The Market for Genetically Modified Foods: Consumer Characteristics and Policy Implications

Gregory A. Baker

Thomas A. Burnham

Address correspondence to:
Gregory A. Baker
Food and Agribusiness Institute
Santa Clara University
500 El Camino Real
Santa Clara, CA 95053-0396
Telephone: (408) 554-5172
Fax: (408) 554-5167

e-mail: gbaker@scu.edu

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INTRODUCTION

U.S. consumers have consistently exhibited a high level of concern for the safety of the foods they eat. They demand food that is free from harmful substances including pesticides, chemical additives, hormones, and antibiotics. Until recently, the controversy over genetically modified foods was largely confined to Europe. However, recent incidents involving genetically modified organisms (GMO's) in the food supply have served to raise U.S. consumer awareness regarding foods that are the product of genetic engineering.

The most prominent of these incidents involves the inadvertent introduction of the genetically modified StarLink corn into taco shells and other food products. StarLink corn contains a gene that enables the corn plant to produce a pesticide to protect it from certain pests. The EPA has only approved the StarLink corn for use in animal feed or industrial purposes, since it is has not been shown that it will not cause an allergic reaction or other adverse effects in humans.

Increased consumer concern for GMO's has manifest itself in consumer demands for increased government regulation in the form of a ban on GMO's in the food supply or mandatory labeling. Government policymakers must balance human safety concerns and other risks with the potential benefits offered by GMO foods. Policymakers are increasingly under pressure to require labeling of the products of GMO's. Food manufacturers have also come under pressure from consumers and some companies have sought to promise consumers that their products are free of GMO's.

The purpose of this research is to develop an understanding of the factors influencing consumers' preferences for GMO food products that will serve to guide policymakers in the development of policy and food manufacturers in developing and marketing products. To date, little research has been published on this topic. Kaiser et al. (1992) studied the relationship between milk consumption and the use of the genetically engineered product bST in milk production. Several studies have analyzed the more general relationship between socioeconomic factors and consumer concern for other aspects of food safety. These include studies examining the relationship between socioeconomic factors and the perceived risk associated with the pesticide residues in food (Ott, 1990; Misra et al. 1991; Baker and Crosbie, 1993; Nayga, 1996; and Baker, 1999).

While previous food safety research will be useful in understanding consumer preferences for GMO food products, some key differences between the concern for GMO food products and other food safety concerns lend support to conducting a study specifically focused on GMO foods. The major difference is that consumer concern for GMO food products is apparently the result of a new and unfamiliar technology that in many cases poses no known scientifically-accepted threat to human health, whereas many other food safety concerns, such as those due to pesticide residues, are the result of well-understood threats to human health.

The objectives of this study are to:

1) determine the extent to which the GMO content of food products will influence consumer preferences for food products; and
2) explore the relationship between consumer characteristics and their preferences for GMO food products.

This information will be useful in developing and characterizing market segments for food products based on information on consumers' concerns for the GMO content of food.

RESEARCH METHOD

In order to determine the effect of GMO content on consumer purchasing decisions, the conjoint analysis technique was used. Conjoint analysis has been widely used in marketing to evaluate consumer preferences for hypothetical products and services (Hair et al., 1992; Acito and Jain, 1980). It is ideally suited for understanding how consumers value various product attributes based on their valuation of the complete product.

Conjoint analysis requires that a hypothetical product be described to participants in the study along with the attributes and attribute levels that define the product. Respondents are then asked to either rate or rank several hypothetical products that are defined by different combinations of attribute levels (Hair et al., 1992). In this simulated market experience consumers are faced with choices similar to those that they would face in making any purchase decision.

In this experiment, the product was defined as corn flakes cereal. Two attributes were deemed to be most important to consumers in making purchase decisions based on the results of a questionnaire filled out by members of a focus group and subsequent discussions with this group. These attributes were price and brand. A third attribute, the GMO content of the corn, was included because understanding the impact of a GMO product on consumer preferences was the primary focus of this study. While other attributes could have been included, it is necessary to balance the number of attributes required to realistically represent the product with the need to simplify the representation so as to not unnecessarily complicate the respondent's task.

The attribute levels are determined based on the levels that consumers might realistically face. Two levels of the brand attribute were described. The first level, "Kellogg's Brand" corn flakes was chosen because Kellogg's is the leading national brand. The second level was "Store Brand" corn flakes and was described as cereal produced for a supermarket like Kroger, Albertson's or Safeway (the three largest U.S. supermarket chains) and sold under their store's label.

The three price levels for an 18 oz. box, $2.75, $3.50, and $4.25, were determined based on the range of prices actually observed for name brand and store brand cereals. The lowest price was slightly below and the highest price was slightly above the non-sale prices actually observed in supermarkets at the time the study was conducted.

The third attribute described the source of corn used to make the cereal. The first attribute level was described as "GMO Corn" and indicated that the corn was grown from seed developed using modern biotechnology or genetic engineering techniques. The second attribute level was described as "Non-GMO Corn" and indicated that the corn was grown from seed developed through traditional breeding techniques.

The hypothetical products were defined by choosing one attribute level for each of the three attributes. A full factorial design was used resulting in 12 hypothetical products. For example, the first hypothetical product was an 18 oz. box of Kellogg's brand corn flakes cereal, made with GMO corn, at a price of $2.75.

A random, national sample of 2,000 people was purchased from a company that maintains a list of the names and addresses of people in over 110 million households. The company compiles the list

using multiple sources including telephone directories, credit card records, census data, court house records, and other public sources in order to ensure the representation of all types of households.

Each of the 2000 people was mailed a survey packet in June and July of 2000. The packet included a letter briefly explaining the purpose of the survey and encouraging their participation, an instruction sheet, a product information sheet, a product rating form, a data sheet, and a postage-paid return envelope. To encourage participation, a $1 incentive payment was included in the mailing. Additionally, respondents were told that they would be entered in a drawing, and that two winners would each receive a Palm Pilot. Follow-up post cards were mailed one and two months after the original mailing.

The instruction sheet generally explained the task and the steps the respondent should follow. The product information page described the hypothetical product and product attributes. The product rating form presented each of the 12 hypothetical products and asked the respondent to rate each product on a scale of 1 to 10 with 1 being least preferred and 10 being most preferred. Respondents were also told that a number could be used more than once. Lastly, the data sheet asked respondents to provide socioeconomic data on themselves and their household as well as their knowledge of biotechnology, their risk preferences and their opinions about GMO's.

Of the 2000 surveys that were mailed, 175 were returned as undeliverable. A total of 448 surveys were returned. After eliminating those surveys with incomplete responses and those that were otherwise unusable, 383 usable responses were obtained for a net response rate of 21%.

In order to determine whether there was non-response bias, the mean age of the respondents was compared to the mean age of the sample. The mean ages were 50.7 and 50.5, respectively, indicating

that there was no evidence of non-response bias. Sample statistics for the 383 respondents are presented in Table 1.

Table 1. Characteristics of Survey Respondents[a]	
Characteristic	Sample Statistic
Gender (% female)	59.0
Mean Age (years)	51.7
Median Household Income Category ($)	25,000-39,999
Competed High School (%)	96.6
Ethnicity (%)	
< White non-Hispanic	82.2
< Black	6.3
< Hispanic	5.2
< Other	6.3
[a]Survey sample size = 383.	

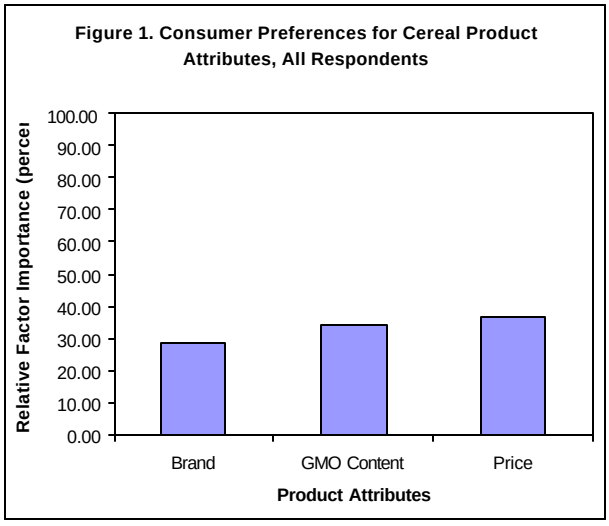
RESULTS AND ANALYSIS

The survey responses were analyzed using the SAS TRANSREG procedure, whereby individual utility functions are estimated by regressing the 12 product ratings on the attribute levels. For the price variable, the actual price is used as the independent variable. For the brand and GMO content variables, dummy variables are used.

The regression results are converted into part-worth scores that indicate the impact of the change in each variable on the product rating score. For the continuous variable, price, this is accomplished by multiplying the price coefficient by the difference in the minimum and maximum price. For the two dummy variables, the part-worth scores are the respective coefficients for the variables. The part-worths may be interpreted as the impact of the each variable on an individual's preference for the

product over the range of the variable. For example, for the price variable the part-worth score indicates the estimated change in the product rating score for each individual based on the difference between the maximum and minimum price.

The part-worth scores may be further analyzed to determine the relative importance of each attribute in a respondent's preference function. The relative factor importance score for each attribute is calculated by dividing the absolute value of an attribute's part-worth by the sum of the absolute values of the part-worths for all attributes. The aggregate relative importance scores for all respondents, calculated by first averaging the preference functions for all 383 respondents are reported in figure 1.



The results presented in figure 1 indicate that, in the aggregate, the importance scores of the three product attributes were roughly equal. Price had the highest importance score, 37%, followed by GMO content and brand, with 34% and 29 %, respectively. This information indicates that no one factor dominates consumer preferences. However, it is of limited value in understanding consumer

behavior since consumers do not make purchase decisions in the aggregate. Product preferences are a collection of many individual purchase decisions based on individual consumers' preference functions.

Market Segment Analysis

In order to better understand how consumer preferences might be revealed in the marketplace market segments were developed. Cluster analysis, a statistical technique used to assign sets of observations into relatively homogeneous groups, was used to develop the market segments based on the each respondent's importance scores. Three market segments were defined as illustrated in figures 2, 3, and 4.

The market segment analysis indicates that the respondents fell into one of three groups. Segment 1 consumers, termed Brand Buyers, consisted of 155 respondents. Their preferences were based largely on the brand of the cereal, with consumers in this group expressing a strong preference for the Kellogg's brand cereal over the store brand.

Segments 2 consumers were labeled Safety Seekers and was comprised of 116 respondents. The Safety Seekers segment was so named because consumers in this segment expressed a strong preference to avoid cereal with GMO content. Their expressed product preference was based largely on the absence of genetically modified material in the cereal. The price or brand of the cereal had relatively little impact on their expressed product preference.

Segment 3 consumers were designated Price Pickers and included 112 respondents. Price Pickers' product preferences were determined primarily by the product's price, with low priced cereal being strongly preferred to high priced cereal.

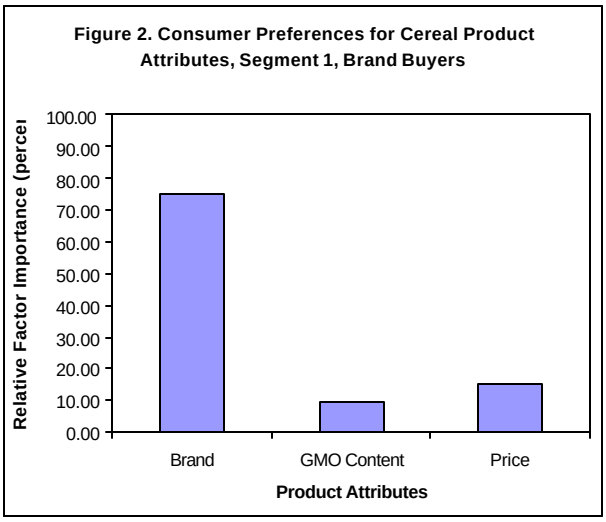


Figure 2. Consumer Preferences for Cereal Product Attributes, Segment 1, Brand Buyers
Relative Factor Importance (perce
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Brand
GMO Content
Price
Product Attributes

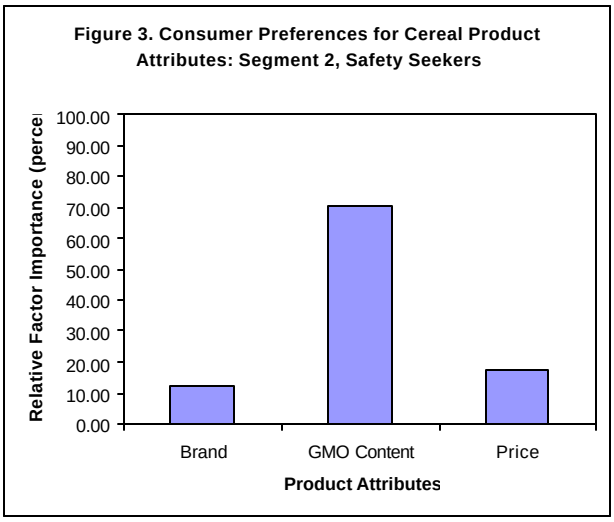


Figure 3. Consumer Preferences for Cereal Product Attributes: Segment 2, Safety Seekers
Relative Factor Importance (perce
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Brand
GMO Content
Price
Product Attributes

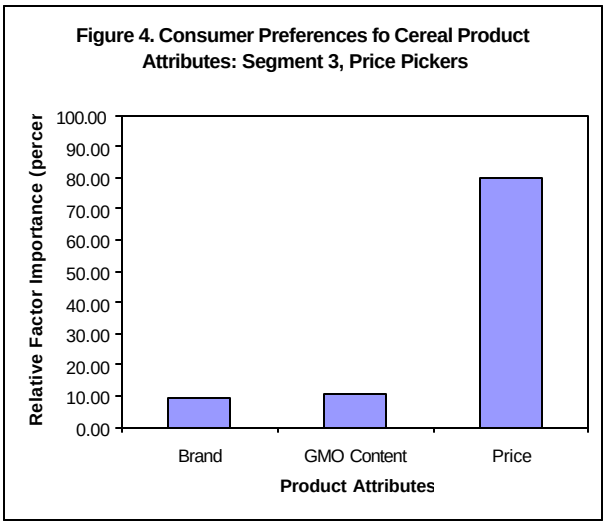


Figure 4. Consumer Preferences fo Cereal Product Attributes: Segment 3, Price Pickers
Relative Factor Importance (percer
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Brand
GMO Content
Price
Product Attributes

In order to examine the differences between consumers in the three market segments, the data describing the characteristics of the respondents was analyzed. Initially, F-statistics were calculated to determine whether the group means for each variable were different from each other. When the F-statistic was significant at the 10% level for a variable, the mean of each segment was compared to the mean of the other two segments for that variable and t-statistics were calculated. The results of this analysis are presented in table 2.

The results indicate that there were relatively few differences in the sociooeconomic characteristics of consumers in different market segments. The F-statistics were not significant for the gender, marital status, children at home, ethnicity, and location of residence variables. However, there were differences among the segments for three socioeconomic characteristics: age, income, and education. Members of the Price Pickers segment tended to be younger, more affluent, and better educated than members of the Brand Buyers or Safety Seekers segments. Price Pickers also had more knowledge of biotechnology than members of the other two segments. This is consistent with the higher level of income and education associated with this group.

It is interesting that the best discriminators of those consumers who want to avoid food with GMO content is their aversion to risk and their opinions regarding the benefits of GMO's. This is consistent with the marketing literature, which has found that a consumer's values are much better predictors of a consumer's behavior than socioeconomic or demographic data.

Table 2. Characteristics of the Market Segments			
	Segment		
Characteristic	Segment 1 Brand Buyers (N=155)	Segment 2 Safety Seekers (N=116)	Segment 3 Price Pickers (N=112)
Gender (% male)	61.3	57.8	57.1
Age (years)*	53.7 [3]	52.2 [3]	48.3 [1,2]
Income ($)*	51838 [3]	51163 [3]	60089 [1,2]
Education (years)*	13.6 [3]	14.0 [3]	15.1 [1,2]
Married (%)	63.9	69.0	60.7
Children at home (%)	35.5	42.2	41.1
Ethnicity (% White)	80.6	80.2	86.6
Residence (% urban)	64.5	57.8	58.9
Biotechnology knowledge[a*]	3.4 [3]	3.3 [3]	3.7 [1,2]
Risk measure 1 (don't like to take chances)[b*]	3.4 [2]	4.1 [1,3]	3.4 [2]
Risk measure 2 (like to experiment with new things)[b*]	3.5 [2]	3.0 [1,3]	3.5 [2]
Risk measure 3 (cautious in trying new products)[b*]	3.1 [2]	3.5 [1,3]	3.1 [2]
GMO's positively affect food quality[c*]	3.2 [2]	2.6 [1,3]	3.4 [2]
GMO's positively affect food safety[c*]	2.9 [2]	2.3 [1,3]	3.1 [2]

Note: F-statistics were calculated to determine whether the variable means of the market segments were different from each other. When the F-statistic was significant at the 10% probability level (indicated by an asterisk (*) after the variable name), individual t-statistics were calculated for each pair of means for each variable. Statistically significant differences at the 10% probability level are indicated by the number in brackets. For example, the [1,2] following the mean age of 48.3 for segment 3 indicates that the mean for this variable is significantly different than the mean for segments 1 and 2.
[a]Biotechnology knowledge indicates the respondents knowledge of biotechnology on a scale of 1 to 5, with 1 representing "no" knowledge and 5 representing "a lot" of knowledge.
[b]Respondents were asked to express their level of agreement with the risk statement on a scale of 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree."
[C]Respondents were asked to express their opinion on the effect of GMO's on a scale of 1 to 5, with 1 representing "negative effect" and 5 representing "positive effect."

To measure a respondent's aversion to risk, they were asked to indicate their level of agreement with three statements: 1) I don't like to take chances if I don't have to; 2) I like to experiment with new ways of doing things; and 3) I am cautious in trying new/different things. Thus a high level of risk aversion is indicated by a high score on questions 1 and 3 and a low score on question 2. Respondents were also asked their opinion regarding the following two statements: 1) What effect do you think the use of GMO's will have on food quality, i.e. taste, freshness?; and 2) What effect do you think the use of GMO's will have on food safety i.e. food allergies, unknown effects? They were asked to indicate their response on a scale of 1 to 5 with 1 signifying a "negative effect" and a 5 indicating a "positive effect."

Consumers in the Safety Seekers segment tended to score higher than members of the Price Pickers and Brand Buyers segments on all three measures of risk aversion. That is, they were more likely to avoid taking chances if they didn't have to; they were less likely to experiment with new ways of doing things; and they were more likely to be cautious in trying new or different products. Safety Seekers also tended to be less likely to believe that GMO's were beneficial in improving food quality or food safety.

DISCUSSION AND CONCLUSIONS

The results and analysis of this research will be useful in the marketing of food products containing GMO's. It indicates that consumers are best differentiated based not on *who they are*, but rather based on *what they believe.* Reaching consumers will be difficult because they cannot be easily identified using demographic factors. On the other hand, understanding that consumers are motivated by deeply held values provides insight into their actions.

Based on the results of this study, it appears that those consumers most resistant to purchasing the products of genetic engineering probably do so for the same reasons that they are reluctant to purchase other new products, that is they are risk averse and slow to change. A strategy of targeting early product adopters, who are most likely to believe that the benefits of the new product outweigh the potential risks, has been successfully used for many consumer products. This is supported by the analysis that indicates that consumers in the market segments least likely to avoid GMO's, the Price Pickers and Brand Buyers, were more likely to believe that GMO's would have a beneficial effect on food quality and food safety, than members of the Safety Seekers segment.

This strategy is similar to that used with microwave ovens. When this product was introduced in the 1950s there were concerns that the new ovens would cause cancer or sterility. However, as more consumers bought the products and the oven's safety was demonstrated over years of use, the product eventually became a common fixture in American kitchens.

Another strategy that may help increase consumer acceptance of GMO food products is to focus on products that have direct benefits for consumers. While GMO products that have increased insect or disease resistance may benefit consumers through lower food costs, the benefits may not be easily

perceived by consumers. On the other hand, benefits such as increased shelf life, improved taste, or greater nutritional value foods are easily perceived by consumers. Such direct benefits make it easy for consumers to understand the benefits they are receiving in return for the perceived increased risk.

The results of this research also have important policy implications. One of the major policy questions concerning GMO's regards the labeling of GMO food products. This research indicates that the presence of GMO's is an important concern for approximately 30% of the respondents in this study, the Safety Seekers. For this market segment, the GMO content of the food was a primary determinant in their product preference. Because of their strong preference for avoiding GMO content, it is likely that they will want information concerning GMO's in the foods they purchase. It is also likely that consumers in the Safety Seekers segment may be susceptible to claims that GMO's are harmful.

Two significant policy questions must be addressed. The first is whether mandatory labeling should be required that would indicate the GMO content of a food. While this would be a significant departure from current food labeling policy since it would be based on the *technology* used to produce the food, it would undoubtedly be welcomed by many consumers.

A second policy question concerns the types of labels food processors and produce marketers should be allowed to use. Because of the potential to make exaggerated claims and to prey on consumer fears, it will be important that labels contain accurate information that is fairly represented.

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