

Glutamine effects catabolic states. Native glutamine is poorly soluble in water. Synthetic glutamine in the form of stable and highly soluble dipeptides enriches food in order to attenuate the expansion of extracellular and total body water. Besides, glutamine influences stress-induced accumulation of extracellular fluid by affecting membrane function, and changes the cellular hydration state. This suggests therapies for extracellular edema. It can also be used to treat insulin resistance, such as diabetes mellitus, sepsis, and trauma. Finally, glutamine (dipeptide) is proposed as a suitable cardioprotective and rescue agent.³⁵³

Phytochemicals can be used as nutraceuticals. Glucose and insulin regulation is an important feature of phytochemicals. *Agrimonium eupatoia* extract carries on insulin-like activity and stimulates incorporation of glucose into glycogen. New hypoglycemic compounds have been proposed like castanospermine, neomyrtillin (bilberry) and myricetin (tea, berries, fruits). To sum up, more than 1,000 plants have been claimed to offer special benefits in the treatment of diabetes. Lentinan³⁵⁴ from mushrooms activates the host's immune system and has antitumor and antiviral activity due to an induction of interferon- γ production. It reduces the toxicity of AZT.³⁵⁵ Prevention of the onset of AIDS symptoms through potentiation of host defense is presently being investigated.³⁵⁶ Flavonoids and phenolic acids from honey possess antimicrobial activity. Isoflavone phytoestrogens, such as daidzein and genistein, in soy have antidiarrheal, hypolipidemic, anticarcinogenic and antiosteoporotic effects. The consumption of high soy food is associated with lower breast and prostate cancer risks and it improves the bone mineral content.³⁵⁷

C. Consumer acceptance of innovation in the food sector

Consumer acceptance is by far the most critical point of the application of biotechnology in the food sector besides the technological feasibility of biotechnological applications. Consumer acceptance of genetically modified food is extremely difficult for several reasons. First of all, the food sector is the subject of great public attention. Negative news from one company can affect the entire food sector. Additionally, the media are interested in sensational negative news about genetically modified food, thus amplifying public controversy about genetically modified food.

353 *Andlauer&Fürst*, Nutraceuticals: A Piece of History, Present Status and Outlook, 35 Food Research International 171, 173 (2002).

354 A polysaccharide characterized as β -1,3-glucan having branching of the 1,6 bonds.

355 A drug commonly used for treating HIV carriers and AIDS patients.

356 *Andlauer&Fürst*, Nutraceuticals: A Piece of History, Present Status and Outlook, 35 Food Research International 171, 174 (2002).

357 *Andlauer&Fürst*, Nutraceuticals: A Piece of History, Present Status and Outlook, 35 Food Research International 171, 174 (2002).

Seed companies, such as Monsanto, Bayer CropScience or Syngenta, have introduced new, innovative genetically modified plant varieties to the market. Most of these varieties are designed for the demands of farmers, like increased resistance and crop efficiency. Only few genetically modified plants with improved quality traits have been marketed. The most important example is Calgene's FlavrSavr tomato. These genetically modified plants have failed to convince consumers. As a consequence, the first generation of genetically modified plants with improved quality traits has been withdrawn from the market. But the acceptance of biotechnology is generally positive as long as biotechnology offers benefits to consumers.³⁵⁸

Additionally, public understanding of science is rather poor and unsteady. Only few consumers can assess biotechnology related to the production of agricultural raw materials because there is an insufficient knowledge base. Moreover, food is a particularly sensitive subject matter.³⁵⁹ Thus biotechnology related to the production of agricultural raw materials affects lives in a more personal way.

Consumer acceptance of biotechnology related to the production of agricultural raw materials is not based on an "objective" technical assessment. Irrational judgements often win out over rational arguments and create distortions of consumer acceptance. The language with regard to biotechnology related to the production of agricultural raw materials has tended to "hijack the debate."³⁶⁰ Quite often, non-scientific reasons for objection have been expressed as scientific doubts, so that these technologies seem to be simply unacceptable. Consumer acceptance of biotechnology related to the production of agricultural raw materials is reflected by the slogans currently used in advertising food. Attributes such as "natural," "organic," or "additive free" address rather the moral attitude of consumers than scientific assessments of nutritional value.

Moreover, the surveys concerning the acceptance of biotechnology in the food sector show a trend towards increased caution. A reliable information policy about biotechnology related to the production of agricultural raw materials could overcome the prejudices of consumers. There are no data about the long-term effects of genetically modified plants, as biotechnology is a rather new technology. Hence, the discussion concentrates on the potential risks of biotechnology related to the production of agricultural raw materials. This debate seems to make biotechnology unacceptable to many consumers for reasons of future food safety.

Last but not least, liabilities for the outcrossing of genetically modified varieties are not clearly defined between the breeders, distributors, and governmental bodies.³⁶¹

358 *Gurau&Randhod*, The Atlantic Divide in Food Biotechnology: Differences in Industry, Market and Consumers' Perception between the U.S. and the UK, 5 *Int'l J. Biotechnology* 141, 153 (2003).

359 *Belton*, Chance, Risk, Uncertainty and Food, 12 *Trends in Food Science&Technology* 32 (2001).

360 *Belton*, Chance, Risk, Uncertainty and Food, 12 *Trends in Food Science&Technology* 32, 35 (2001).

361 *Gurau&Ranchhod*, The Atlantic Divide in Food Biotechnology: Differences in Industry, Market and Consumers' Perception between the U.S. and the UK, 5 *Int'l J. Biotech.* 141, 144 (2003).

Biotechnology in the food sector is more accepted by consumers in the U.S. than in the EU. Most consumers in the U.S. are comfortable with the commercialization of genetically modified plants.³⁶²

Consumer acceptance of biotechnology related to the production of processed food is harder to assess. The public discussion about biotechnology in the food sector concentrates on the implementation of biotechnology related to the production of agricultural raw materials. Biotechnology related to the production of processed food is considerably less addressed.

There are no public sanctions on cheese processed with chymosin derived of genetically modified microorganisms. The dairy sector has implemented genetically modified microorganisms to a large extent. Nevertheless, there are hardly any reactions from consumers. Also the media hardly address the application of biotechnology related to the production of processed food. Headlines like "GM oilseed rape harms bees and butterflies"³⁶³ reflect the media's focus on biotechnology related to the production of agricultural raw materials.

Non-governmental organizations often protest against genetically modified plants. But genetically modified microorganisms in the production of processed food seem to be ignored by them. The most active opponent of genetically modified organisms, Greenpeace, only addresses issues relating to biotechnology used in the production of agricultural raw materials. Biotechnology related to the production of processed food is completely neglected. The Greenpeace booklet "Food Assistant – Food without genetically modified organisms – special topic dairy products" focuses only on genetically modified plants used as food or feed. The fact that the dairy industry is based on genetically modified organisms is not addressed at all.³⁶⁴ Greenpeace defends this policy with the disclaimer that such genetically modified microorganisms are cultivated in closed systems of factories and are not intended for release into the environment. Greenpeace concludes that genetically modified microorganisms are not as "dangerous" as genetically modified plants.³⁶⁵ But there is no denying that protest activity like destroying field trials generates more media attraction than entering a dairy factory.

362 IFIC, *Consumer Attitudes towards Food Biotechnology* (2000), Washington, DC 2000, *Einsiedel*, *Cloning and its Discontents - A Canadian Perspective*, 18 *Nature Biotechnology*, 943 (2000), Eurobarometer, *Opinions of Europeans on Biotechnology in 1991*, Concertation Unit for Biotechnology in Europe, Brussels 1991, *Gaskell et al.*, *Biotechnology and the European Public*, 18 *Nature Biotechnology* 935 (2000), *Priest*, *US Public Opinion Divided over Biotechnology*, 18 *Nature Biotechnology* 939 (2000).

363 Translated version, original German title: "Genraps schadet Bienen und Schmetterlingen," *Der Spiegel*, March 22, 2005, available at www.spiegel.de/wissenschaft/mensch/0,1518,347732,00.html.

364 Translated version, original German title: "Ratgeber-Essen ohne Gentechnik – Schwerpunkt Milchprodukte," Greenpeace, *Essen ohne Gentechnik – Ratgeber für gentechnikfreien Genuss, Schwerpunkt Milchprodukte*, 8th ed., Hamburg 2005.

365 Greenpeace, *Essen ohne Gentechnik – Ratgeber für gentechnikfreien Genuss, Schwerpunkt Milchprodukte*, 8th ed., Hamburg 2005, 10.

Biotechnology brings enormous benefits to the production of agricultural raw materials and the production of processed food. Though biotechnology will not address all future food needs, it will be essential to feed a growing world population. To put the impact of biotechnology in a nutshell:

"Biotechnology is providing a common technical base on which the pharmaceutical, chemical, agricultural, and food production industries can be united (...)." ³⁶⁶

Applications of biotechnology must be mutually acceptable to consumers, legislatures, farmers and food processors. The success of biotechnology will depend on the attitudes of consumers. Appropriate information policy and public understanding are therefore crucial. ³⁶⁷

Biotechnology must overcome consumer antagonism. Consumers only pay attention to biotechnology as it relates to the production of agricultural raw materials. Biotechnology related to the production of processed food is hardly perceived by consumers. The controversies surrounding genetically modified food are substantial. The attention paid to process technologies involving genetically modified organisms is minimal and negligible. ³⁶⁸

Regulations of food biotechnology are an obstacle for the implementation of biotechnology. Biotechnology related to the production of agricultural raw materials as well as in the production of processed food is subject to a complex regulatory framework. Regulations concern the identification of genetically modified food ingredients. Further restrictions apply to the testing of genetically engineered plants and organisms. The implementation of biotechnology in the food sector is limited by restrictive regulatory approval in the EU.

The labelling obligation for food derived of genetically modified plants is supposed to have obvious "ramifications," as consumer acceptance is difficult to gain with respect to clear differentiation and isolation. ³⁶⁹ Food production aids that are derived from genetically modified microorganisms do not have to be labelled. This seems to be inconsistent, as both microorganisms and plants involve genetic modification. The regulatory approval of food made from genetically modified plants is handled rather restrictively in the EU. The *de facto* moratorium on products from genetically modified plants also affects imports of genetically modified plants. Consequently, the EU has refused to allow the sale of 30 U.S. products derived from genetically modified plants since 1998 for precautionary reasons. "This trade barrier harms farmers and consumers around the world by denying them the benefits of productive, nutritious and environmentally friendly biotech products." ³⁷⁰

366 Kenney, *Biotechnology: The University-Industrial Complex*, New Haven&London 1986, 218.

367 Madden, *Food Biotechnology - An Introduction*, ILSI 1995, 36,
available at www.ilsil.org/publications/ilsifobi.pdf.

368 Gardner, *The Development of the Functional Food Business in the U.S. and Europe*, in: *Goldberg* (ed.), *Functional Foods, Designer Foods, Pharmafoods, Nutraceuticals*, London 1994, 468, 478.

369 Gardner, *The Development of the Functional Food Business in the U.S. and Europe*, in: *Goldberg* (ed.), *Functional Foods, Designer Foods, Pharmafoods, Nutraceuticals*, London 1994, 468, 477.

The European Council allows the marketing of genetically modified plants. But it enforces strict labelling and traceability standards.³⁷¹ The U.S., Canada, and Argentina are the main exporters of genetically modified agricultural products. These countries have requested that the WTO establish a WTO dispute settlement panel on the European policy with regard to genetically modified agricultural products.³⁷²

Finally, investments in agricultural biotechnology are declining.³⁷³ *McElroy* summarizes:

"Most life science investors have historically shied away from supporting agricultural biotechnology, but changing consumer acceptance and refinements in infrastructure, intellectual property management and regulations sector may make the sector more attractive in the coming years."³⁷⁴

*Straus*³⁷⁵ warns of the devastating consequences of discriminating against plant biotechnology through politically motivated regulation. Europe runs a great risk of losing out in this important field of technology - all the more galling given that it was in Europe where much of the pioneering research took place.³⁷⁶ Consequently, while plant biotechnology is declining in Europe,³⁷⁷ it continues to grow elsewhere in the world, creating numerous new jobs.

370 *Zoellick*, U.S. Requests Dispute Panel in WTO Challenge to EU Biotech Moratorium, press release by the USTR of August 7, 2003, available at www.ustr.gov/releases/2003/08/03-54.pdf.

371 All products that contain more than 0.9% genetically modified organisms are to be labelled. The traceability requirements are regarded as costly and implement, U.S. Launches Trade War on GM food, 2(2) *European Biotech News* 5 (2003).

372 If the U.S. succeeds, the EU is to compensate U.S. farmers for their export losses an estimated sum of U.S.\$300 million per annum, *Transatlantic GM Trade War Escalates*, 2(3) *European Biotech News* 5 (2003).

373 U.S. venture capital investment in biotechnology increased from less than 4% of total VC funding in 2000 to 9% in 2002. However, of those venture capitalists who claim a significant interest in the life sciences, only a handful have invested in agricultural biotechnology. Available at www.ventureeconomics.com.

374 *McElroy*, *Sustaining Agbiotechnology through Lean Times*, 21 *Nature Biotechnology* 996, 2003.

375 *The Need to Protect Intellectual Property in Plant Science*, *Syngenta Lectures Issue 2*, 2003, 34, 41.

376 *Zambryski et al.*, *Ti Plasmid Vector for the Introduction of DNA to Plant Cells without Alteration of their Normal Regeneration Capacity*, 2 *European Molecular Biology Organization Journal* 2143 (1983).

377 Syngenta decided in 2004 to move its research activities for genetically modified plants entirely from Europe into the "more sympathetic climate of the U.S." Available at www.guardian.co.uk/gmdebate/Story/0,2763,1252345,00.html. Previously, Monsanto has also decided to withdraw from the European seed market.