Factors Affecting College Students' Knowledge and Opinions of Genetically Modified Foods

Chad M. Laux, PhD – corresponding author
Visiting Assistant Professor
Purdue University
2705 Enterprise Drive
Anderson, IN 46013
claux@purdue.edu
ph: 765-648-2905
fax: 765-648-2912

Gretchen A. Mosher
Graduate Research Assistant
Iowa State University
1551 Food Sciences Building
Ames, IA 50011
gamosher@iastate.edu
ph: 515-294-6358
fax: 515-294-6383

Steven A. Freeman, PhD
Associate Professor
Iowa State University
104 Industrial Education Bldg. II
Ames, IA 50011
sfreeman@iastate.edu
ph: 515-294-9541
fax: 515-294-1123

Executive Summary

The use of biotechnology in food and agricultural applications has increased greatly in the past decade and is considered a highly controversial topic. To determine factors which may affect the opinions on genetically modified (GM) food products in college students, students attending a Midwestern land-grant university were surveyed. Factors examined included nationality and discipline of study of the students, awareness levels of GM food, acceptance levels of GM food, and safety perceptions genetically modified food. Results indicated students born outside of the United States had more negative opinions of genetically modified foods than American-born students. Students who were studying in a physical-science based curriculum had a more positive opinion of GM food than students studying in a non physical-science based curriculum. In addition, students who reported a higher level of acceptance of genetically modified foods felt more positively about the safety of the technology.

Abstract

The use of genetically modified (GM) foodstuffs continues to be a controversial topic worldwide. A survey of U.S. college students at a large, land grant, Research University was examined. Students born in the United States and students who studied physical science had more positive opinions of GM food than international and non-physical science students. These data are one more illustration of the gap between scientists and non-scientists regarding the genetic modification of foods.

Keywords: genetically modified food, college student awareness, survey study

Introduction and Justification of Study

The word biotechnology seems to be a magnet for polarizing views. The ability to improve plants, animals, and microbes by applying exact genetic changes to existing products is made possible by biotechnology (Keener and Hoban n.d). One prominent use of biotechnology has been in the field of agriculture (Knight 2006; Comstock 2001).

Global use of genetically modified (GM) plants has increased rapidly since their commercial introduction in 1996. Desirable traits such as insect and herbicide resistance and improved nutritional content resulted in a large increase in the number of hectares planted globally. The prevalence of GM crops has increased every year since their introduction and will likely continue (James 2006).

Despite the increased use of GM food products, the process and application of this technology is not well understood in the United States. Several recent surveys demonstrate the lack of understanding regarding GM foods by the American public (Hallman et al. 2004; Falk et al 2002; Hallman and Hebden 2005). When surveyed, approximately one quarter of consumers incorrectly believed very few products in the American supermarket contained food products with GM ingredients. A more accurate estimate is that 60 to 70 percent of food products sold at supermarkets have ingredients produced using genetic modification (Byrne 2006).

American public opinion on the safety of GM food products has remained stable over the last ten years, with approximately one quarter to one third of those surveyed agreeing that genetically modified foods were safe. About one third of the population surveyed disagreed that genetically modified foods were safe and the remaining third of the population remained undecided (Byrne 2006, Hoban 2001; Shanahan 2003).

Nationality also plays an important role in public opinion on biotechnology processes in agriculture. Consumer opinion has been shown to differ by nationality and is believed to be partially based on the nature of consumer trust in experts (Knight 2006). Hoban (2001) found that consumers in the United States and Japan had the highest trust in scientific experts while Europeans perceived consumer and environmental groups to be the most trustworthy. Consumer opinion studies indentify U.S. consumers as the least concerned about negative safety issues related to genetically modified food while European and Asian consumers report more concern (Chern et al. 2003; Pew Initiative 2005).

College students form a sub-population of the general public and this group is of special interest to both researchers and marketers for several reasons. College students are likely to be younger and more highly educated than the general population. They also may have a greater awareness of the concerns of biotechnology use in agriculture (Finke and Kim 2003). Much of this awareness is gained thorough science coursework, laboratory work, professor and instructor beliefs, and beliefs of the student's family. In addition, students at this age may not have formed a strong opinion and may be more open to studying the issues related to biotechnology from a variety of perspectives (Wingenbach, Rutherford, and Dunsford 2003).

College students are also of interest to marketers because of their potential income and their influence on general public opinion. Numerous studies have shown increased lifetime income for college graduates, but the benefits go beyond higher income levels. College graduates are more likely to be more open-minded, with more cultured, rational, and consistent thought patterns. In addition, college attendance has been shown to lower prejudice levels and increase knowledge of global issues (Rowley and Hurtado 2002). These data suggest college students are future opinion leaders and will have the income levels ensuring a high level of choice in purchasing decisions.

For these reasons, the opinions of college students must be an important consideration for agribusinesses that plan to market GM products.

Even with higher education levels, when surveyed about GM products, college students in the United States show a lack of understanding in concepts and processes behind GM technology. Wingenbach, Rutherford and Dunsford (2003) found that while college students surveyed felt confident in their knowledge of biotechnology practices, only 30 percent answered the questions posed to them correctly. A low positive relationship was found between the students' perceived and actual knowledge of biotechnology and between students' assessed knowledge and level of acceptance for biotechnology practices.

In addition, nationality has been found to be a significant factor in college student opinion concerning genetically modified foods, just as it has with the general population (Gaskell 2000; O'Fallon, Gursoy and Swanger 2007; Li et. al. 2002; Hallman and Hebden 2005).Approximately 42 percent of American students surveyed expressed concern about health risks from genetically modified food while over 86 percent of Korean students felt the same level of concern (Finke and Kim 2003). With the same sample of students, only 13.5 percent of Korean students surveyed felt no concern compared with 42.4 percent of American college students who perceived no concern about the health risks of genetically modified foods.

Wingenbach, Rutherford and Dunsford (2003) found alignment of college student and general public opinion concerning acceptance of genetically modified foods. When asked about their level of acceptance on the subject of food biotechnology practices, nearly 30 percent of students surveyed indicated a positive opinion; approximately 26 percent had a negative opinion and almost 26 percent were neutral about the subject (Wingenbach, Rutherford and Dunsford 2003).

The purpose of this study was to examine differences in student opinion in the areas of nationality and field of study regarding the awareness, acceptance, and safety levels of genetically modified foods. The design of the study and factors tested differed from other published reports in several ways.

First, the population for this study included students from a wider variety of disciplines than previous studies. Work by Wingenbach et al. (2003) and Finke and Kim (2003) sampled students in the field of agriculture and from a general psychology course, respectively. The population for this study was not based on a single sub-group of students, but consisted of all students enrolled at a Midwestern land-grant research-intensive institution. Second, the international students in this sample were studying in the United States while in other studies international students surveyed were studying in their respective home countries(Finke and Kim 2003; Li et al. 2002). Finally, college students in this sample all attended a Midwestern land-grant university of science and technology, which may affect the baseline attitudes of the population regarding agricultural technologies. All of the above factors could influence the opinions of the sampled students and limit the generalization of the data beyond the sample parameters.

Methodology

To measure awareness, acceptance levels, and safety perceptions, an instrument developed for a previous survey (Hoban 2001) was used with minor modifications. The survey was pilot tested on a small group of students (n = 26) with similar characteristics to the larger sample but who were not included in the final sample. Data collection was guided by three research questions.

1. Do college students have an accurate perception of their knowledge of GM food technology?

2. Do nationality and field of study affect college students' perceptions of safety concerning GM foods?
3. Do acceptance levels of GM foods vary by nationality or discipline of study of college students?

Four scaled response items were used to determine respondent awareness of GM foods, acceptance levels on the use of genetic modification in foods, and safety perception regarding GM foods. When measuring awareness, four point scales were used ranging from "none" to "a lot". Acceptance levels and safety and consumption perceptions were measured on three point scales. Three additional questions asked students about their nationality and field of study. Students wrote their field of study on the questionnaire and students were also asked to identify the academic unit where their major was administered. Researchers classified the majors as either physical science based or non-physical science based.

Physical science is defined by the Merriam-Webster dictionary as fields which study the properties of energy and non-living matter. Although strictly defined by fields such as physics, chemistry, astronomy, and geology, some overlap with fields in biological sciences is often apparent. These fields might include: biochemistry, biophysics, virology and paleontology. In the case of this study, physical science fields included disciplines such as: agricultural biochemistry, food science, and meteorology in addition to the subject areas listed in the definition.

To determine the awareness of the students, two questionnaire items were used. The first asked the students how much they had heard about genetically modified food products and the second item asked if they had consumed a product containing GM foods. This methodology was employed because past research has indicated very few Americans surveyed know the extent of GM ingredients contained within foods sold in the United States. Several studies have found

very low numbers of Americans surveyed have been able to correctly answer survey questions asking about consumption of GM foods. In this case, the assumption was that students who knew a lot about GM foods would also recognize that they had most likely consumed GM products (Pew 2003; Hallman et al. 2004; Falk et al 2002; Hallman and Hebden 2005).

The relationship between awareness and acceptance was also tested. When the accurate information about the prevalence of GM ingredients in the U.S. food supply is shared with respondents, their reactions vary. One theory of awareness and acceptance is that the more people know, the more intense their support or opposition. As further knowledge is gathered by consumers, they will make different decisions than they might with less knowledge (Fischoff 1995). An additional outcome of increased awareness may be a feeling of anger that the GM foods were "hidden" from them without their consent (Hoban 2001). The third item on the survey was used to test the relationship between the much-studied variables of awareness (both perceived and actual) and safety perception.

The final item on the survey questioned students on their support of the use of genetic modification in food and agriculture areas. This item measured the students' acceptance of GM technology as applied to food and agriculture and was tested against field of study, nationality, and awareness levels to determine if a significant relationship existed. The relationship between acceptance levels and safety perceptions of students was also tested.

The seven-item survey was administered electronically to the student body at a land-grant university in the upper Midwest. A cover letter preceded the survey to brief subjects about the project and its purpose. Consent of respondents was assumed if the student voluntarily clicked on the link to begin the survey. Student response was self-selected and this limits the ability to generalize the results beyond the sample. Valid questionnaires were received from 762 students.

The responses were representative of the total campus population regarding field of study and nationality (Iowa State University Office of Institutional Research 2005).

Using SPSS, version 14, frequency distributions and cross-tabulations were carried out for all of the questionnaire items. To test whether a relationship existed between variables the Chi-square test of independence was used (Agresti and Finlay 1999, 253-256). On selected variables, adjusted residuals were studied to learn more about the relationship identified by the Chi-square test of independence (Agresti and Finlay 1999, 261-262).

Results

Valid responses (N=762) were obtained from students attending an upper Midwest land-grant research intensive university. Frequency data on the sample will be presented first and then inferential data will be shared. Table 1 shows the characteristics of the students surveyed. Uneven sample sizes are the result of missing data.

Table 1. Characteristics of Students

Nationality[1]	Frequency	Percentage
American	718	94.3
International	43	5.7
Major [2]		
Physical Science	361	47.6
Non-Physical Science	344	45.4
Unsure	53	7.0
Academic Unit of Major[3]		
Agriculture	191	25.9
Business	77	10.4
Design	39	5.3
Engineering	188	25.4
Human Sciences	214	29.0

Liberal Arts & Sciences	30	4.1

[1]N = 761; [2]N = 758; [3]N = 739

Frequency data for the question on awareness of GM foods illustrates a student body relatively confident in their knowledge of GM foods, with nearly 75 percent professing either some or a lot of knowledge. Less than 4 percent of students surveyed had heard nothing about genetic modification of foods. In the follow-up question, over 55 percent of students believed they had eaten GM foods. Less than two percent of students thought they had not consumed GM food, and nearly 43 percent were not sure. Tables 2 and 3 show the distribution of these data.

Table 2. Awareness – How Much Have Student Heard About GM Food Products?

Awareness Level	Frequency	Percentage
Heard Nothing	29	3.8
Heard a Little	170	22.3
Heard Some	349	45.8
Heard a Lot	214	28.1

The data cross-tabulation examining the variables of awareness and consumption provide a response for the first research question which asked if the college students surveyed had an accurate perception of awareness of GM foods. Students were asked about both awareness levels and consumption patterns and responses were compared to see if they aligned appropriately (i.e. students with high awareness should recognize they have consumed GM foods).

Although the assumption for this case is a positive relationship between perceived knowledge and consumption, it is important to acknowledge the possibility that students could have a lot of knowledge but have not consumed GM food products.

Table 3. Cross-tabulation of Perceived Awareness and Consumption

Consumption	No	Not Sure	Yes	Percentage
Awareness				
Nothing	0	26	3	3.8
A Little	3	130	37	22.3
Some	5	146	198	45.8
A Lot	4	22	188	28.1
Percentages	1.6	42.5	55.9	100

These data suggest that awareness and consumption align as expected, with those students who had more awareness more likely to believe they had consumed GM foods while those who had less awareness were more likely to be uncertain about consumption patterns.

Inferential statistics were used to test the null hypothesis of an independent relationship between seven pairs of variables.

- Student awareness of GM foods and acceptance of the technology
- Student awareness of GM foods and the safety perception of these foods
- Acceptance levels concerning GM foods and the nationality of the student
- Acceptance levels concerning GM foods and the student's discipline of study
- Acceptance levels concerning GM foods and the student's safety perceptions
- Safety perceptions regarding GM foods and the student's discipline of study
- Safety perceptions regarding GM foods and the nationality of the student

Of the variable pairs tested, dependent relationships were found for four variable pairs. Other pairs of variables did not show evidence of a significant relationship. Adjusted residual analysis helped to determine the nature and relative strength of the relationship (Agresti and Finlay 1999, 253-256). A notable finding was the lack of a dependent relationship between awareness and

acceptance levels. Table 4 illustrates the dependent relationships found among survey variables using the Chi-Square test of independence.

Table 4. Chi-Square Values of Variables

Variables	Chi-Square Value	Degrees of Freedom	[4]Significance Level
[1]Safety Perceptions / Field of Study	9.96	4	0.041
[2]Safety Perceptions / Nationality	9.80	2	0.007
[1]Acceptance Level / Field of Study	9.78	4	0.044
[3]Acceptance Level / Safety Perceptions	419.90	6	0.000

[1]n=758; [2]n=761; [3]n=762; [4]Significant at 95% Confidence Level

The strongest relationships found using residual analysis were noted between the variables of acceptance levels and safety perceptions. These data suggest those who are more supportive of GM foods are more likely to feel they are safe and people who do not support GM food products are less likely to think the foods are safe.

An adjusted residual value above 2 provides evidence against the null hypotheses of an independent relationship between each pair and adjusted residual values above 3 are considered strong evidence for a significant relationship between the two variables (Agresti and Finlay 1999, 261-262). Table 5 illustrates the pairs of relationships exhibiting strong evidence of a significant relationship.

Several other pairs of variables provided evidence of a significant relationship. The following pairs had adjusted residual values above 2, but below 3: discipline of study and safety perceptions, nationality and safety perceptions, and acceptance levels and discipline of study. The data measuring the relationship between discipline of study and safety perceptions suggest students who study physical science are more likely to feel positively about the safety of GM foods than those who study fields outside of physical science. Data also suggest American

students feel more positively about the safety of GM foods than international students. Finally, college students who study physical science are less likely to be uncertain regarding their support of GM food products than are college students studying in non-physical science areas.

Table 5. Strong Relationships as Measured by Adjusted Residual Analysis

Variable Pairs	Adjusted Residual Value	Relationship
[1]Physical science major / Uncertain safety perceptions	-3.1	Strong negative
[2]Positive acceptance / Uncertain safety perceptions	-11.3	Strong negative
[2]Positive acceptance / Unsafe perception	-8.3	Strong negative
[2]Positive acceptance / Safe perceptions	14.6	Strong positive
[2]Negative acceptance / Uncertain safety perceptions	3.1	Strong positive
[2]Negative acceptance / Unsafe perceptions	15.4	Strong positive
[2]Negative acceptance / Safe perceptions	-9.4	Strong negative
[2]Uncertain acceptance / Uncertain safety perceptions	10.6	Strong positive
[2]Uncertain acceptance / Safe perceptions	-9.7	Strong negative

[1]n=758; [2]n=762

Discussion and Implications

The survey sample was drawn from the student body at an upper Midwestern land-grant university. Students from all academic areas of the university were included in the population

and responded to the survey. The largest number of responses came from the Colleges of Agriculture, Engineering, and Human Sciences, which is where much of the curriculum in biotechnology relating to food and agriculture is concentrated. This may partially explain the larger response rates from these areas. In addition, because the survey respondents self-selected themselves, those who responded could represent the views and opinions of outliers rather than the typical opinions. Uneven and small group sizes among international students prevented researchers from dividing this group further. All of these factors may introduce bias, limiting the ability to generalize these data to other groups.

Based on the self-reported area of study from each student, each discipline offered was classified into a physical science or non-physical science major. Some students provided unclear descriptions of majors and these were classified as unknown. These data represented a small portion of the sample and were not found to differ substantially from the physical science or non-physical science group.

The first research question compared the responses concerning students' perceived awareness to their actual awareness as measured by their belief regarding past consumption of GM foods. Other studies have found both college students and the general public tend to overestimate their knowledge on the topic but fail to answer the consumption question correctly. In fact, nearly all Americans have consumed GM foods – avoiding these foods requires a great deal of effort and an unusually advanced of knowledge of the food and agriculture system (Wingenbach et al. 2003; Hallman and Hebden 2005; Pew 2003). However, it must be acknowledge that although it is difficult to not consume foods made with GM products in the United States, it is not impossible. The low numbers of respondents who professed a lot of knowledge, but no

consumption may be consumers who pay very close attention to what they instead of consumers who have overestimated their knowledge.

The data collected from this sample of college students suggests a higher level of perceived knowledge than the general consumer population. Nearly 75 percent of those surveyed declaring at least some knowledge of GM technology as applied to food. A large portion of these students (over 55 percent) believed they had consumed GM foods and another 42.5 percent indicated uncertainty as to whether they had consumed GM foods. These values and their levels of alignment are higher than previously published results.

The relationship between acceptance levels and safety perceptions showed predictable patterns, but with slightly higher levels of acceptance than other published data. Over 70 percent of respondents indicated a clear acceptance of the use of genetic modification in agriculture and food while less than 10 percent found the technology's use in food and agriculture unacceptable. Acceptance of a technology and perceptions of safety do not always align, but in this case, over 56 percent believed GM food products were safe for human use. Less than 5 percent felt the foods were unsafe, but nearly 40 percent report that they are still undecided on the safety of GM food products.

Although these data show an expected relationship, some additional implications can be taken from the information. First, safety perception appears to be a major component in determining acceptance. The strongest relationships were between acceptance and safe perceptions and low acceptance and unsafe perceptions, and this is not unexpected. However, the relationships between the opposite pairs (high acceptance and low safety, low acceptance, high safety) were not as strong the previous pairs. This suggests that perceptions of safety may only play a partial

role in determining acceptance. Students who were unsure about their acceptance of GM foods were also more likely to feel uncertain about the safety of the products.

Marketing implications based on these data may seem contradictory to the previous statement about safety playing only a partial role, but for those consumers who are uncertain, safety seems to play a large role in determining that emotion. Marketing GM foods successfully may involve a heavy emphasis on the safety of the products at several levels, addressing consumption, environmental, social, and ethic concerns. However, based on these data, other components beyond safety may play a role in the final decision of the consumer.

The variables of nationality and field of study were tested against both acceptance levels and safety perceptions. Three of the four Chi-squared tests of independence rejected the null hypothesis of no relationship between the variables. The only variable pair not providing enough evidence to reject the null hypothesis was acceptance level and nationality.

Residual analysis was performed for the remaining three pairs to determine the strength of the relationship. Evidence for significant positive relationships was found for physical science majors and positive safety perceptions and international students and negative safety perceptions. Significant relationships were also noted between American students and positive safety perceptions and non-physical science majors and uncertainty regarding safety of GM technology in agriculture and food.

These data suggest several points which were addressed in the research questions and research hypotheses. Nationality appears to play a role in the safety perceptions of college students, as American students felt more positively about GM technology as used in food and agriculture and international students felt more negatively. Field of study could also play a role, as the data show physical science students are more likely than non-physical science students to have positive

safety perceptions about GM food and agricultural processes. In this study, nationality was not found to have a relationship with acceptance levels and this was the only pair of the four which was not found to have a dependent relationship. These data contradict findings which show international students to have lower acceptance levels for GM foods than American students (Finke and Kim 2003).

The population chosen for this study was drawn from a single university and although it was representative of this particular university, it may not be representative of U.S. college students in general. The Midwest location of the university may have impacted several of the factors, most notably awareness and acceptance levels. Finally, the survey administration provided for self-selection of participants. Those who elected to take part in the study may have perceptions, knowledge, and opinions quite different from those who did not participate.

The relationship between academic discipline of the students and their perceptions of safety and acceptance illustrates the continuing divide between scientists and non-scientists on topics considered to be controversial (Chappell and Hartz 1998; Priest 2000). Priest (2000) found people with a broad university-level science education are more likely to feel more positively about the use of genetic modification in foods. Although students who graduate in science may have more positive feelings about GM foods, they may not work at marketing and developing these products.

Implications based on these findings align with advice given by Wansink and Kim (2001). They suggest developing education strategies on GM foods will be more effective if consumers are grouped into several categories based on their level of knowledge, their information processing style, or their existing predisposition toward genetic modification. Scientists have been shown to have greater knowledge and acceptance of the technology, but this group should remember that it

is often the non-scientist who does the communicating in the form of marketing, writing, or education. Increased scientific training for the non-scientist could address some of these issues. Future research in this area is recommended, especially in the area of academic discipline and additional factors which may affect acceptance and safety perceptions of college students. These students represent the next generation of consumers and positive feelings towards GM food products would further advance the adoption and acceptance of GM foods. Similar research in different sections of the country and on different types of university campuses would also prove interesting for comparison purposes.

Although the debate between those who advocate for genetic modification applications in food and agriculture and those who oppose it will continue, the consumer will play a role in the continued development of the technology by participating in the discussion, implementation and evaluation of genetic modification as it is used in food and agriculture.

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