

Biotechnology in Foods and Drinks

- *New foods and Drinks*
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- *Support and Opposition*
- *Research into Public Perceptions*

EUROPEAN FEDERATION
OF BIOTECHNOLOGY

EFB

TASK GROUP ON
PUBLIC PERCEPTIONS
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Biotechnology is a rapidly expanding field of science with many different applications. One area of application is in the production of new varieties of foods and drinks, either by modern developments of conventional techniques, or by genetically modifying the products themselves, or producing them using genetically modified organisms or their products. The aims are to increase the range and quality of products available, to reduce their price and to protect the environment. Preceding the advent of such products onto the market, questions are being raised about their safety, labelling, need and ethics. Measures for their regulation and labelling, which will be implemented in all countries of the European Union, are being developed by the European Commission.

The aim of this briefing paper is to review the scientific developments in biotechnology for the production of foods and drinks, to analyse the important issues concerning the public about them and to review the developing legislation for their regulation and labelling. In this context there is the common need for information and understanding about these topics and therefore the overall aim

Table 1: Traditional processed foods using biotechnology

Alcoholic beverages; beer, wine
Cheese
Bread
Vinegar
Yoghurt
Fruit and vegetable products
• Pickles
• Soya sauce
• Sauerkraut
By-products of fermentation
• Enzymes
• Flavours
• Additives
Dietary supplements
• Amino acids
• Vitamins

of this briefing paper is to provide balanced information to advance the debate about them.

The paper results from the combined contributions of scientists, industrialists, and governmental, environmental and consumer group representatives. It is intended for information and does not represent the views or policy of the European Federation of Biotechnology or any other body.

The Terms in Use

Biotechnology is the integration of natural sciences and engineering in order to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services (EFB General Assembly, 1989). This definition is applicable to both "traditional" and "modern" biotechnology. "Traditional" biotechnology refers to the conventional techniques which have been used for many centuries to produce beer, wine, cheese, bread and other foods (Table 1). "Modern" biotechnology embraces all methods of genetic modification by recombinant DNA and cell fusion techniques together with the modern developments of "traditional" biotechnological processes.

New Foods and Drinks

Historically biotechnology is closely related to food production both in the selective breeding of food plants and animals and in food processing using microbial enzymes. Traditional selection techniques have been employed to develop a great variety of plants, animals and micro-organisms for the production of a wide range of food products and ingredients for processed foods. These conventional techniques are widely accepted and do not cause public concern.

Genetic modification techniques are now being used in the production of new foods

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Table 2: Overview of research on genetically modified crops

Product/Food	Action/Application
Apples	Insect resistance (bacterially-derived)
Bananas	Integrated pest management of viruses, fungi and nematodes
Broccoli	Slow ripening for longer freshness
Celery/Carrots	Crispness retention
Chicory	Increased availability of fructans
Coffee	Better flavour, higher yields and lower caffeine
Cole Crops	Resistance against insect predators
Corn	Insect resistance
Cucurbita	Viral, fungal and bacterial resistance
“Euromelon”	Ripens on demand
Grapes	New seedless varieties
Lettuce	Smaller size and insect resistance
Potato	Several disease resistances
Rapeseed	Production of hard fats in the plant High temperature frying oil, low in unsaturated fats
Raspberries	Slower ripening through ethylene control
Soybean	Herbicide resistance Soy oil with lower palmitic acid content
Strawberries	Frost resistance
Sunflower	Lower saturated fatty acid content
Tomatoes	Improve colour and flavour, slow down softening Resistance to viral diseases
Wheat	Herbicide resistance

Genetic modification techniques are being used to achieve many of the same aims as traditional breeding and selection methods but have two main advantages. First, they provide the means of controlling the introduction of genes with much greater prediction and precision than can be achieved by the traditional methods. Second, they make it possible to introduce copies of genetic material into unrelated species hitherto impossible to achieve by traditional techniques.

Adapting micro-organisms for more effective food production: Genetically modified chymosin from yeast was developed to replace rennet, traditionally extracted from the stomachs of calves, in the milk-curdling stage of cheese production. It countered an approaching worldwide shortage of calf rennet and was also found to produce cheese of a more controlled quality. In some

European countries, such as Great Britain and Italy, it is now routinely used in cheese production.

Increasing the resistance of plants to diseases and pests: A considerable amount of research is being carried out in this area with many applications likely in the near future. Some genetically modified crops which are now being field tested have had a gene inserted which codes for a substance toxic to insects made by the bacterium *Bacillus thuringiensis**. This confers resistance to insect predators without the use of insecticides.

Increasing the resistance of plants to herbicides: To lower the burden of herbicides in the environment, plants are being developed with resistance to specific herbicides. Weed-killing can then be carried out with selective herbicides which are biodegradable and/or with less frequent crop treatment.

Developing plants withstanding more extreme conditions: Research still largely in the experimental stage is aimed at developing plants with enhanced tolerances to drought, frost and soil salinity. Larger areas of the earth could then be used for agricultural production with crops being grown closer to the market resulting in reduced transport costs and loss of food product.

* *Bacillus thuringiensis*: This bacterium produces Bt toxin, which protects plants from predators (mainly insects). A bacterial suspension is usually sprayed over the crop but recent biotechnological research is focusing on genetically modifying certain plant species to make their own Bt toxin, hence making the pesticide spraying superfluous.

Developing foods with improved qualities: Much research is being carried out in this area and some products are near to marketing. One example is the “*Flavr Savr*” tomato. Tomatoes are usually picked green to avoid softening and loss of product during transport and storage with the result of loss of flavour. By blocking the enzyme polygalacturonase, the rate of softening is slowed, allowing the tomato to remain longer on the vine with the aim of improving flavour without loss of product.

Improving animal farming: Animals are an important part of the diet throughout the world. Research is therefore aimed at enhancing such factors as growth rate, and parasite and disease resistance. The major effort, however, is directed at genetic modification of crop plants for animal feed, of micro-organisms or enzymes to improve the nutritional value of animal foodstuffs and in the animal health sector for pharmaceuticals, vaccines and diagnostics.

Developing foods with specific properties: Foods fulfilling specific functional properties with respect to certain diseases and allergies have begun to be produced intended to improve the quality of life for affected people.

Current Concerns

There is great need for public discussion and debate about these technologies because of their potentials, their possible risks and the public concerns which they have aroused. The following aims to set out the main arguments with the intention of providing a basis for the reader to draw his own conclusions.

Present-day consumers are highly heterogeneous with differing and changing perceptions about food preferences, safety and quality. A common factor is that most consumers have become increasingly discerning irrespective of genetic modification. Conventionally-produced artificial additives such as flavourings and colourings appear occasionally to have had adverse effects, eg hyperactivity in some children, although such links have never been demonstrated by controlled studies. Residues of conventionally-produced compounds used during production processes, eg pesticides, hormones or antibiotics, have sometimes led to temporary withdrawal of certain products from the market. In some countries public opposition has led to the banning of food irradiation. The result has been to make the public want to know about the contents of food products and their production methods.

Safety aspects: People wish their food to be as “natural” as possible in spite of the fact that most foods and drinks nowadays are processed in various ways. They feel that the more “natural” the product, the safer it is to eat. Therefore it follows that there are

and drinks and have become a subject of public apprehension and debate. Table 2 lists examples of genetically modified crops. These and other products are still largely at the research and development stage with few having yet reached the market. They can be divided into three main categories with the use of genetic modification varying considerably among them:

- manufactured foods and drinks by grinding, mixing etc. (eg noodles, soft drinks)
- bio-processed foods and drinks by using micro-organisms (eg cheese, alcoholic drinks)
- fresh foods and drinks (eg vegetables, meat, fruit juice)

Genetic modification involves the insertion of one or a small number of scientifically well-characterised genes into the food plant, animal or micro-organism. Usually these genes are not directly derived from the originating organisms but are chemically synthesised copies. They either alter the functional property of enzymes or change the characteristics of food products themselves. With manufactured and bio-processed foods and drinks, enzymes produced by genetically modified organisms are used to aid food production and are not usually present in the final product. Genetically modified fresh foods and drinks are themselves intended for human consumption. The new gene products within them, which are proteins, carbohydrates or fatty acids, are most probably digested in the same way as the thousands of other different proteins, fatty acids and carbohydrates which make up our daily diet.

doubts about the safety of products involving genetic modification since it is seen as an “unnatural” process. However scientists and non-scientists may regard “naturalness” differently. To a non-scientist the introduction of genetic modification in connection with food may be regarded as something fundamentally different but this is a distinction not made by scientists. Almost all common foods in our diet come from the breeding, hybridisation and selection of plants, animals and micro-organisms over many centuries. These are also genetic techniques which could therefore be regarded as “unnatural”. Genetic modification, like conventional genetic techniques, introduces new genetic material. It differs only by enabling the transfer of genetic material between species which was previously not possible because of breeding barriers.

Concern is expressed about the possible health hazard of consuming food containing modified genetic material. All food contains DNA and it is most probable, but not proven, that all DNA in food, whether modified or not, is digested and cannot be taken up by the cells lining the human intestine. On the other hand, if the DNA were not to be digested, bacterially-derived genes for antibiotic resistance used as genetic markers during the transfer of desired genes might confer resistance to the normal bacterial flora of the human intestine. Potential health problems of antibiotic resistance and allergenic susceptibility might then arise. However, resistances to antibiotics are natural properties of many bacteria frequently present on foods and regularly consumed by human beings. Such antibiotic resistance marker genes can also be deleted after the research phase and eliminated from the final product.

Questions are raised about the chance of hazardous levels of toxins, new substances or allergens occurring in genetically modified crops. This possibility is not unique to genetic modification because it has also occurred as a result of traditional plant breeding. However, the food producer or manufacturer has the legal responsibility of ensuring the safety and quality of his products and therefore the absence of any harmful substances.

It has been suggested that possible adverse effects in the environment by “biological pollution” from genetically modified crop plants could occur through pollen flow into related wild species and to other crops. A new weed might be created or previous artificial means of control might no longer be effective if genetically modified crop traits such as herbicide resistance were to find their way into weeds. If traits such as insect or virus parasite resistance were to be introduced into weeds then naturally occurring control systems might no longer function.

These possibilities are, however, improbable for several reasons. Weeds overcome man-made crops because they are better adapted by natural selection resulting in a more advantageous combination of genetic characteristics. Introduction of any new gene, such as herbicide resistance, will be likely to disturb this advantageous combination of characteristics. Disruption of a natural control system by transferring parasite resistance would depend additionally on the weed having been susceptible previously to that parasite. This is highly improbable as parasites are usually adapted specifically to their hosts through natural selection. Effective change in resistance or susceptibility is unlikely. “Biological pollution” from escape of genetically modified food animals is unlikely as they are normally large, contained, and easily recaptured except for farmed fish.

Other possible adverse environmental effects are that the conferring of herbicide resistance might lead to increase in dosage, as crops could then withstand higher levels of application. Additionally the frequent use of a single herbicide might lead to adaptation by weeds for resistance to that herbicide. These possibilities are being examined by extensive risk assessment trials in various countries.

Socio-economic aspects: There is debate firstly about the so-called “substitution effect” of developing products which may replace Third World crops with important economic value to these countries. Secondly, some aspects of modern biotechnology may have large impact on farming systems. Some anticipate that genetically modified food production may replace traditional farming with biosynthetic industrial processes controlled by multinational corporations. Finally, the conferring of herbicide resistance to crops may lead to dependence by farmers on the specific herbicides and hence their producing companies.

On the other hand there is the view that biotechnology offers crops for the Third World especially adapted to diverse farming conditions and practices, and with potentially higher nutritional value and higher income. Biotechnology is neither capital nor energy-intensive and does not require new raw materials. Conservation of the environment is also offered through energy producing crops saving destruction of natural resources. It is for these reasons that several developing countries have already made substantial investment and progress in biotechnology.

Biological aspects: There is discussion about the loss of genetic diversity among the world’s species

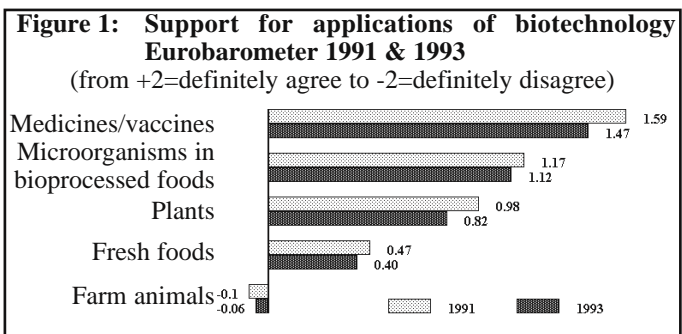
and hence loss of genetic resources. The traditional methods of crop and animal improvement have already narrowed down the genetic diversity of species by intensive selection of specific characteristics. As genetic modification is a faster method for selection than the traditional methods, there is the possibility of increasing the rate of this process resulting in more rapid and greater loss of genetic diversity. On the other hand, however, genetic modification *per se*, together with conventional breeding methods, results in the creation of new genetic combinations, hence increasing diversity. It also provides techniques for the preservation of the germplasm of threatened species.

Ethical aspects: There is a diversity of views amongst the general public at large and religious groups about the transfer of genes of human origin to other species and of animal origin to other animals or plants. The fact that genetic modification makes it possible to transfer genetic traits between non-related species causes concern to those that hold that the earth was created by God and evolution is in His hands. Mankind therefore must not be allowed to use genetic modification to interfere with Nature and evolution on Its own account. However most members of Christian and Jewish groups find genetic modification acceptable. Muslims, Sikhs and Hindus object where religious food taboos would be transgressed⁽¹⁾.

Some people disagree with genetic modification on the non-religious grounds of the intrinsic value of Nature. To them, technologically changing the genetic make-up of a species is unnatural and harms the integrity of Nature. The higher the life form of the organism, the greater the ethical concern tends to become. The greatest opposition is against genetic modification of animals. Animal welfare organisations and their members stress that Mankind has a moral obligation to care for animals and to honour their intrinsic value.

Support and Opposition

There is a spectrum of support and opposition about genetic modification in virtually all European countries. Support comes from the industries using biotechnology, industrial organisations and from the sections of national governments and the European Commission concerned



with the development of biotechnology. These provide information to the general public and facilitate a range of activities aimed at fostering public awareness, understanding and involvement in the debate. At the national level, in Germany for example, there is the German chemical industry "Initiative Pro Gentechnik" and in Switzerland the "Gen Suisse Foundation".

Resistance is probably higher in Germany than in any other country in the world. Initial opposition increased rapidly during the 1980s from left-wing groups and *Die Grünen* (The Green Party). Now the leading organisations are "Gen-Ethisches Netzwerk", "BUND" and an initiative supported by many organisations and institutions called "Essen aus dem Genlabor - natürlich nicht" (Food from the Genetics Laboratory - naturally not). In Austria, *Arche Noah* is devoted to maintaining plant genetic diversity by traditional methods and wishes to see stricter controls on the development of genetically modified varieties. In Belgium *Vita Vitalis* campaigns against patenting of genetically modified plants and animals. In The Netherlands, *Stichting Mondiaal Alternatief* (Foundation for Ecodevelopment) promotes "the worldwide social and ecological need for a conservation strategy for the entire biosphere". In the USA a group of nutritionists, food activists and leading chefs, headed by the professional campaigner Jeremy Rifkin, developed *The Pure Food Campaign* with logo and slogan "We do not serve genetically engineered food".

Research into public perceptions

Studies have been carried out into public perceptions, consumer attitudes and ethical implications of biotechnology in food and drink production. Direct comparison between the studies is not possible due to different approaches and methodologies.

In 1991 and 1993 surveys were carried out for the Commission of the European Union on the opinions about biotechnology in Member States (Eurobarometer 35.1⁽²⁾ and 39.1⁽³⁾). During the two years, overall support for genetic modification, while positive except in the case of farm animals, decreased slightly (Figure 1). For the use of biotechnology in the production and processing of food, Europeans tend to agree that this kind of research is worthwhile and should be encouraged, but the level of support is much less than that for its use in the healthcare area. Using genetic modification in the improvement of micro-organisms for bio-processed foods and in plant breeding received greater support than in fresh food production, while its use with farm animals was regarded neutrally. Stronger governmental control was sought for all categories. Higher levels of concern were expressed in Northern European countries than in Southern.

In a Dutch study of acceptance of food biotechnology, SWOKA Institute for Consumer Research⁽⁴⁾ concluded that products made with genetic modification are not necessarily regarded as being less acceptable than products made otherwise. Acceptance depends primarily on the perceptions of consumers about the benefits of the product and the absence of negative consequences for health, environment or society.

A survey of enquiries to the UK Food Safety Advisory Centre⁽⁵⁾ showed that there was a low level of awareness of the claimed benefits from the use of biotechnology in food and drink production. Nearly half of the enquirers said that its use would make food less safe and nearly half could not say whether it would or not. Almost all enquirers said that limits should be placed on the use of genetic modification in food production and 84% said that such food should be clearly labelled.

In the USA, consumer research⁽⁶⁾ showed that a higher proportion of people would buy biotechnology food products if they were cheaper but had the same quality as traditional products than if they had improved quality and taste but were more expensive. 85% of respondents considered information about whether biotechnology was used to be very important on a food label.

Regulation and Labelling

Appropriate regulation is a prerequisite from the point of view of both the general public and the food and drink industry. There are some similarities and some differences between European countries and the USA in the regulation of genetic modification. In the USA the Food and Drug Administration (FDA) regulates foods on the basis of their safety and quality regardless of the means by which they have been produced. In Europe there is no equivalent overall agency for food regulation. Member States carry out their own regulation with consequent differences between them and the European Commission has therefore proposed harmonising regulation.

The proposal for a Regulation on Novel Foods and Novel Food Ingredients (COM (92) 295), amended in December 1993 as COM (93) 631, deals with novel foods. It aims to facilitate free movement of food products between European Union Member States which could be hindered due to differences between national laws. The concept of "novel" is partly connected with the technology used for their production (unlike the USA FDA regulations). The proposed Regulation has specific provisions for genetically modified foods and drinks but is not restricted to them. It lays down provisions for the placing on the market of food or food ingredients which have not hitherto been used for human consumption or which have been produced by processes that result in a significant change in their composition, nutritional value and/or intended use.

All food and food ingredients, thus including novel foods, have to be approved under the existing categories of fair trading, public health and official controls. The proposed Regulation on Novel Foods and Novel Food Ingredients will not only impose a duty of care on all persons placing a new food product on the market to ensure that it is safe but will also create a system where a notification which can lead to an authorisation procedure is required for the placing on the market of all novel foods and novel food ingredients.

Novel foods have to fulfil the general labelling requirements set out in the labelling Directive 79/112/EEC. In addition the proposed Regulation on Novel Foods and Novel Food Ingredients stipulates that labelling requirements will be laid down to inform the consumer of differences in the characteristics of the novel food or ingredient when compared with conventional food or ingredient. It remains to be seen whether genetically modified products will need to be labelled as such. Surveys show that the majority of the general public wants information about such foods. Current discussions between industry, consumer organisations and government are about which types of information and the ways in which that information can best be provided.

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