Anticipating public reaction to the use of genetic engineering in infant nutrition¹⁻³

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ABSTRACT  Public acceptance of new food products will be the major determinant of their commercial success. I present selected findings from two national social science research projects aimed at gauging consumer knowledge of and understanding consumer attitudes about biotechnology, as well as about the specific use of genetic engineering in milk production. People are more willing to accept products if they understand them and are assured by credible sources that such products are safe and effective. Perceived health concerns and ethical issues will be important to many people and are an important challenge to acceptance. Women tend to be more skeptical about these new products than are men. I make recommendations for more-effective educational efforts, based on social science research, that could increase acceptance by key consumer groups and, ultimately, the commercial success of bioengineered food products.  *Am J Clin Nutr* 1996; 63:657S-62S.

KEY WORDS  Genetic engineering, biotechnology, public perception, consumer acceptance, infant nutrition, policy, education, marketing, ethical issues

INTRODUCTION

Milk is an important and emotion-laden food. This is particularly true with respect to infant nutrition. Genetic engineering offers the opportunity to produce infant formulas that are more like human milk, and such improvements in milk-based infant formulas should be welcomed by consumers if they understand the benefits of such products. In general, biotechnology has the potential to significantly advance the development of new food and health care products. However, this potential will be realized only if consumers perceive the products to be safe and effective. They also must believe that the use of biotechnology is ethically and socially acceptable.

Political leaders have noted that consumers will be the ultimate judge of emerging biotechnologies such as genetic engineering. The response of consumers will determine the success or failure of specific products (1), and sound decisions by consumers will require that they have sufficient information. For example, parents will look to trusted sources such as pediatricians and other health care professionals for advice on these products. Education of consumers, physicians, and others is necessary to facilitate public acceptance of biotechnology. For this education to be effective, it will have to be based on in-depth assessments of public awareness and attitudes.

The use of genetic engineering in infant nutrition faces many of the same (and even greater) challenges as do other products of biotechnology. Biotechnology is developing in a context of public concerns about nutrition and health, especially as they relate to new and emerging technologies. Consumers are becoming increasingly concerned about food safety. The public perceives certain practices, such as the use of chemicals, as risky. Other concerns about biotechnology, such as ethical issues, also draw public attention. The Office of Technology Assessment (2) recently concluded that “Society in general is more skeptical of the need for new technologies. Scientific illiteracy combined with a lack of knowledge about agriculture leads some people to misunderstand how and why biotechnologies will be used.”

Scientists, public policy makers, and educators have become concerned about how the public perceives and responds to risks (3). Considerable work in this area provides insights into how people may respond to new products developed through biotechnology. The public increasingly demands greater protection from all risks, and often resists making any types of tradeoffs, especially with health (4).

Social factors could also influence consumer concerns about new milk products developed through biotechnology. Most people base their decisions and opinions about new foods on intuition, emotion, and selective perception of information. Perceptions of new products are influenced by attitudes toward science and technology in general (3), and a large segment of society is distrustful of new and unfamiliar technologies. These problems are compounded because most people have little understanding of or appreciation for how food is produced.

Subjective factors often determine whether a potential risk is acceptable or unacceptable to consumers (3). One of the major factors that make a risk unacceptable is the extent to which people believe that they bear the risk involuntarily. Risks will also be perceived as more serious if they are considered artificial (a result of manipulation of the environment) rather than naturally occurring. People find known risks (i.e., those that are understood) more acceptable than those that are unknown. Many people tend to mistrust industry and doubt that the

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government is able to effectively monitor and ensure food safety.

Public perception and acceptance of new food products have their roots in social and cultural values (3). Responses to risk are shaped by social influences and communication with friends, family members, and others (5). People have different beliefs and values, based on such factors as early experiences, education, and personality. In addition, the lay public often has very different conceptions of risks than do scientists and other professionals. Public perception is reality for most people. Analyzing public attitudes about biotechnology is challenging, but increasingly important.

HIGHLIGHTS OF RECENT SURVEYS

To better anticipate how consumers will react to new infant-nutrition products developed through genetic engineering, it is helpful to look at how consumers respond to biotechnology in general. In the past few years I have designed and conducted two major national projects on that subject (6, 7). The samples in both surveys were representative of the country as a whole. I highlight some of the key findings of this work in this article; no attempt will be made to present all of the information gathered.

The first project was a national telephone survey conducted in the spring of 1992 for the US Department of Agriculture (USDA) (6). A total of 1228 interviews were completed by the Applied Research Group at North Carolina State University. Focus groups were held to further explore consumers’ reactions to specific applications of biotechnology and to generate ideas about educational needs.

More recently, I designed and conducted a study for the Grocery Manufacturers of America (GMA) that focused specifically on consumer attitudes about the use of recombinant bovine somatotropin (BST) in milk production (7). This was one of the first products of biotechnology to be approved for food production and it generated a significant amount of controversy. For the GMA study, 1004 telephone interviews were completed by ICR Survey Research Group in January 1994 (after BST had been approved for use by the US Food and Drug Administration).

Acceptance of biotechnology

Most people tended to have fairly positive attitudes toward the general use of biotechnology. Almost three-quarters of the respondents in the 1992 USDA survey believed that biotechnology would benefit them personally during the next 5 y. Two-thirds of the respondents in both the USDA and the GMA surveys said that they supported the use of biotechnology in agriculture and food production. Even more in the 1994 GMA survey (82%) supported its use in the development of new medicines. However, the various products of biotechnology differed considerably in their acceptability to consumers.

In both surveys the respondents were asked to rate the acceptability of different applications of biotechnology (Table 1). Most people found the use of biotechnology to produce human insulin or other medicines to be acceptable or were neutral toward this use. It is interesting, however, that 14% found even this use unacceptable. The use of biotechnology to produce crops that resist insect damage or herbicides was about as acceptable as were medical uses of biotechnology. Public acceptance dropped off somewhat when it came to the use of biotechnology to produce disease-resistant farm animals. The respondents gave the lowest overall rating to the use of biotechnology to develop new food ingredients, such as flavorings. Results were consistent between the two surveys, which were conducted 2 y apart.

The acceptability of BST was assessed by one question on the USDA survey and four questions on the GMA survey (Table 1). The goal of the GMA study was to determine what influence factual information had on acceptance. The respondents’ initial acceptance (after they had heard only a brief definition) was relatively low; their acceptance rose somewhat after they had been given the following information: “All milk, including milk from cows that have received BST, contains the same, small amount of BST.”

The USDA survey analyzed respondents’ views about the more complex area of food products that had clearly transgenic characteristics. This set of questions was introduced with the statement “Genes from most types of organisms are interchangeable.” Two-thirds of the respondents said that they would accept “potatoes made more nutritious through biotechnology if genes were added from another type of plant, such as corn.” However, only one-quarter found such potatoes acceptable “if the new genes came from an animal.”

Two examples were used to determine reactions to animal-animal gene transfers. The respondents were asked whether they would accept “chicken made less fatty through biotechnology if genes were added to the chicken from another type of animal.” Only ~40% of the respondents said they would find this acceptable, and >90% of respondents would not accept such chicken if the genes came from a human.

Moral implications of biotechnology

With its dramatic power, biotechnology raises several ethical and moral issues for many people. The USDA study assessed whether people would have moral objections to the use of biotechnology in either animal or plant applications. Only one-quarter of respondents thought that the use of biotechnology to change plants would be morally wrong. The respondents had more negative views about the ethical aspects of animal biotechnology. More than one-half believed that the use of biotechnology to change animals was morally wrong.

Toward the end of the focus groups we described an application that exemplified the moral or ethical aspects of biotechnology. This involves genetically engineering pigs to produce human hemoglobin through the insertion of a human gene. The participants were asked to discuss how they felt about this application, which has already been developed. They had concerns about the process, as well as misgivings about religious, medical, and animal-welfare issues. Concerns were also raised about how biotechnology might be used in the future.
From a medical ethics standpoint, most people supported the use of pigs to produce hemoglobin. They indicated that this application was similar to other medical uses of animals and that it would create a larger, safer blood supply. Many indicated that they would be willing to receive transfusions of hemoglobin produced by pigs; others, however, had reservations about “blood from a pig.”

Certain people seem to be more concerned about religious ethics than were others. One woman summed up the negative attitudes: “You could have some kind of moral or spiritual problem with that.” Another woman in the same focus group, however, stated, “I don’t think there is anything morally wrong, fundamentally, with this.” Several men objected strongly to the whole concept of biotechnology on the grounds that it is “against God’s will.”

We saw differences between men and the women in their opinions about ethical treatment of animals that relate to this example. Women were concerned that the pigs would experience pain. As one woman stated, “I don’t think it’s ethical to create a life form that’s miserable.” Women were also concerned about killing the pigs, because “you are destroying an intelligent life.” None of the men, however, expressed concern about animal welfare.

Some people stated that they would find it emotionally distressing to eat transgenic pork. As one woman stated, “I wouldn’t objectively, but way back down emotionally, maybe esthetically, it would make me cringe.” Other people said that they would feel “queasy” about eating a human gene. Some said that they would not have any problem with it, because “it’d still just be pork.” Others were less enthusiastic, but said that they would “probably get used to it.” Several stated that it would be unethical to waste the meat if the pigs were to be slaughtered anyway.

### Awareness of biotechnology

Greater awareness of biotechnology and its products will likely result in more positive attitudes about its use. Both surveys included several measures of awareness (Table 2). The results indicate that the public knows little about new or traditional practices. The respondents in the 1992 USDA survey were asked about traditional methods of crop and livestock improvement through breeding. Just more than one-half of them had heard or read about breeding. The respondents were also asked two specific questions about their awareness of biotechnology; when they were presented with just a definition their awareness was lower than it was after they were told about specific applications. Almost one-half had heard or read either a lot or some about possible applications of biotechnology.

The respondents in the later GMA survey also had relatively little awareness of biotechnology. Even after 2 y of fairly extensive media coverage, awareness was low: just more than one-third had heard or read either a lot or some about biotechnology. On the other hand, one-third claimed to have heard nothing about biotechnology. When they were asked about specific products of biotechnology their awareness was not
TABLE 2
Amount respondents had heard or read about biotechnology and related topics, 1992 and 1994

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Traditional breeding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>15</td>
<td>32</td>
<td>39</td>
<td>14</td>
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<tr>
<td>Definition of biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1992</td>
<td>25</td>
<td>38</td>
<td>30</td>
<td>8</td>
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<tr>
<td>1994</td>
<td>32</td>
<td>33</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Products of biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>13</td>
<td>40</td>
<td>38</td>
<td>9</td>
</tr>
<tr>
<td>1994</td>
<td>27</td>
<td>40</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Bovine somatotropin (BST)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>62</td>
<td>19</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

* Data are from Hoban and Kendall (6) (1992 survey) and Hoban (7) (1994 survey).

significantly higher, and their awareness of BST was even lower than it was of the general topic of biotechnology. Only one in five had read or heard a lot or some about BST. Surprisingly, almost two-thirds said that they had heard nothing about BST.

Information needs and sources

Given the low degree of public understanding of biotechnology, education presents both challenges and opportunities. One-fifth of the respondents in the USDA survey had a lot of interest in learning more about biotechnology. Almost one-half reported some interest. Another one-fifth had only a little interest and the rest (14%) said they had no interest in learning more about biotechnology. The respondents who reported having at least "a little" interest were asked how important it would be to receive a variety of information about biotechnology. More than two-thirds thought it would be "very important" to have information about the potential risks or negative effects of biotechnology. Most of the rest said that such information would be somewhat important. Just less than two-thirds said that it would be very important to have information about new uses of biotechnology in human health care. One-half of the respondents indicated that it would be very important to have more information about the potential benefits or positive effects of biotechnology. About 40% said that information about new uses of biotechnology in food production would be very important. Almost as many believed that information about how the government regulates biotechnology would be very important. The information they considered the least important was about the basic science of biotechnology. However, even in this case, more than one-third said that this information would be very important and more than one-half said that it would be somewhat important.

Several questions on the GMA survey were used to determine the respondents' interest in information about BST. About one-quarter had a lot of interest and more than one-third expressed some interest. Only 20% said they had no interest in learning more about BST. The respondents with at least "a little" interest were asked what types of information about BST they would be interested in. A wide variety of answers were given; the major area of consumer interest involved a better general understanding of BST—what it is, how it works, and why it is needed. The second most important area involved specific information about the safety and potential health effects of milk from cows given BST. The respondents also expressed considerable interest in the testing and regulatory processes.

One of the keys in public acceptance of products derived from biotechnology is the extent to which consumers get their information from trusted sources. The sources that consumers turn to for information will vary considerably in their credibility. The ratings that the respondents gave to various sources of information in the GMA survey are presented in Table 3. The six most trustworthy sources of information (ie, those with the greatest percentages of "a lot" responses) are all scientific organizations, university scientists, and government agencies.

Influences on consumer acceptance of biotechnology

Additional analyses provide insights into the types of consumers who will be most likely to accept products of biotechnology. Women appeared much less likely than men to accept these applications. Respondents with more formal education were much more likely to accept the products than were those with less formal education. Those with higher incomes were also more likely to find the products acceptable. Respondents who rated religion as more important in their daily lives were less likely to find biotechnology acceptable. Respondents with a greater interest in science and technology tended to have a greater acceptance of biotechnology. Other attitudes about and general awareness of biotechnology were also significantly related to the respondents' acceptance of new products. Those who had read or heard more about biotechnology were much more likely to find the applications acceptable than were those with less awareness. We found a similar pattern with increased interest in biotechnology.

TABLE 3
Amount of trust in sources of information about the safety of bovine somatotropin (BST)

<table>
<thead>
<tr>
<th>Source</th>
<th>None</th>
<th>Some</th>
<th>A lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Medical Association</td>
<td>13</td>
<td>46</td>
<td>41</td>
</tr>
<tr>
<td>National Institutes of Health</td>
<td>11</td>
<td>55</td>
<td>34</td>
</tr>
<tr>
<td>Food and Drug Administration</td>
<td>17</td>
<td>51</td>
<td>32</td>
</tr>
<tr>
<td>American Dietetic Association</td>
<td>14</td>
<td>55</td>
<td>31</td>
</tr>
<tr>
<td>University scientists</td>
<td>12</td>
<td>59</td>
<td>28</td>
</tr>
<tr>
<td>State departments of agriculture</td>
<td>12</td>
<td>60</td>
<td>28</td>
</tr>
<tr>
<td>Registered dietitians</td>
<td>14</td>
<td>66</td>
<td>20</td>
</tr>
<tr>
<td>Dair farmers</td>
<td>19</td>
<td>61</td>
<td>20</td>
</tr>
<tr>
<td>Extension service</td>
<td>20</td>
<td>63</td>
<td>17</td>
</tr>
<tr>
<td>TV news reporters</td>
<td>30</td>
<td>54</td>
<td>16</td>
</tr>
<tr>
<td>Company that makes BST</td>
<td>37</td>
<td>52</td>
<td>11</td>
</tr>
<tr>
<td>Packaged-food manufacturers</td>
<td>41</td>
<td>52</td>
<td>7</td>
</tr>
<tr>
<td>Chefs</td>
<td>46</td>
<td>48</td>
<td>6</td>
</tr>
<tr>
<td>Activist groups</td>
<td>52</td>
<td>43</td>
<td>5</td>
</tr>
<tr>
<td>Grocery stores</td>
<td>52</td>
<td>44</td>
<td>4</td>
</tr>
</tbody>
</table>

* Data are from Hoban (7).
IMPLICATIONS AND RECOMMENDATIONS

The results of these surveys have implications for the use of genetic engineering to produce new types of infant-nutrition products. Research suggests that new infant-nutrition products developed through genetic engineering will likely face some challenges in gaining consumer acceptance. The key barriers to acceptance involve lack of understanding, perceived risks, and ethical concerns. Consumers want to be assured by experts whom they trust that the products of biotechnology are safe, effective, and beneficial. The perceived benefit-to-risk ratio will be the major driver of acceptance. A few will want scientific information about the product but most will not need that information. People will also have to be comfortable with the process from an ethical standpoint.

That women tend to be more skeptical about new products developed through biotechnology may present particular challenges with new infant-nutrition products. Our focus groups suggest that women are not necessarily more negative, but they do have many more questions and they tend to see technology in a much broader perspective. They are more likely to recall problems with technologies in the past (especially those that affected them directly, such as birth control devices). Furthermore, because women traditionally have the social roles of caregivers and food gatekeepers, they will likely be key decision-makers in the use of these products. Special efforts will have to be made to understand women's attitudes and needs. Educational programs should work through channels such as women's magazines and trusted sources (such as obstetricians and pediatricians).

The use of BST presents an important case study for public acceptance of infant formulas developed through biotechnology. In fact, BST may have been a more difficult challenge in terms of acceptance because of the considerable controversy that had been ongoing for several years. Several groups (even including some dairy farmers) actively opposed BST and used a variety of tactics to attempt to sway public opinion. It is unlikely that as much opposition to infant-nutrition products will be raised by organized antibiotechnology groups. Such groups may, in fact, no longer have much influence by the time these products have been developed and approved.

BST was a particular challenge because it was the first widely publicized food product to be developed through biotechnology. It also faced the perception that it had little benefit for consumers. However, despite significant media coverage in the previous months, most consumers we interviewed had little awareness of BST. We concluded that BST was not an important issue for most consumers. Although some consumers did express some concerns about BST, such attitudes did not seem to affect their consumption of milk. Survey results predicted that the use of BST would have no effect on milk consumption, and market data, in fact, proved this to be true. Despite all the controversy, milk consumption in the United States did not change in the first year after the approval of BST.

Most consumers want to know more about biotechnology. They clearly want factual information about the products used in producing milk. Their preferred sources for such information are physicians and independent scientific organizations. Trust and credibility have two primary dimensions: first, the sources must be perceived as expert (ie, they have the knowledge and capability to present the information) and, second, credible sources must also be perceived as having relatively little vested interest or bias that would influence their willingness and ability to give factual and balanced information.

With this background, it is possible to suggest some educational strategies to help ensure the acceptance of new infant-nutrition products developed through biotechnology. Consumers (especially parents of infants) are the ultimate target audience. However, it will be impossible to reach all consumers directly. Efforts should be concentrated on educating a variety of key opinion leaders (such as public officials, health professionals, and media representatives). These leaders will in turn educate and influence consumers about new infant-formula products that are developed through biotechnology.

To appeal to the interests of various audiences, educational messages must be developed at different levels of complexity and detail. Education should help make the exotic more familiar. Safety concerns must be addressed with clear, concise, and objective information that is attributed to a trustworthy source. Information should be balanced and should address both benefits and potential concerns associated with the product. The vehicles for delivering such messages should include mass media (television, newspapers, and women's magazines), point-of-purchase information (brochures, in-store displays, videos, and toll-free numbers on labels), physicians' offices, and parents' groups. It will also be important to provide sources for further information (for example, consumer toll-free hot lines and computer networks).

Moral and ethical issues are an important challenge that may limit initial acceptance by some consumers. Education is necessary for acceptance, but it still may not be enough if moral concerns are strongly held. The major ethical issue for many people is the desire to know that there are limits to the way scientists and companies are using the power of biotechnology. Citizens want a role in shaping the future direction of this technology. People want to make sure that societal issues are served by scientific advances (8). It all comes back to confidence and trust. People want to be assured that trustworthy experts are serving their interests. Before addressing such complex and emotional issues, it will be important to understand the basis for such beliefs.

More social science and marketing research is clearly needed on the specific infant-nutrition products being developed through genetic engineering. It will be vital to understand the attitudes and knowledge of both consumers and opinion leaders (such as pediatricians). It will also be important to determine the views and interests of religious leaders, ethicists, journalists, and consumer activists. These groups help frame the debate over these products and genetic engineering in general. Such research should initially use a variety of qualitative methods (such as focus groups and interviews with opinion leaders). Quantitative surveys,
such as those described in this article, will also be benefi-
cial, particularly as the products get closer to market.

CONCLUSIONS

Social trends and cultural values will influence public reac-
tions to the new products of biotechnology. Food, especially
that given to infants, will always be an emotional and personal
issue. However, given enough time, patience, and thought, it
will be possible to make these and other products of biotech-
nology a success. The key will be to inform and involve the
right people early in the process. Above all else, it is important
that everyone involved in bioengineered food products under-
stand and respect public perceptions, even if they do not appear
to be based on scientific fact.

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