgium) with a certain profile (stratification according to age and educational background) to study the research aims and to test the related hypothesis. The time to complete the questionnaire was estimated to be 25-30 minutes. This study was conducted from the 15th of march till the 8th of may 2013.

Participants

In total 4363 people were involved in this study. The resulting sample consisted of 51.7% females and 48.3% males. The average age was 46.77 year, varying from 20 to 93 years. Participants had to meet specific condition like age, gender and education level. There were 5 age groups: 20-30 years (20.3%), 31-40 years (17.0%), 41-50 year (21.1%), 51-60 years (20.7%) and plus 60 years (20.9%). There were 3 classes of education level. People whose highest certificate was primary school were classified in the first class (16.6%), while people with a certificate lower secondary school or higher secondary school were assigned to the second class (42.2%). The third class included highly educated participants who had completed college or university (41.3%). Participants contributed voluntary so they didn't receive any form of compensation. All results were entered in a standardized Excel file that could be easily integrated in an SPSS file.

Research Instruments

A survey on paper was presented to participants, consisting of the following parts: (1) socio-demographic information; (2) respondents' subjective and objective knowledge about genetics and biotechnology and (3) their attitude towards GMOs.

First, sample characteristics such as gender, age and education level were included in the questionnaire. Second, the respondent's knowledge about genetic modification was measured in two different ways: The *subjective knowledge* about GM was measured using five self-designed statements about how familiar people think they are with GMOs. These items were evaluated using a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The reliability of the subjective

knowledge cluster was high (Cronbach's $\alpha = .88$). The *objective knowledge* (score on 20) was measured using 13 true and false questions about genetics, biotechnology and GMO legislation as well as short answer questions like 'Where in the human body are the genes?' In addition, participants were asked to indicate which organisms (of a list of 5) contained DNA. A standardized sum score was calculated on the base of all correctly answered questions. Finally, participant's attitude towards GM plants was measured by asking the respondents to evaluate six cases with a GM application. A five-point Likert-like scale was used, varying from (1) *I am very negative about this application* to (5) *I am very positive about it*. Only cases of green biotechnology were included because several studies already showed that the general attitude towards medical applications of biotechnology is more positive and the main problem is genetically modified food (Eurobarometer, 2006; Savadori et al., 2004). The cases were about (1) disease-resistance, (2) enhanced nutritional value, (3) yield increase, (4) stress tolerance for cold or salt, (5) biofuel and (6) molecular pharming in plants.

Data analysis

Survey data was transferred from the Excel file to SPSS, version 20. Sum scores were calculated for Attitude and both types of knowledge. Regression analysis was performed to verify the influence of knowledge on attitude.

Results

First the subjective knowledge was measured: people think that they have a quite good knowledge about GMOs ($M=16.91$, $SD=5.21$, $Max.=25$). But the objective knowledge scores reveals that their knowledge about genetics and biotechnology is very poor ($M=9.69$, $SD=3.95$, $max.=20$). The average score on the true/false questions was $5.00/13$ ($SD=2.72$). The attitude of the Flanders citizens towards green biotechnology was positive ($M=3.80$, $SD=0.76$, $max=5$). They were the most positive about the biofuels with a score of 4.0 ($SD=.94$), followed by the production of pharmaceutical proteins in plants with $M=3.91$ ($SD=.94$). They were the least positive towards genetically modified plants that had a higher yield ($M=3.59$, $SD=1.026$). In view of a regression analysis, the correlation between the research variables was studied. A rather high correlation was

observed between the subjective and objective knowledge ($r(4358)=-.552$, $p<0.01$). The correlation between the subjective ($r(4357)=-.162$, $p<0.01$) and objective knowledge ($r(4361)=-.143$, $p<0.01$) and attitude towards GM plants is weak. The results of the stepwise regression analysis indicate that both types of knowledge together hardly predict attitude towards GM plants (adjusted $R^2 = 0.03$, $F_{(2, 4356)}=68.15$, $p<0.01$).

Discussion and conclusion

Worldwide, Flanders is a major player in the field of biotechnology. Therefore it is of great value to evaluate what Flanders' inhabitants think of GM and what they know about it. Especially because attitude penetrated at political level and influences the legislation on GMOs. In this study we focused on the opinion of the citizens of Flanders. First, our study demonstrated that people have a rather positive attitude towards GMOs. No GM application was (rather) negatively evaluated. The attitude towards GM plants ranges from rather positive to very positive. Based on studies from other countries and the results for Belgium in the Eurobarometer, we expected a more negative attitude (Gaskell et al., 2010). A possible explanation could be that the recent GM potato field trial destruction in Flanders resulted in more sympathy for scientists and their GM potato. Also, no possible risks were mentioned in the cases in our questionnaire, and the specific applications were exemplified by referring to possible advantages. In that regard, it has been reported that the formulation of the questions could clearly have an influence on the outcome of the results (Desaint & Varbanova, 2013). In addition, the results of our study reveal that people think they know a lot about GM whereas their actual knowledge level is poor. The predictive value of both types of knowledge on attitude towards GM plants was measured through a stepwise linear regression model. The regression analysis shows that knowledge explains only 3.0% of the variance in attitude. What people 'think' they know seems to have a stronger influence on attitude as compared to what they actually know. This is confirmed by other studies (House et al., 2005; Lusk et al., 2004). This can be explained by the fact that people with a higher subjective knowledge feel less influenced by new information (Lusk et al., 2004).

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