

The Impact of Health on Consumer Acceptance of Biogenetic Foods: The Case of Celiac Disease Sufferers

This study concerns celiac disease sufferers' knowledge, perceptions and acceptance of biogenetic foods. Mailed questionnaires from 258 Quebec celiacs were analyzed. Celiacs were as confident in food safety controls as the general Quebec population and were as likely to insist on mandatory labeling of biogenetic foods. However, they were more supportive of the development of biogenetic foods, saw fewer population risks from them, and were somewhat less concerned about their possible negative health effects.

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Recent advances in the use of biotechnology in the food industry have caused uneasiness among consumers (Bord & O'Conner, 1990; Douthitt, 1995; Grobe & Douthitt, 1995; Misra, Grotegut & Clem, 1997; Optima, 1994; Sapp, Harrod & Zhao, 1994; Sparkes, Shepherd & Frewer, 1994; Sparkes & Shepherd, 1994). Biogenetic engineering of foods permits the rapid transfer of specific genetic traits from one living organism to another. Traditional methods of producing genetic hybrids through cross fertilization are much slower and less precise. In addition, they do not permit the transfer of genes from one species to another, such as from corn to soybeans (AAFC, 1996; ISFT, 1996; Kreuzer & Massey, 1996).

Even though genetic engineering offers numerous possible applications in the production of new foods and food substances (Monsanto, 1995), consumers are worried about the safety of genetic foods for human consumption (Optima, 1994) and are uncertain of the ethical implications of creating new biogenetic foods (Sparkes et al., 1994; Hoban, Woodrum & Czaja, 1992). Despite increasing apprehensions, consumers are not necessarily rejecting the idea of consuming genetically modified foods. Several studies have already found that consumers are willing to purchase such foods (Optima, 1994; Misra, Grotegut & Clem, 1997; Buhr, Hayes, Shogren & Kliebenstein, 1993; Duhaime, Lachance, Tremblay, Pelletier, Rousseau & Tremblay, 1997; Frewer, Howard & Shepherd, 1996). Their willingness to purchase seems to vary depending on the specific nature of the genetic modification and on the perceived tangible benefits of the modification (Frewer, et al., 1995; Optima, 1994).

Consumers who suffer from food allergies or intolerances are necessarily more preoccupied with the impact of foods on their health (Metcalf, Astwood, Townsend, Sampson, Taylor & Fuchs, 1996). Will such consumers hesitate even more to embrace emerging biogenetic foods? This exploratory study reports on findings from a sample of celiac disease sufferers regarding their knowledge, perceptions and willingness to purchase biogenetic foods specifically engineered for their consumption. Celiac disease results from a permanent intolerance to the gliadin (but not the glutenin) present in wheat gluten, as well as to similar prolamins present in many other grains. Diets of celiac disease sufferers are extremely restricted in choice of foods from the bread and grains food group. Using biogenetic engineering, it may be possible to produce glutenin that would be totally exempt of gliadin, for use in bakery products. Such products would offer celiac disease sufferers not only a greater variety of bakery products, but also products with enhanced sensory properties (texture and elasticity). This study was part of a larger multidisciplinary project on the use of biogenetic engineering to produce bio-medical plant bi-products, such as insulin, interleukine-2, proteins and purified glutenin.

Research Methodology

The population of interest for this study was all adults living in the province of Quebec, Canada, who were diagnosed or who had children diagnosed with celiac disease. The sampling frame for the study consisted of all members, both past and present, of the Fondation quebecoise de la maladie coeliaque based in Montreal, Quebec. The lists of former and current members contained approximately 1,700 names. Using a simple random sampling technique, 617 names were selected to receive a mailed questionnaire.

The questionnaire was composed of 229 questions grouped in five sections: socio-demographics, health, food purchasing and consumption habits, daily hassles caused by celiac disease and perceptions of biogenetic foods. The questionnaire was pre-tested to verify question comprehension by celiac disease sufferers. The survey was mailed in the fall of 1996 with a cover letter explaining the study's objectives and steps taken to insure the confidentiality of responses. Due to cost constraints, no follow-up reminder was sent. A total of 299 questionnaires were returned resulting in a response rate of 49 percent; however, 20 questionnaires were discarded because they were too incomplete or because the respondents admitted that they were not following a gluten-free diet. An additional 21 respondents were dropped from the current study because they were under the age of 18. The final sample size for this study is 258. Most respondents were female. Ages ranged from 18 to 84 with an average of 48.6 years ($s=12.8$ years). Over half of the respondents had completed Quebec's junior college system or had university degrees. The median gross household income was between \$40,000 and \$60,000 (Cndn) a year.

The following section compares the descriptive findings (%) from this study of Quebec celiac disease sufferers to those found in two general population studies, one of 1,008 Quebecois (Duhaime et al., 1997) and one of 2,000 Canadians (Optima, 1994), regarding consumer knowledge and attitudes towards biogenetic foods. Readers should note that the percentages given take into consideration those who did not respond to a given question. Results from the analysis of a PROBIT model predicting celiac sufferers willingness to purchase bakery products with biogenetically engineered glutenin are also summarized.

Results and Discussion

Knowledge of Biogenetic Foods

After briefly defining what constitutes a genetically engineered food, the questionnaire used in this study asked how much the respondent had already heard about such foods. Only 35 percent of those sampled indicated that they had already heard about such foods. Duhaime et al. (1997, p. 81) found that 82 percent of the Quebecois who responded to their telephone survey had already heard about food biotechnology in general. Optima's (1994, p. 9) nation wide telephone survey of Canadians found that 70 percent of those sampled said that they had already heard about tomatoes genetically modified to increase their shelf life and flavor.

This very large difference in prior knowledge of biogenetic foods potentially indicates that Quebec celiac disease sufferers are much more ignorant of biogenetic foods than are the general Quebec and Canadian populations. However, this celiac study collected data by means of a mailed questionnaire, whereas both of the general population studies used telephone surveys. The results from the general public surveys may reflect a very strong social-desirability bias among the general public with regard to knowledge of biogenetic foods (i.e., people do not want to verbally admit to someone else that they have not already heard about biogenetic foods).

Confidence in Safety Controls

The level of confidence in government and industry controls over the safety of new food products was relatively high among Quebec celiac sufferers. Twenty-one percent totally agreed and 58 percent somewhat agreed that they are confident. In Quebec, Duhaime et al. (1997, p. 80) found that 22 percent of their respondents reported being very confident in government control over the quality of new foods in general, and an additional 65 percent had a moderate level of confidence. In a similar vein, 85 percent of the Quebecois sampled were very confident or moderately confident in food manufacturers' control over new food quality. However, Optima (1994, Annex B, p. 16) found that only 23 percent of Canadians sampled 'totally' or 'somewhat' agreed that biotechnology is adequately controlled by government.

In general, Quebec celiac sufferers appear to mirror the confidence of the larger Quebec population regarding safety controls over new biogenetic foods. The level of confidence in controls would appear to be lower in the general Canadian population; however, levels of confidence in food safety controls may have increased in the years since the Canadian study was conducted.

Labeling of Biogenetic Foods

When asked whether the labeling of genetically modified foods should be mandatory, 82 percent of the celiac disease sufferers were totally in agreement and 12 percent somewhat agreed. Ninety-five percent of Canadians surveyed by Optima (1994, p. 19) agreed that they would want genetically modified foods be so labeled; however, only 83 percent agreed that food product labels should signal that a biotech process was used to produce it (p. 18). The Duhaime et al. (1997) study had no question regarding labeling of genetically modified foods. It appears that Quebec celiac sufferers mirror the larger Canadian sentiment that biogenetic foods should be so labeled.

Support the Development of Biogenetic Foods

When asked how much society should be encouraging the development of genetically engineered foods, 36 percent of celiac sufferers agreed that such foods should be 'strongly encouraged', but an additional 45 percent indicated that it should be 'encouraged'. In response to a simple 'yes/no' question, 69 percent of the Quebecois surveyed by Duhaime et al. (1996, p. 82) supported the use of biotechnology in the production of food. The Optima study (1994, p. 31) found that 37 percent of Canadians surveyed agreed that the government should encourage the development of biotechnology *in general* despite possible risks. Quebec celiac disease sufferers appear somewhat more supportive of the development of biogenetic foods than the general population in Quebec. Since the question asked by Optima (1994) is so different than that asked by the current study and by Duhaime et al. (1997) it is difficult to say whether Quebecois are more supportive of biogenetic foods than the general Canadian population.

Support for Specific Biogenetic Foods

The questionnaire in the current study explained that it may be possible to genetically engineer glutenin totally exempt of all traces of the toxic gliadin which provokes celiac disease. It was noted that this biogenetic glutenin could improve the texture and flavor of bakery products specifically marketed to celiac disease sufferers. Respondents were then asked to what extent society should be encouraging the creation of biogenetic glutenin. At this point, the percentage of respondents indicating 'strongly encouraged' jumped to 55 percent, with another 30 percent indicating that this particular application of genetic engineering should be 'encouraged'. These results imply that people whose health status is compromised by dietary restrictions more strongly endorse the development of biogenetic foods when those foods are designed to improve their own situation.

Duhaime et al. (1997, p. 84) reported that 83 percent of the Quebecois surveyed specifically supported the production of a more nutritious potato through the genetic transfer of a gene from rice. This is also a sharp increase over the 69 percent who supported the production of biotech foods in general (p. 82). The Quebec population, like the celiac sufferers in this study, have more favorable attitudes toward biotech foods that are modified for purposes of nutrition. Unfortunately, Optima's (1994) study of Canadians had no comparable question regarding the level of support for the development of a tomato genetically modified for shelf life and flavor.

Risks from Biogenetic Foods

When asked their degree of agreement with the phrase 'Genetic engineering generates more public risks than benefits', 11 percent of celiac sufferers totally agreed and 25 percent somewhat agreed. In Optima's study (1994, p. 7), 42 percent agreed with the phrase 'Science and technology have helped to make the world we live in more risky' and 33 percent agreed with the phrase 'Biotechnology might make the world we live in more risky' (p. 29). Duhaime et al. (1997, p. 81) found that 15 percent of Quebecois surveyed strongly agreed that 'Science and technology have helped to make the world we live in more risky', while 45 percent somewhat agreed. In general, these results imply that the general Quebecois population sees more risks from the use of biotechnology, while Quebec celiac sufferers and the Canadian population see fewer risks.

When specifically asked about health risks, 27 percent of the celiac disease sufferers indicated that they would be 'very' worried about personal health risks associated with genetically modified glutenin. An additional 38 percent said they would be 'somewhat' worried. In contrast, almost 50 percent of the Canadians surveyed by Optima (1994, Annex, p. 5) indicated that they would be 'very' worried about general health risks from a tomato genetically modified for better shelf life and flavor. An additional 16 percent said they would be 'somewhat' worried. Thus, the Quebec celiac disease sufferers were much less likely to be 'very' concerned about health risks from a specific biogenetic food. The Quebecois in Duhaime et al.'s study (1997, p. 83) were asked whether they thought agri-food biotechnologies *in general* would have mostly beneficial or mostly negative effects on human health. Only 29 percent felt that agri-food biotechnologies would have a mostly negative impact on health.

Purchase Probability

When asked about how probable it was that they would actually purchase food products containing genetically modified glutenin, 28 percent of the celiac sufferers surveyed indicated that they would most assuredly purchase them and an additional 55 percent indicated that they would probably purchase them. This level of willingness to purchase was much higher than that found in the two general population studies. Optima (1994, p. 18) found that only 49 percent of the Canadians surveyed were willing to purchase foods produced using biotechnology if they were more nutritious than other foods. When Optima (1994, Annex B, p.5) specifically asked about willingness to purchase tomatoes genetically modified to improve shelf life and flavor, only 26 percent of those surveyed reported that they would 'very likely' purchase such tomatoes and 18 percent believed that it was

'somewhat likely' that they would purchase such tomatoes. The celiacs' high degree of willingness to purchase indicates a rather great potential for a niche market for biogenetic foods specifically designed for their consumption.

In their survey, Duhaime et al. (1997, p. 85) found that 52 percent of Quebecois would be likely to purchase a genetically modified potato that was of better quality and flavor, but cost ten percent more. The current study also addressed the issue of price. Gluten-free foods specifically produced for celiac sufferers currently cost much more than foods produced for the general public. Despite paying more for gluten-free products, these products have inferior texture and flavor because they are gluten-free. After explaining that genetically modified glutenin, exempt of toxic gliadin, could be added to gluten-free products to improve their texture and flavor, 31 percent of celiac sufferers indicated that they would be willing to spend one to five percent more to obtain them, an additional 16 percent would be willing to spend six to ten more, and seven percent were willing to pay over 10 percent more. Again, these results indicate a rather great potential for a niche market of specifically designed biogenetic foods, despite the likelihood that such foods would cost these consumers more.

Predicting Purchase Probability

The second goal of this paper was to estimate a PROBIT model of celiac sufferers' willingness to purchase bakery products containing biogenetic glutenin. Willingness to purchase was coded such that 0 indicated some degree of hesitation regarding the respondent's willingness to purchase and 1 indicated that the respondent believed that they would 'definitely' purchase. Among the explanatory variables were three socio-demographic characteristics (age, sex and education), health status (measured by frequency of celiac disease symptoms), current dietary habits (frequency of consuming gluten-free bread and satisfaction with gluten-free products currently on the market) and attitudes toward health and biogenetic foods (reading about nutrition/health, ethical beliefs regarding biogenetics, level of confidence in safety controls on biogenetic foods, desire for labeling of biogenetic foods and fear that biogenetic glutenin would pose a personal health risk). Due to item non-responses for the nine variables in the model, the sample size dropped to 144. T-tests of differences between those remaining in the analysis versus those excluded indicated that those who dropped out due to missing data were significantly older, were women and were less well educated.

Both LOGIT and PROBIT models were estimated, but the results from the PROBIT model more accurately fit the data. The Pesaran-Timmermann test statistic for the model was 4.59 ($p=0.000$) and the pseudo-R-Squared was 0.24. Willingness to purchase was accurately predicted for 76 percent of the respondents who remained in the analysis. The marginal effect of each independent variable on the probability of purchase was computed at the mean. Results, presented in Table 1, indicate that age, sex and education did not significantly influence willingness to purchase.

Those celiacs who more frequently experienced the classic symptoms of their disease (diarrhea, flatulence and stomach pain) were less willing to purchase food products containing biogenetic glutenin. Celiacs who frequently experience symptoms are likely more sensitive to the presence of gliadin in their diets. They may doubt the efficacy of the biogenetic process to completely eliminate all traces of toxic gliadin and, therefore, be fearful of purchasing products containing biogenetic glutenin. As anticipated, the results from the model indicate that celiac sufferers who were less satisfied with gluten-free products currently on the market were significantly more willing to purchase products containing biogenetic glutenin. However, frequency of consuming gluten-free bread had no significant influence on their willingness to purchase new bakery products containing biogenetic glutenin.

Three variables measuring general concerns about biogenetics and biogenetic foods also impacted willingness to purchase products with biogenetic glutenin. Each of these variables had relatively large marginal effects on willingness to purchase. As expected, those celiac sufferers who were most concerned about the ethics of biogenetics and who had little confidence in government and industry controls over the safety of new food products

Table 1

Probit analysis of celiacs' willingness to purchase biogenetic bakery products (0=not willing)(n=144).

Independent Variables	Regression coefficient	Coefficient/ standard error	P-value	Marginal effects
Age	-0.003	-0.289	0.773	-0.001
Sex (1=female)	0.272	0.968	0.335	0.055*
Education	-0.080	-0.642	0.522	-0.026
Frequency of symptoms	-0.181	-2.719	0.007	-0.058
Frequency eat gluten-free bread	-0.177	-1.217	0.226	-0.056
Satisfaction gluten-free products	-0.234	-2.475	0.015	-0.074
Frequency read nutrition/health	-0.133	-0.748	0.456	-0.042
Believe biogenetics is ethical	0.384	3.719	0.000	0.122
Confident industry/gov't controls	0.513	2.095	0.038	0.163
Believe in mandatory labeling	0.669	1.870	0.064	0.154**
Fear health risk of biogenetic glutenin	-0.119	-0.796	0.428	-0.038
Ordinate	-3.570	-2.562	0.012	

*Probability for men minus probability for women

**Probability for 'not believing' in mandatory labeling minus probability for 'believing'

were the least willing to purchase foods with biogenetic glutenin. Celiac sufferers who believed strongly in the mandatory labeling of biogenetic food products were also those who were more willing to purchase foods with biogenetic glutenin. Perhaps those who are unwilling to purchase foods with biogenetic glutenin anticipate that, should such foods become available, they would turn to non-traditional food sources that guarantee their products as being free of biogenetic glutenin. The labeling of products with biogenetic glutenin would thus become a mute point.

Duhaime et al. (1997, p. 137) tested a LOGIT model of Quebecois' willingness to purchase biotech foods if they were of better quality and taste, but cost ten percent more than other foods. According to their results, confidence in government and industry controls over food quality did not significantly predict willingness to purchase, nor did ethically accepting the use of biotechnology to modify plants. Having a positive attitude toward science and technology, supporting the development of biotech foods and believing that biotechnology generates more positive effects than negative were among the variables in their model that did significantly influence willingness to purchase.

Conclusions and Implications

It appears that this sub-group of the Canadian population, suffering from the devastating effects of celiac disease, are as confident in government and industry controls over the safety of new food products being introduced on the market as the more general population. They are also as likely to agree that labeling of biogenetic foods should be mandatory. However, they are more supportive of the development of biogenetic foods (especially biogenetic glutenin), see fewer risks to the general population from biogenetic foods, and are somewhat less concerned about possible negative health effects from consuming a specific biogenetic food than are the general public. Celiac sufferers appear hopeful that biotechnology can help to diversify and improve foods, and this is especially true concerning foods that might be specifically developed for their own personal consumption. They also report being much more willing than the general Canadian public to purchase foods containing genetically engineered food additives. However, results from the multivariate Probit analysis indicate that the more they experience the symptoms of celiac disease (i.e., the greater their sensitivity to the presence of gliadin in their diet), the less they are willing to purchase foods with biogenetic glutenin. The severity of a food allergy or intolerance may temper enthusiasm for new food products purported to be safe for their consumption. In contrast, the less they are satisfied with current gluten-free food products specifically designed for their consumption, the more they are willing to purchase new foods with biogenetic glutenin.

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Endnotes

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