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SPECIAL ISSUE: FOOD

EUROPEAN COMMISSION
Joint Research Centre

ABOUT THE IPTS REPORT

The IPTS Report was launched in December 1995, on the request and under the auspices of Commissioner Cresson. What seemed like a daunting challenge in late 1995, now appears in retrospect as a crucial galvaniser of the IPTS' energies and skills.

The Report has published articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda The long drafting and redrafting process, based on a series of interactive consultations with outside experts guarantees, quality control.

The first, and possibly most significant indicator, of success is that the Report is being read. The issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time Since then, its circulation has been boosted to 7000 copies Requests for subscriptions have come not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N Africa, etc.

The laurels the publication is reaping are rendering it attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions as the Dutch TNO, the German VDI, the Italian ENEAand the US Council of Strategic and International Studies.

Moreover, the IPTS formally collaborates on the production of the IPTS Report with a group of prestigious European institutions, with whom the IPTS has formed the European Science and Technology Observatory (ESTO), an important part of the remit of the IPTS. The IPTS Report is the most visible manifestation of this collaboration.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS, to these one could add the Italian translation volunteered by ENEA· yet another sign of the Report's increasing visibility The fact that it is not only available in several languages, but also largely prepared and produced on the Internet World Wide Web, makes it quite an uncommon undertaking.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead

P r e f a c e

This IPTS Report special issue has been dedicated to the different aspects of food, nutrition and consumer health, highlighting the place this subject occupies in the European Union political agenda and the importance the Commission and myself attach to it.

Citizens concern about the implications of their food habits on health, has been rising in recent years. The consequences, for example, of the increased use of pesticides in agriculture; the use of hormones and veterinary drugs on animals; genetic engineering; have generated, on the part of the consumer, desires for transparency in the food industry and increased efforts to avoid food fraud.

The technology for ensuring food safety and quality is evolving rapidly. The legislator needs to reconcile the need to provide a safety framework for consumer protection, whilst endeavouring to preserve industrial competitiveness, employment and growth.

This situation clearly indicates the need to support research at institutional level within the Commission. The Joint Research Centre (JRC), is already providing the relevant Commission services with independent scientific and technological support, for the preparation and implementation of EU legislation on food for human consumption.

The Vth Framework Programme will launch a "Key Action" in Food and Health which will mobilise the EU scientific community in pursuance of the solutions to these problems and concerns. In addition, the JRC will

re-deploy some of its resources in order to undertake work to harmonise and validate methods to detect toxic products in food and water (e.g. mycotoxins, hormones, veterinary drugs, heavy metals). It also proposes to develop anti-fraud technologies.

I have asked my services to co-ordinate their efforts, and to join together with other EU research institutions, in pursuit of these objectives.

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SPECIAL ISSUE: Food

EDITORIAL

The recent "mad cow" affair has made the inadequacies of the European agro-food system painfully obvious. It is now time to win back consumers' confidence and reassure them over food safety. The European Commission has responded to this need by defining new lines for policy in this area. This special issue of the IPTS report offers us the opportunity to examine some of these themes.

Ironically, it is precisely as, thanks to technical innovations, **the production of foodstuffs is becoming more and more sophisticated** (see the article in this issue on the new polysaccharides) that **the level of safety does not seem to be improving**. At the same time "functional foods" (see the article on the trends in the market for these foods), half-way between food and medicine, are undergoing rapid development in order to meet consumers' health concerns. The loss of confidence in "classic" foods has but strengthened this trend.

Investigations carried out by European consumer organizations in recent years have shown that in the case of **a number of foodstuffs, the level of safety is far from optimal** and that **consumers' health may even at times be in danger**. This subject was discussed in the special issue of the IPTS report which covered a number of aspects of health policy (issue 17, September 1997). One of the articles in that issue dealt with rapid alert systems and technologies aimed at preventing food-related illness. Food safety is more than ever at the centre of the new direction taken by the food policy being put in place at community level. Beyond, the preventive sanitary aspect of a nutrition policy also shows its merits, as described in the article presented further on this topic.

In this context the President of the Commission, during his speech to the European Parliament on 18 February 1997, argued for the gradually setting-up of a **genuine European food policy whose main axis would be to protect the health of consumers**. Three general principles can be identified:

- the separation of scientific and legislative responsibilities;
- the separation of legislative authority and responsibility for control;
- increasing both transparency and the dissemination of information throughout the control and decision-making process.

These principles were confirmed by the Commission in its Communication on consumer health and food safety of 30 April 1997 (COM(97) 183 final).

We now know that **over and above consumers' concerns, food safety is vital for the proper functioning of the market**. It is therefore not only essential for the protection of consumers but it also makes it possible to ensure the smooth running, in economic terms, of the chain of production, transformation and marketing of foodstuffs and agricultural produce.

Scientific consultation has therefore become a cornerstone of the new European food policy, whose aim is to be able to constantly increase the availability of products which are both safe and healthy and guarantee that primary agricultural produce, finished products and all intermediate processes and products are evaluated in terms of their potential risk for human health.

The Commission's new orientation on the subject rests on three principles:

- The **principle of excellence**: scientific advice should be of the highest possible quality.
- The **principal of independence**: the scientific personalities appointed to scientific bodies should not have any ties or interests that might interfere with their mission.

The **principle of transparency**: all interested parties should be given ready access to the information concerning the working procedures of the committees and the advice they give.

Risk analysis is also an essential element in the new orientation given European policy. It is a systematic procedure integrating scientific evaluation of dangers and their probability of occurring in a given context (risk evaluation); an appreciation of the whole range of measures making it possible to maximize the level of protection offered to consumers (risk management); and the exchange of information with all concerned parties in order to explain and justify the proposed measures (risk communication). It should be recalled that the concept of "zero risk" does not exist and that the information on the level of risk is therefore essential for the consumer. The JRC has an important role to play here.

A third aspect is the definition of a new approach for ***inspection and control***. In the veterinary and plant-health sectors the application of community rules is the responsibility of Member States. It is therefore necessary to develop, as far as possible, official European audit procedures in order to evaluate the activities of the competent authorities and make an effort to ensure a satisfactory level of security throughout the European Union.

In the case of monitoring foodstuffs the existing audit-based procedures for surveillance and evaluation of the official systems of control in the Member States will be maintained. As is already the case, controlling the application of rules intended to prevent economic fraud (for example incorrect information concerning quality or inappropriate labelling) will be kept.

The subject of control raises a problem at Union level. Official control of foodstuffs is the responsibility of Member States, but these do not always possess the same resources or have the capacity to put them into practice. Thus, in order to guarantee European consumers a certain minimum level of control as regards key parameters throughout the European Union, ***it is desirable to establish coordinated control programmes.*** A European scientific organization such as the JRC could support such a coordination.

Food policy must be expressed by means of ***effective legislation*** which follows a hierarchy of pursued goals. This has not really been the case to date: community legislative initiatives in the food sector have been reached from various different legal bases defined by the treaty in order to respond to different objectives for action, in particular to put in place and set running the common organizations for the agricultural produce market in the framework of the Common Agricultural Policy, and to ensure the free circulation of foods in the single market. ***Health protection and quality and safety were only a reference*** in the establishment of the criteria defined for harmonization, which sought to eliminate the obstacles to free circulation. Safety in some ways 'cuts across' the legislation and so different aspects of it appear in various sections.

For this reason the Commission has kicked off a broad consultation process with its ***Green Paper*** on the general principles of food legislation in the European Union.

Any policy regarding food which seeks to establish consumer confidence must take in *research into alternative solutions*, which mainly concerns agricultural produce and its *modes of production*, as well as ***an effort to give information*** in response to consumers' new expectations.

Over the last ten years **there has been a generalized raising of awareness among consumers concerning the need to follow patterns of sustainable growth**. This has been characterized by a realization of the urgent need to respect the environment for both food production and consumption while safeguarding health.

In this context **consumers have come to show an increasing interest in the methods used to produce the foodstuffs** available to them. Increasing numbers of consumers seek to assure themselves that the products they consume are produced by methods which are not harmful to the environment or the animals reared. These themes are looked at by two of the articles in this special issue, which look at the need to change food policy and the need for integrated management of food production. The first of these two articles traces the evolution of the concept of 'organic' food towards processed foods and the need to adapt food policy to respond to consumers' expectations. The second article describes the growing application of life-cycle assessment to agricultural production and food processing in order to reduce their impact on the environment.

Related to these ideas, there is currently a debate over the ethical and environmental implications of recent scientific progress such as the application of genetic engineering to the production of foodstuffs (the use of genetically modified organisms) or the application of cloning techniques. The article on novel foods brings up related aspects of safety and information for consumers. Given consumers' fears regarding foods, all new developments are received with a great deal of scepticism. It is therefore necessary to make significant efforts at communication in order to reassure consumers and convince them of the advantages of these novel foods.

We hope that this special issue will provide a response to some of these concerns.

L. Bontoux

Food applications of the New Polysaccharides Technology

Miguel Vega García and Laurent Bontoux, IPTS

Food

Issue: As a technological novelty, new polysaccharides are to be classified under the *Council Directive on food additives other than colours and sweeteners*. This will make it necessary to either include these new polysaccharides under the current definitions of this Directive or to add new definitions for them. For example, there is now a new 'natural' physically modified starch that does not fit in the definition of 'modified starches' of the Council Directive.

Relevance: The policy implications of these new additives, most of which have been developed by multinationals, will be two-fold: on the one hand, they will need a special classification under the Directive on food additives, and on the other hand, the foreseeable increasing demand for starch will directly affect the regulation of certain starch crops regulated by the Common Agricultural Policy.

Analysis

Carbohydrates comprise one of the main groups of biochemical compounds present in the human body. In scientific terms they are described as polyhydroxy aldehydes or polyhydroxy ketones, or substances that yield such compounds upon hydrolysis, and they can exist either as single units (monosaccharides), or joined together in molecules ranging from two units (disaccharides) to hundreds of units (polysaccharides).

The best known monosaccharides are glucose, galactose, and fructose. These also happen to be the most important nutritionally and the most abundant in nature. An example of the importance of monosaccharides for human life is glucose, which is transported by the bloodstream to body tissues to which it supplies energy.

Glycosidic linkages, a sort of molecular bond, join monosaccharide units together to form disaccharides. There are three important disaccharides: maltose (two glucose units linked together), lactose (a galactose unit linked to a glucose), and sucrose (glucose joined to fructose). Linkages among disaccharides lead to large chains called polysaccharides, such as cellulose, starch, and glycogen which are the three most important. Starch is the major storage form of glucose (energy) in plants, whereas glycogen is the

Carbohydrates are among the most important substances for life. They comprise three classes of molecules: monosaccharides, disaccharides and polysaccharides

Food

Monosaccharides and disaccharides include a number of sugars, such as glucose, which are important sources of energy. Polysaccharides include cellulose, glycogen and starch

Starch is widely used as a food additive on account of its ability to form gels when heated

Natural starch has the drawback that it can cause a granular texture, thus so-called 'modified starches' are preferred by the food manufacturing industry

storage form of glucose in animals. Cellulose is the structural material of plants, creating cell-walls and other higher structures.

These polysaccharides play an important role in human metabolism. While starch is the most important source of energy in the human diet, cellulose, often known as dietary fibre, is not absorbed by the human intestine and is therefore naturally excreted. It provides regulation to our digestive system.

The uses of polysaccharides in the food industry

The most important polysaccharides traditionally applied to food formulation are saccharose as a natural sweetener; starch as gelling agent; cellulose-based compounds as thickeners; and pectin to form emulsions. The most relevant for this article, are starch and cellulose.

Approximately 1.0 billion tonnes of starch are produced annually in the form of agricultural products such as corn, potatoes, cereals and rice. More than half is used as food or animal feed after minimal processing while the remainder undergoes industrial transformations.

The main reason for using starch as an additive in foodstuffs is its ability to form gels when heated. Therefore its main uses are as a gelling agent in foodstuffs such as infant foods and concentrated soups, or as a replacement of animal gelatine. However starch from cereals and potatoes is prone to a problem known as retrogression, meaning that it tends to form granular and compact textures in the final product. To solve this problem the chemical industry has developed several procedures to modify the gelling properties of starch in order to avoid these undesirable textures. These procedures add biochemical compounds or chemical and physical agents to obtain 'modified starches' that suit the texture needs of the final products.

Cellulose is the main cell-wall component of higher plants and hence the most abundant organic compound, and the most abundant carbohydrate, on Earth. Cellulose and its modified forms serve as dietary fibre because no form of cellulose is digested by humans and thus none provides significant calories. However dietary fibre does have important functions in the regulation of the digestive system.

Purified cellulose powder and microcrystalline cellulose are widely used forms of cellulose in food formulation. They have negligible flavour, colour, and microbial contamination and report the following major functions in food formulations:

- To stabilize foams and emulsions
- To form gels with salvelike textures
- To stabilize pectin and starch gels under heating
- To modify textures
- To improve adhesion
- To replace fat and oil
- To control ice crystal growth

Cellulose is insoluble except in a few special solvents that can disrupt the intermolecular bonds. However, certain derivatives of cellulose are water soluble and important as food gums for food formulation: *Carboxymethylcelluloses*, *Methylcelluloses* and *Hydroxypropylmethyl-celluloses*. These food gums are classified under the European Directive on food additives other than colours and sweeteners, and are shown in Table 1.

Table 1: Starch and cellulose additives included in Council Directive 95/2/EEC on food additives other than colours and sweeteners

E number	Additive
E 460	Cellulose (Microcrystalline and Powdered)
E 461	Methyl cellulose
E 463	Hydroxypropyl cellulose
E 464	Hydroxypropyl methyl cellulose
E 465	Ethyl methyl cellulose
E 466	(Sodium) Carboxy methyl cellulose
E 469	Enzymatically hydrolysed carboxymethylcellulose
E 1404	Oxidized starch
E 1410	Monostarch phosphate
E 1412	Distarch phosphate
E 1413	Phosphated distarch phosphate
E 1414	Acetylated distarch phosphate
E 1420	Acetylated starch
E 1422	Acetylated distarch adipate
E 1440	Hydroxy propyl starch
E 1442	Hydroxy propyl distarch phosphate
E 1450	Starch sodium octenyl succinate

The new polysaccharides technology

Polysaccharides technology has moved fast in recent years to come up with high-tech products to meet the consumer and the industry needs. Bacterial cellulose, functional native starch ('natural' starch) and polysaccharides produced by fermentation, are technologically advanced polysaccharides produced to suit food industry needs. The main applications of these high technology products are as thickeners, stabilizers, binders, gelling agents and fat-replacers for a wide range of food products. Most of them, especially 'natural' starch, represent breakthroughs in food technology.

Bacterial cellulose or microfibrous cellulose

A food cellulose, produced by microbial fermentation has been put forward to provide improved functionality at lower usage levels than other cellulose-based ingredients. It can be used as a thickener, stabilizer and binder in a variety of food products, including low or non-fat applications.

According to technical professionals the new ingredient is chemically identical to plant cellulose but has much smaller fibres which are bundled together to form a three-dimensional structure resembling a web. These fibres offer up to 200 times more surface area than other forms of cellulose. Since the ingredient is insoluble, the individual linkage points on the strands are unaffected by temperature, pH, salts, oxidisers, and shear. Water-soluble cellulosics do not exhibit the same degree of stability under these conditions.

Because of its properties and structure, microfibrous cellulose seems to have important applications in a variety of food formulations

Although cellulose cannot be digested by humans it has a wide range of uses as a modifier of the flavour, texture or other properties of manufactured foods

Technical progress has made a wide range of polysaccharide products available to meet the needs of the food industry. Such products include thickeners, stabilizers, gelling agents and fat replacer

Food

Microfibrous cellulose, which is produced by microbial fermentation, has a wide variety of uses where stability and lack of flavour interaction under a wide range of conditions are important

Functional native starches are reported to offer the same properties as modified starches without having been subjected to chemical or enzymatic modification

A number of fermentation-produced polysaccharides have become available, offering an alternative to gelling agents of animal origin

where low use levels, lack of flavour interactions, foam stabilization, and stability under broad pH, temperature, and freeze-thaw conditions is needed. Potential uses for the fibre ingredient could include pourable and spoonable dressings, sauces, and gravies; frostings and icings; sour cream and cultured dairy products; whipped toppings and aerated desserts; and frozen dairy products.

The bacterial cellulose is produced by microbial fermentation of *Acetobacter xylinum* combined with coagents, such as *sucrose* and *carboxymethylcellulose*, to promote a higher dispersion of the product. The Bacterial cellulose has been determined to be 'generally recognized as safe' (GRAS) by the FDA-USA. A part from this recently developed product, a bacterial cellulose gel, called *nata*, has come to be eaten mainly as a dessert delicacy in the Philippines.

Fermentation-produced polysaccharides

First, there was *Xanthan*, then there was *Gellan* and now *Curdlan* has become the third fermentation-produced polysaccharide to be approved by the Food and Drug Administration for food use in the United States. This product allow gel formation when simply heated in an aqueous suspension. It therefore differs from other gelling agents which require special conditions in addition to heating in order to form gels. The replacement of animal gelatine by other gelling agents is becoming an important issue triggered by concerns raised by BSE.

Manufactured and marketed under the name of Pureglucam, by Takeda U.S.A., this fermentation-produced ingredient has been widely used in countries such as Japan, Korea, and Taiwan. It may be used to improve texture and water-holding capacity of several products such as meat, poultry, and seafood products. Other food-applications may include improvement of the consistency of pasta, the viscosity of sauces and dressings, and the shape and texture of desserts. It may also be used as an essential ingredient to formulate new functional or/and novel foods, including reduced-calorie products.

This ingredient, produced by the micro-organism *Alcaligenes faecalis* var. *myxogenes*, was approved by the US Food and Drug Administration on December 16, 1996.

Functional native starches

Produced by a physical process, these starches are reported to have the properties of modified starches without being chemically or enzymatically modified. These functional native starches certainly represent a breakthrough in starch technology because they open the possibility of labelling the added starch in food formulation as a natural ingredient. Called Novation, the series of starches are being introduced by the National Starch and Chemical Company, Bridgewater, N.J.-USA.

Suppliers and producers are continuously searching for natural ingredients in order not to list ingredients with 'E-numbers' on the final product label. Although the E-number indicates the European Union's permission to use the concerned ingredient (and is therefore a stamp of approval) E-numbers have an extremely negative image for European consumers.

Functional native starches, reportedly produced by a physical -and not chemical or enzymatic- process are claimed to offer temperature resistance, shear and pH tolerance, storage stability, a smooth texture and a non-pasty mouthfeel. They are also marketed as providers of a flavour profile that allows delicate and distinct

flavours in finished food products. These starches may be used in dairy products, soups, condiments, dressings, high and low pH gravies and sauces, baby foods, and fruit preparations.

Typically, native starches cannot withstand the high heat, shear and acid conditions encountered by processed foods during processing and storage. Proprietary technology developed by a global, cross-functional team from the National Starch and Chemical Company, produced a series of starches that work well in most food systems. Additionally, the team discovered that the process that provides the functionality also allows the flavours of many foods to have greater impact. These benefits provide opportunities for the food industry to formulate new products or reformulate existing products with a range of new marketing and flavour claims.

The Novation product launch was fully integrated in terms of functions, timing and geography. The Novation starches are made by new technology designed to deliver performance similar to that of traditional starches along with flavour enhancements while meeting the label criteria of native starches. The Novation starches are made by new technology designed to deliver performance similar to that of traditional starches along with flavour enhancements while meeting the label criteria of native starches.

Implications for European Directives

These new polysaccharides present regulatory challenges for two pieces of European legislation:

- Council Directive 95/2/EEC of 20 February 1995 on food additives other than colours and sweeteners, and its proposed amendment (97/C 76/09).
- Council Regulation 258/97/EEC of 27 January 1997 concerning novel foods and novel food ingredients. This Regulation concerns the placing on the market within the Community of novel foods or novel food ingredients such as those consisting of or isolated from micro-organisms, fungi or algae.

There are two main legal questions for these new polysaccharides: on the one hand the European Commission will have to decide whether or not to regulate these new products, and on the other hand, an affirmative answer will lead to another question: should they be regulated as ingredients or as additives?.

It is fairly clear that bacterial cellulose and fermentation-produced polysaccharides will be classified under category d of article 1 of the Regulation concerning novel foods and novel food ingredients. This category classifies foods and food ingredients consisting of or isolated from micro-organisms, fungi or algae, such as bacterial cellulose and fermentation-produced polysaccharides. However this may cause confusion because cellulose has always been classified as an additive and not as an ingredient. This may induce changes in the current classification of cellulose as an additive in the Directive on food additives other than colours and sweeteners, specifying that the cellulose labelled E-460 is a non-bacterial cellulose.

How to regulate the new functional native starches is even less clear. Manufacturers hope to label them as natural compounds and therefore avoid the regulations. The current regulations would support this aspiration since the functional native starches do not fit within the current definition of 'modified starches' of the Directive on food additives other than colours and sweeteners. The reason for this situation is obvious: the state of the art of food technology when the regulation was drawn up could not give starch the right properties without chemical

Food

Functional native starches are claimed to be able to offer temperature resistance, shear and pH tolerance, storage stability, a smooth texture and a non-pasty mouthfeel

New polysaccharides have two main implications for regulations: should they be regulated? and should they be classed as additives or ingredients?

Manufacturers would prefer to label functional native starches as natural compounds thereby avoiding regulations

Food

The amount of starch processed in the future is likely to increase in line with economic growth. This has implications for demand and thus for the stance taken by the Common Agricultural Policy

The CAP currently protects EU starch production from imports from third countries and subsidizes exports to compensate for the higher-priced raw material

It may be time to think of encouraging European starch-crop production in a wide variety of ways from taking political measures to applying modern biotechnology

treatment. Therefore, the related legislation defines those substances obtained by one or more chemical treatments of edible starches as 'modified starches'.

Nowadays food-technologists from the National Starch & Chemical company have forced policy-makers to question whether or not to regulate this new functional native starches. There are three options:

- To label the product as a natural ingredient (the approach favoured by industry),
- To change the current definition of 'modified starches' or add a new one for functional native starches within the Directive on food additives other than colours and sweeteners, or
- To classify them within the Regulation concerning novel foods and novel food ingredients.

Greater knowledge of the physical process applied in the production of functional native starches is needed in order to be able to make a final decision on this issue.

Implications for the CAP

The amount of starch processed into food and industrial products is likely to increase in the future - roughly in line with the rate of increase of the Gross National Product - and may have implications for the Common Agricultural Policy. Starch already finds uses in a wide variety of applications such as food formulation, paper-making, textiles, adhesives and drilling fluids. One of the main reason for this increasing use may be found in environmental pressures to replace certain chemicals to which carbohydrate derived products appear as an alternative. A good example is the development of carbohydrate derived surfactants because of their low environmental impact and their 'green' image on the market.

Nowadays world trade in starch, including modified starch and by-products in principle runs under a free market but there is a certain amount of protection against imports in the EU.

The product belongs to the Common Market Organization for Cereals. It benefits from a specific refund regime to promote its use in the internal market of the Union: to allow the industry using starch as a raw material to be competitive with similar industrial products imported from third countries without any protection (e.g. paper, chemicals), specific compensation is granted. This refund covers the price difference between EU starch, produced under CAP-conditions, and starch produced on the world market from cheaper raw material. More than 3 million tonnes of starch a year benefit from this regime.

Besides this measure intended for the internal market, exports of starch are promoted via a similar subsidy, the so-called export refunds. The reform of the CAP, however, and in particular the continuous price decrease of arable products, should lead to a disappearance of these refunds as soon as these products, such as cereals an potatoes, are at price level of the world market.

Due to the technological developments described above it seems clear that starch is becoming an increasingly attractive raw material and that demand for certain starch crops is likely to increase. As a result, and in the context of the evolution of the European CAP, it may be time to think of encouraging European starch-crop production in a wide variety of ways from taking political measures to applying modern biotechnology. The wrong policy decisions in this area may give an advantage to the USA. This is already the case for the starch by-products in which huge technological investments and government support have enabled the USA to take over the market.

Conclusions

The development of high-tech ingredients or additives, such as the polysaccharides addressed in this article, illustrates several important trends. These ingredients or additives are customized and tailor-made for specific food-category needs. Their development shows an integrated use of agriculture and food technologies, and of course, industry's increasing concern with addressing consumer demands regarding nutrition and quality of food formulation.

The appearance of these new polysaccharides is likely to have implications for European legislation, mainly for the Directive on food additives other than colours and sweeteners and for the Regulation concerning novel foods and novel food ingredients.

It is time to carry out foresight studies on the starch market since its new uses may lead to increasing demand for starch crops. Technology will play a dominant role in the future development of the starch market. Examples of these trends are biotechnology to produce starch crops addressing industry and consumer needs, and new technologies to produce functional native starches and/or to improve the commercialization of starch by-products.

Keywords

polysaccharides, starch, functional native starch, bacterial cellulose, fermentation-produced polysaccharides, ingredients, food additives

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Food

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Food

'Novel Foods' Regulations: Letting EU Consumers know what's on the Menu

Marina Leonardi, *ENEA*; Marina Miraglia, Roberta Onori, Carlo Brera, *Istituto Superiore di Sanità*

Issue: The rapid development of food technologies and biotechnology in particular have brought certain foods and ingredients not previously in widespread use onto the market for human consumption. Important food safety aspects of these so-called 'novel' foods are regulated at EU level. This includes consumer protection and information, mainly through labelling and clarification of the requirements to be fulfilled by the producers before they obtain the authorization to place their 'novel' food product on the market.

Relevance: One of the most important features concerning novel foods in the current debate on food policy and in particular on consumer protection, is the link, which is now stronger than ever, with environmental issues. However, Regulation 258/97/EEC, focuses mainly on food safety aspects and labelling requirements. As a result, the specific guidelines that will follow are likely to help refocus the discussion on important practical issues.

The Fifth Framework Programme reflects growing public perception of food quality as a social issue and the possible positive role of biotechnology

Recent EU regulation (258/97/EEC) defines a 'novel' food as any food originating from a genetically modified organism or from an unusual source

What are novel foods?

The EU's Fifth Framework Programme (1998-2002) defined 'Health and Food' as a research priority among the key actions to be addressed in the *Living world and ecosystem* thematic programme. The quality of food is increasingly being perceived as a social issue and sometimes even as a matter of public concern. At the same time biotechnology is seen as a tool for 'the production of a safe, healthy, balanced and varied food supply'. It is important that this becomes the point of view shared by public and private research, governmental institutions and, finally, consumers.

Recent EU Regulation (258/97/EEC) gives a stringent definition of a 'novel' food as being one that in any sense originates from a genetically modified organism (GMO) - sometimes commonly referred to as a transgenic food - or that presents a novel molecular structure or derives from unusual alimentary sources, which are listed more in detail in Article 1.

The prospect is now for more and more promising classes of novel foods to be produced by micro-organisms, fungi or algae, in 'cell factories', for the manufacture of valuable metabolites. Animal or vegetable tissues may also be used for the same purposes. These viable organisms may or may not have been genetically modified to enhance, for example, the yield of the final product. In this article the authors will concentrate mainly on the case of the foods deriving from genetically modified organisms (GMOs). The unifying concept in these biotechnological applications

is that biologically derived molecules, structures, cells or even the entire organism are used to carry out a specific process or to reach a definite target.

A so-called 'novel' food may not in fact be very different, at least as far as appearance or general organoleptic characteristics are concerned, from its traditional counterpart. However, the food may be 'novel' simply because the production process is *not one that is currently used.* Foods that have been submitted to a new technological process that has affected their structure or their composition e.g. from a nutritional point of view, are therefore classed as novel.

The EU Regulatory Framework

The new Regulation governing novel foods and novel food ingredients came into force in May 1997, thus permitting the exposure of European consumers to a new category of foods. It is the outcome of rather lengthy preparatory work by the Commission, several draft proposals of the Regulation having been compiled and discussed since 1992. The final text is intended to give a legislative framework at European-Union level which responds to the rapid world-wide evolution of emerging scientific disciplines and newly appearing technological processes. As usual, the main objectives of European lawmakers, such as the harmonization of different legislations of the EU member states for the smooth functioning of the internal market, are clearly stated. The so-called 'novel' foods must pose no danger to consumers (crucial issue: safety assessment). At the same time European consumers have the right to recognize this new kind of food and be able to distinguish it from the traditional ones, i.e. not to be misled by an insufficiently clear label. Moreover, having in specific cases to do with a substitute product (a food product that replaces the usual one), they must not be exposed to an unforeseeable risk, for example deriving from the presence or absence of a particular component in the normal food or food formulations.

It is still too early to see what the main effects of the new Regulation are likely to be on the internal food market. Nevertheless, it represents a huge step forward with respect to certain general aspects of controversial novel foods. Many topics are fairly well defined, such as the scientific basis for the food safety assessment and how this topic links with other problems such as environmental issues and Directive 89/397/EEC on Official Control. Some other questions remain to be answered or clarified such as labelling and the overlap with the HACCP (Hazard Analysis and Critical Control Point) system. European food producers may wonder what they are really expected to write on the labels of their food products and what is the clearest and most correct phraseology to use. Furthermore other topics to be developed are the improvement of a data bank on the composition of novel foods and their traditional counterparts as well as the development of suitable analytical methodologies to identify foods produced by means of genetic engineering. The European Commission is co-financing research work in this area being carried out in a group of fourteen partners representing five EU Member States and two other European Countries. This is intended to develop and evaluate analytical methods to identify foods produced by genetic engineering.

Safety Assessment

One of the first international meetings dealing with the main issue of transgenic food safety, convened by the Food and Agriculture Organization and the World Health Organization (FAO/WHO), was held in Geneva in 1990. One of the main objectives was to draw up scientific

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In the future we can expect to see an increasing variety of foods from new algae, fungi or microbial sources, in both their original and genetically modified forms. Many such foods will have a similar flavour and appearance to traditional ones

These novel foods must not represent a danger to consumers arising from the presence or absence of particular components

Regulation 258/97/EEC represents a big step forward in the control of 'novel' foods. Assessment and the links with environmental issues are now clearly defined

The safety assessment of novel foods is based on the principle of substantial equivalence, entailing comparison with an unmodified version of the same or a similar food

Consumers, policymakers and legislators tend not to be very familiar with the new technology becoming available to food manufacturers

principles and develop new methodologies for the evaluation of transgenic food safety. The principle of substantial equivalence was established by the Organization for Economic Co-operation and Development (OECD) in 1993. According to it *'an existing organism used as food, or as a source of food, can be used as the basis for the comparison when assessing the safety for human consumption of a food or food component that has been modified or is new'*. This concept can be used with due flexibility on a case by case basis for the different foodstuffs. Basic information on the characteristics of the host organism, genetic modification and inserted DNA are the first elements to be taken into consideration for transgenic foods, along with the characteristics of the modified organism, in particular as far as the stability of the introduced genetic material is concerned. Unintentional effects of the genetic modification must also be investigated. This is usually more difficult and, in this respect, compositional characteristics, that are essential to the definition of substantial equivalence, play a crucial role. Nutrient, anti-nutritional factors and toxic substance levels should be compared with the natural ranges occurring in traditional counterparts; also the comparison of phenotypic characteristics in genetically modified plants may be helpful.

However it should be noted that the lack of substantial equivalence *'per se'* does not imply that the food product is not safe, even though its safety has to be assessed through longer and more careful *in vitro* and *in vivo* studies.

Novel foods should be easily recognizable to the consumer

As already mentioned, food technologies have made major steps forward in recent decades, and are partly responsible for changes in consumers' dietary habits including the often cited food globalization of consumption.

In the specific case of foods deriving from genetically modified organisms, the new technological processes available to food manufacturers are based on the continuous progress made by biochemistry, microbiology and genetic engineering, with which everyday consumers are usually not very familiar. The final technological application of this scientific know-how may lead to even more unfamiliar ways of producing our daily meals. As an example, consumers, policy- and lawmakers will have perhaps heard technologists discuss the advantages of using high pressures in the preservation of foodstuffs, but they are unlikely to have a clear idea of what the new process consists of. The same feeling is brought about by the usage of genetically modified organisms in the food chain: risks and benefits need to be clearly discussed, information is essential, starting from clear labelling of foodstuffs. In the context of the need for information and transparency the availability and reliability of analytical methodologies aimed at distinguishing between transgenic foods and their traditional counterparts is essential.

The presence of a modified sequence of nucleic acid in a transgenic food and knowledge about it makes it possible to develop analytical methods for the correct identification of these foodstuffs with different experimental approaches. One co-ordinated effort in this direction is a research project, financed by the European Commission, which is currently taking place in the framework of the Standards, Measurements and Testing Programme. The development of detection methods will be followed by their final validation with inter-laboratory trials in a group of experienced European laboratories. The final target is to convert the evaluated methods into CEN standards. Another outcome will be the preparation of a database collecting all available information on genetically modified foods which

are already being marketed, the modified sequences and suitable primers and probes for their detection.

Efforts should be devoted to improving the consumer's level of education in the field of food production and dietary habits in order to make people more aware of their choices. Developments in food technology are making it more and more common to find formulations where a common ingredient has been substituted by a new one, conferring better technological or even nutritional characteristics. In particular this latter aspect could be correlated with recent increases in food allergies or other adverse reactions to foods. If a consumer is aware that he or she suffers from a specific food allergy he or she needs to be reassured from the label on a food product made of different ingredients that it is free of his or her specific allergen. This factor is even more significant for novel foods.

Transgenic food and food allergies

The potential allergenicity of food deriving from GMOs is a crucial issue. The genetic modification of organisms makes the expression of an allergen (a specific protein) possible in a new organism. The identification of a brazil nut allergen in transgenic soybeans has become a well-known example of this risk. However, from a more general perspective, the same technology, that may give rise to an enhanced risk to develop adverse reaction to foods, may be paradoxically helpful in preventing the problem of food allergies. In fact new development of gene technology could finally lead to 'gene replacement' at the normal locus of the gene. Meanwhile other approaches are being used to suppress target gene expression. It may even be possible for researchers to actually inhibit the expression of genes which code for allergenic proteins. The possibility of producing wheat deficient in gliadins at source, rather than consuming only gluten-free food formulations could offer a new chance for people suffering from celiac disease. Recent estimates of the number of people suffering from this disease, tend to put the figure much higher than previously thought, possibly ranging from 300,000 to 550,000 people in Italy only. Why should researchers, and possibly also policymakers, not look at the possible advantages of exploiting the linkage between genetic modification and food allergies?

Clear labelling is obviously one effective tool in avoiding the risk of inducing unsuspected food allergies in the case of foods containing exogenous proteins which might be capable of inducing allergenic responses in consumers. However, this may be still not enough. There is always a risk of contamination -a concept more frequently associated with microbiological or chemical contaminants- along the food processing chain particularly if the same production line is used to process different raw materials and is not properly cleaned during the changeover. The possible solution of this problem lies in the framework of the overlap between novel food production and HACCP.

Novel foods and HACCP principles

Directive 93/43/EEC on Food Hygiene represents a turning point in that it finally acknowledges the need to offer consumers enhanced levels of safety. As it has been pointed out in the safety assessment considerations previously discussed, many different topics have to be considered by producers prior to the use of transgenic foods. One additional concern is over the possibility of genetically modified organisms that have not undergone official evaluation for safety assessment entering the food chain. The novel food Regulation clearly refers to the

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It is possible to base analytic techniques identifying transgenic foods on the presence of modified sequences of nucleic acid. A database containing this information for all marketed transgenic foods is therefore going to be created

The possibility of creating transgenic foods which do not contain certain allergenic substances associated with their non-transgenic equivalent should be investigated

The risk of unexpected allergic reactions to transgenic foods could be minimized by proper labelling, providing the proper controls are set up to avoid contamination

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directive 89/397/ECC and this indirectly implies the principles of HACCP regarding health protection, food quality and consumer interests, including the needs of particular groups of population, labelling as well as possible frauds. Possibly the problems related to novel foods should be included in the HACCP systems and *vice versa*.

Conclusions

The promise taken along with the application of modern biotechnology applied to the food chain (food primary production, transformation and preservation) is manifold, so is the debate taking place all over the world. Will biotechnology make food production more sustainable at world level and in this respect help fulfil the earlier promises of the 'green revolution'? The controversial answer to this question is based on the concept of 'sustainability', the meaning of which is far from being unanimously agreed upon. Should a genetically modified crop, which is more resistant to abiogenic factors and can give rise to higher yields of production, be considered in line with the concept of sustainability or should the concept prevail that it is more important to avoid any risk of unbalancing a specific ecosystem?

Another major question is whether biotechnology will make our food supply safer. The answer to this question necessarily refers to both the previously mentioned concept of substantial equivalence and also to HACCP principles. With reference to the latter it is important in the writers' opinion to determine if new and specific hazards are intrinsic to the introduction of transgenic or novel foods, their relative importance, and if the prevention of these possible hazards can be effectively obtained by means of specific 'Critical Control Points' or 'CCPs'. Consequently, in order to comply with the Council Directive 93/43/EEC of 14 June 1993, food business operators should develop, on a voluntary basis, specific 'guides to good hygienic practice', covering identification, control and monitoring activities relevant to critical points in the whole food processing chain from preparation, to distribution steps.

The EU's Fifth Framework Programme (1998-2002) includes 'Health and Food' among the key-actions of the Thematic Programme *Living World and Ecosystem*, which are significantly linked together. Feuerbach once said that 'men are what they eat', and in this spirit a healthier way of eating can obviously play a role in enhancing overall quality of life. The EU has chosen to provide to its citizens a 'permanent framework' to guarantee an enhanced food quality level. In order to reach this ambitious target, it may be possible to use the development of novel technologies, in particular biotechnology, as a powerful tool, if correctly addressed. The meaning of 'correct' in this case can only be decided by the interactions of the demands of different interest groups: consumers, public and private research, farmers, breeders and food manufacturers, policymakers, religious and environmental organizations.

Keywords

novel foods, food biotechnology, safety assessment, food allergies, HACCP principles

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From Alternative Agriculture to the Food Industry: The Need for Changes in Food Policy

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Issue: The development of organic agriculture has developed bottom-up, emerging from the 'counterculture' characterized by organic farmers, environmentalists and 'political' consumers. National authorities and supranational institutions have responded by establishing rules and control systems for organic agriculture over the last decade. Organic food production is now developing fast in some EU member states. This recent development is not only marked by more positive attitudes towards organic products from the food industry but also by an increasing need for a matching response in terms of food policy.

Relevance: The EU regulation 2092/91/EEC is mainly focused on organic agriculture, but as the food industry enters this field the need emerges for a more specific interpretation, development and implementation of the organic principles and methods in processing, handling and distribution. Whether the development of EU regulations will meet future consumer demands will be of great importance.

Introduction

In the context of growing industrialization of farming and food production and a tendency towards deregulation public concern over its impact on the environment, biodiversity, etc. has increased

Food production in the OECD and other countries has become highly industrialized over the last 3 or 4 decades. Technology has been implemented in farms as well as in distribution and processing plants. Farms are growing both in terms of size and production volume. National governments and supra-national political institutions are now working on the deregulation of agricultural policies, leaving it more to the market-economy to decide what type of agriculture and food production we shall have. In the last decade there has been a growing concern in society of the impact from the food production process on the environment, health, working-environment, biodiversity, etc. One of the reasons for this concern is the pollution of groundwater - the dominating source of drinking water in many member states. The increasing pollution of this resource reduces the number of clean and safe drinking water sources dramatically. Other examples concern food safety. A list of the safety issues can be illustrated by the now almost common scientific names: Salmonella, Listeria, BSE, etc. The result of this is that the consumers are loosing confidence in the products from this production system.

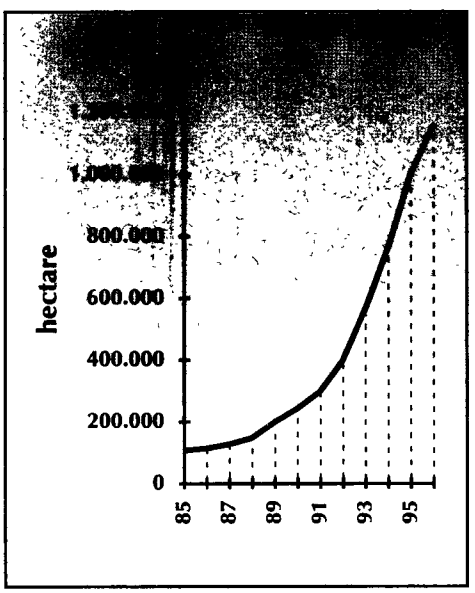
Even though this production system has been successful for decades, the increasing number of symptoms indicate a need to assess the overall

production regime behind it. A search for other possible production regimes would come out with organic production as a relatively new but successful production system. This article investigates to what extend and under what conditions the organic production system offers a realistic alternative.

The development of organic production systems

As a response to the negative impact of modern food production a social movement gave birth to organic production principles. They were developed and promoted by organic farmer organizations, consumer organizations, environmentalists and some workers' unions. The principles were developed as a concrete response to the criticism of the negative impact of conventional production regimes. As shown in Figure 1, the organic acreage in Europe has increased rapidly in the last decade.

Figure 1. Development in organic acreage in Europe (Lampkin 1996).



The International Federation of Organic Agriculture Movement (IFOAM), an international umbrella non-governmental organization, has organized the major part of this movement for the past 25 years. The major principles and methods for organic production, according to IFOAM (1996), reflect requirements for conversion to organic agriculture, crop production, animal husbandry and, in more general terms, requirements for storage and transportation of products, processing and social justice. These requirements can be illustrated by a few examples: the recycling of organic matter and nutrients, the exclusive use of alternative methods to synthetic fertilisers, pesticides and herbicides, and the provision of husbandry systems appropriate to behavioural needs.

Institutionalization of Organic Production

The sociologist Anthony Giddens (1991) introduces the role of social movements in establishing systems and regimes in society. He used the concept of **structuration** to indicate the process through which we as actors in society are creating the structures we later will be acting within. The development of organic agriculture was started as a bottom-up strategy. Belasco (1989) relates the organic farming movement (in the USA) to the counterculture in the 80's. Most of the people involved did not have any practical farming experience but they had good social networks. They experimented with farming principles that excluded pesticides and artificial fertilizers and they translated their experiments with production principles and methods into guidelines.

For organic agriculture this means, according to Giddens, that where some farmers originally were actively creating an interpretation of the concept of organic agriculture (requirements for production principles, etc.) these concepts now become universal and publicly known through the establishing of rules, legislation and control systems. State authorities and supranational

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The International Federation of Organic Agriculture Movement (IFOAM) has been defining the main principles and methods of organic farming for the last 25 years

Organic farming grew out of a counterculture but has become increasingly institutionalized with rules, legislation and control systems forming at national and supranational levels

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authorities have in the last decade established rules and control systems for organic agriculture. Denmark did this in 1987, the EU in 1991[1] and the USA are expected to launch their federal organic standards this year. Initiated by WTO, the United Nations (FAO/WHO) Codex Alimentarius has also been preparing international standards for organic products.

The EU regulation 2092/91/EEC is closely related to the principles of IFOAM. But they differ on some specific requirements and their main aims. The aims of the movement are more far-reaching and fundamental. The EU regulation focuses on non-restricted marketing of the organic products within the EU, while the movements tend to focus on closed and local circles. The EU regulation is general and meant to be extended by implementation, labelling and inspection of member state authorities. The member state authorities inspection system can either be operated by state authorities or approved private bodies. This certifying system with labels and inspections is of great importance to the marketing of organic products. The inspection and labelling system is intended to guarantee consumer confidence in the products. As organic production is more labour intensive (and expensive) its economic survival depends on consumer trust as well as their interest and disposable income.

National and supranational regulations now define organic agriculture and organic products. The above mentioned farmers that earlier participated in developing rules will be subject to this new regulation, and their role in influencing and defining will change. New actors and interests have been activated (retail companies, food industry, employers, employees, environmental organizations, administration, research institutions, etc.). The arena for the discussion on organic food has been greatly enlarged.

Thus, the committed grassroots debate and development has been formalized and regulated. The conditions for dialogue have changed and some interests have gained more influence, while others have lost out. Evidence of this is that the distance between the organic farmer and the consumer is becoming larger. Also the consumer's ability to influence the development of organic food production has decreased as they are less organized and powerful than the new actors in 'the organic arena'.

Denmark represents one of the countries with the longest history with state regulation of organic production[2] (10 years), so it would be expected that many of the social and institutional effects of this political awareness will be more perceptible here. And the experiences must be expected to indicate a tendency also for other EU member states if not EU as such.

The organic agricultural act and the growing consumer demand for organic products has been an important element for organic agriculture. In Spring 1997, 14 % of the milk distributed from the largest Danish dairy (MD-Foods) to retail stores was organic. There had been almost no previous advertising of organic products from the company. Initiatives from new and established companies have been taken to import other organic products to the growing Danish consumer market.

As in Europe, 12 states in the USA have had organic-farming legislation for many years. But while the EU has the advantage of 6 years experience with regulation of organic agriculture the US federal regulation is facing an implementation period. On the other hand the US regulation could cover also other and new aspects of organic production than the EU regulation.

The regulation and formalization of the debate has entailed a shift in relationships. Consumers are now more distant from producers and have lost influence to large organizations

Sales of organic products in the US show impressive growth rates. The same trend is also apparent in other industrialized countries

As for organic sales the latest figures from the USA show impressive growth rates. From 1989 to 1997 the yearly growth rates were estimated to be 20%[3]. This growth reflects that the gap between organic and non-organic products has shrunk. In 1995, 889 new organic products were introduced (35 % more than in 1994), and the increasing demand for convenience products is reflected in these figures. In this way a lot of these new products is ready-to-eat meals; beverages, baby foods, baking mixes, frozen vegetables etc. The same tendency can be observed in almost all the industrialized countries. One of the biggest food companies in Japan, Mitsubishi is planning to double its 1996 volume of organic vegetables. This means that organics will constitute 20 percent of the company's total frozen food imports.

A Danish study

Food-processors, food industry wholesalers and retail distributors were asked about their expectations for demand for organic products in a recent study (Nielsen and Kristensen 1997) and 73% of the responding companies said that they expected to see an increase in demand. Interestingly, the report also showed that the established food industry has come to include organic products in its range. Nevertheless, it is smaller businesses that predict greatest growth in demand for organics.

Many previous restrictions on processing organic products have now been removed from the rules of organic production, and companies now realize that organic production - according to the EU rules - is mainly about technical standards. However, companies report difficulties in the following areas:

1. The supply of organic raw materials.
2. Marketing.
3. Authorization and control.
4. The quality of the raw materials.
5. The rules for organic production.

Many of these difficulties are typical of any new production paradigm. But the difficulties with the rules and control of organic production indicate also that the specific, current standards represent a challenge for companies. Large companies in particular indicate problems in suitable production methods.

Large companies are finding conversion to organic practices particularly difficult

For instance, the EU regulation's restriction in additives is a big challenge in seeking new ways in processing the food. Almost 50% of the Danish companies emphasize the necessity of developing new processing technologies.

The Danish study shows that the organic food production over the last 10 years has stabilized and still have unexploited potentials. Four characteristics should be mentioned:

1. The newcomers to organic food production are to a great extent large and established companies. These companies can afford a short-term decline in sales.
2. There has been a widening of the markets for organic products: exports, supermarket chains, public institutions etc.
3. The companies who are involved in organic production have positive expectations for the future, and finally
4. This trend can be observed in almost all industialized countries.

In a Danish study food-processors, food industry wholesalers and retail distributors said that they expected demand for organic products to continue rising

Conclusions and Perspectives

This development of an alternative food production system can be characterized by three stages. First, **the informal period** where the diffusion of ideas, knowledge and methods are closely related to close and very informal

The development of an alternative food production paradigm falls into three stages: an informal period, an initial growth period and an industrialization period

There is a potential conflict between the food industry who would like to see regulations relaxed and consumers who prefer to see them tightened. Discussions on regulations need to involve both parties

links and networks. Then, **the initial growth period** where the close relationships are transformed into a growing need to get organized. Entrepreneurship is a major driving force, but different levels (i.e. regulation) are getting activated. The relatively close relationship between producer and consumer dominates and confidence in this relationship is a major driving force, especially for the producer. The third stage is **the industrialization period** characterized by a break-through in the market but also by conflicts related to the existence of institutions related to other regulatory needs.

The current EU regulation was established during the second stage. The development of the regulation for organic agriculture takes place under these conditions **and** an institutional framework that refer to the strategies of what has been called conventional food production.

To this point the demand for organic products is getting along very well with traditional productivist interests. Demand is increasing. But will the interest of the consumers and of the industry keep converging in the years to come? Will they have the disposable income to afford organic food? In other words will the consumer be 'loyal' to organic products and be interested in buying still more organic products? This will depend crucially on the direction in which the regulations for organic products develop in the years to come. As many consumers want to have a choice of for example GMO-free food or food free from growth stimulating substances - which is the case for organic products today - a change in the standards for organic products which allows GMO will reduce the consumers interest in these products.

Against this background, the conflicting areas will be closely related to what will happen primarily on regulation and standard setting and secondly on the construction of (scientific) knowledge, methods and the development of technologies suitable for organic production. Thirdly it will be important to create conditions for a dynamic process, where the ongoing change in demand and expectation among the consumers will be adopted and implemented into this process.

There are indications among actors that the future definition of organic production principles could either be tightened, or relaxed. The Danish study shows a tendency for the established food industry (the major companies with only a limited experience with organic products) to want the regulations to be relaxed. On the other hand different customers indicate a demand for tightening regulation (for instance for additives, and adding rules for energy use, social impact and working environment). Another interesting finding is that only a minor part of the Danish food industry (10%) finds GMO and genetic engineering compatible with organic production, suggesting that the food industry is sensitive to consumer preferences.

The experience with organic products indicate that it is possible to connect consumer behaviour and interest with preventive production methods. It is possible (but it is still not known to what extent) to use a market demand to pull production methods in a more sustainable direction, even though this may result a higher price for the consumer. This indicates that any revision of regulations should involve customers. There is also a growing interest among other stakeholders of modern food production to get involved.

A dynamic development of organic food production could be supported by a policy based on the following elements:

1. Give a high priority to the dialogue with consumers and other actors;
2. Support the setting of production standards and guidelines that secure the conditions for:
   - consumer loyalty and interest,
   - a level playing field for the industry and
   - the pursuit of sustainability at a political level.
3. Incentivate research, development and experiments as a basis for new and better understanding of barriers and potentials.
4. Develop and disseminate knowledge that will support better conditions for developing new applied technology and production methods.
5. Integrate experiences, knowledge and practical skills from concerned and affected actor groups. Good qualifications and the know-how on different levels in an organization will support the flexibility and ability to integrate and implement new needs and tasks.

Keywords

Organic food, consumer demand, sustainable production, food industry

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Notes

1. Regulation of organic animal products are still not complete.
2. As a political act the Danish state established a legislation on organic farming (Lov om Økologisk Jordbrug) in December 1987.
3. Natural Foods Merchandiser, September 1997.

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Integrated Chain Management of Food Products

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Issue: As consumers' environmental awareness increases there is growing demand for foods with reduced environmental impact. There is also a trend for consumers to produce their own food in a biological or 'organic' way or to modify their purchasing behaviour in favour of foods which carry a 'bio-label'.

Relevance: Within the EU's 5th framework programme it is stated that not only should a safe, healthy, balanced and varied food supply be secured within Europe but also that environmental issues should be taken into account. This paves the way for greater use of Life Cycle Assessment (LCA) as a tool for developing food products with reduced environmental impact.

Introduction

Like all human activity food production has an impact on the environment, however this sector has been slower than manufacturing to integrate the concept of sustainability

Like all other human activity, the production and consumption of food has an impact upon the environment. The food chain covers the production (agriculture), processing, distribution and consumption of food. The concept of 'sustainability' has been integrated into manufacturing industry in recent years, but only recently has this concept been incorporated into food production, where it mainly focuses on agricultural production processes and the conversion of agricultural products into final food products.

In the following paragraphs, a brief description of the state-of-the-art of LCA will be given. Its potential for screening food chains will be discussed and an overview will be given of remaining problem areas. Some recommendations will then be given on how more sustainable patterns for food production and consumption might be achieved.

LCA methodology

LCA takes a 'cradle-to-grave' approach starting from the extraction of the raw material through to production, use and final disposal

LCA is a method for identifying and quantifying potential environmental impacts throughout the life-cycle of a product (AFNOR, 1996). A 'cradle-to-grave' approach is applied starting from the extraction of the raw material through to production, use and final disposal. In the case of food products the following need to be included in the analysis: agricultural production of the raw materials (arable, animal, microbial), conversion into consumer goods, packaging and distribution, conservation and finally preparation and consumption.

The methodological framework proposed by ISO (AFNOR, 1996) consists of the following four components:

1. Goal and scope definition: in the first phase of an LCA, the intended use of the LCA (the goal) and the breadth and depth of the study (the scope or level of detail) have to be clearly defined.
2. Inventory analysis: in this phase, consumption and emission data (use of

resources, releases into the air, water and land) are collected on each process that is part of the system studied.

3. Impact assessment: In this phase, the results of the inventory analysis are translated into specific environmental effects (e.g. CO_2 emissions are related to the greenhouse effect, SO_2 emissions to acidification, etc.).

3. Interpretation: In this last phase of an LCA, the results of the inventory analysis and of the impact assessment are critically analysed and interpreted. This may lead to conclusions and recommendations to decision-makers. It may also result in an identification of opportunities to improve the environmental performance of products or processes.

LCA of food production and consumption: Application areas and case studies

Table 1 below lists some common applications of LCA in the area of food production and consumption.

Food

The ISO model defines four stages to LCA: goal and scope definition, inventory analysis, impact assessment and interpretation

Table 1. Applications of LCA in the food chain

Application Area	Application
Agriculture and food industry	• Environmental improvement of production systems • Identification of 'hot spots' in the chain • Assessment of environmental impacts of agriculture (biomaterials versus traditional materials) • Comparison of different production methods • Support and implementation of eco-audit procedures (e.g. EMAS) • Guide purchasing decisions on ancillaries (agrochemicals, fertilizers, etc.) • Development of environmental performance indicators • Communicate environmental performance
Wholesale and retail	• Guide purchasing decisions (choice of suppliers) • Comparison of own products with products of other wholesale companies and retailers (benchmarking) • Communicate environmental performance of products
Consumers and consumer organizations	• Guide purchasing decisions (e.g. via ecolabels) • Benchmarking between suppliers and brands
Policy makers	• Developing long-term food strategies • Development of environmental performance indicators • Development of cleaner technology/production programmes • Definition of Best Available Technologies (BAT) • Development of production and product standards • Development of ecological criteria for the award of an ecolabel for agricultural products • Support of financial mechanisms (e.g. taxes on environmentally less friendly products) • Screening of alternative European agricultural policies

The main purpose of these food LCAs is to determine the differences in resource use and environmental impact between different systems with equivalent functions. Each will imply one or more of several constraints, for example a fixed area of land (e.g. the area of arable land in a specific region), a minimum quantity of food required for the people or consumer requirements (e.g. food quality and safety).

Table 2 below gives a brief overview of some recent LCA case-studies on foods.

Table 2. Overview of some LCA studies on food

Product studied	Context	Reference
Wheat	Test for methodological concepts European Concerted Action (5 countries)	EC DGVI, 1997
Milk powder Port meat Soy bean oil Sugar Potato starch	Test for methodological concepts Financed by two Dutch ministries	Blonk, 1997
Pork and lamb meat	Identification of 'hot spots' Study commissioned by the Norwegian Meat Co-operative	Moller, 1997
Beef	Identification of 'hot spots' Study commissioned by the Norwegian Meat Co-operative	Moller, 1997
Tomato ketchup	Screening LCA Identification of 'hot spots' Own research	(Andersson et al. 1994)
Margarines and minarines	Feasibility of using 'environmental measures' for communicating the environmental performance of products Study commissioned by spread manufacturer	(Krozer, et al, 1992)
Rye bread and ham	Information gathering for food industry	(Weidema, et al, 1995)
Canned goulash	Combined assessment of food + packaging	(IÖW, 1992)

Food production and consumption results in local environmental impacts (e.g. depletion of abiotic resources, land use, biodiversity, water use and desiccation, acidification, ecotoxicity, eutrophication). Further work for developing impact assessment methods for interpreting these impact categories is needed.

Methodological improvements

A number of large scale projects have been set up which aim at the further improvement of LCA methodologies for agriculture and food production.

Recently, a European Concerted Action was started in order to investigate how LCA may be applied to agricultural production, to identify methodological difficulties which require further research and to harmonize the approaches of different research groups from five European countries (EC, DG VI, 1997).

The Dutch Centre for Environmental studies (CML) has contributed to this European work and continued its efforts in this area together with two other institutes. This resulted in a manual for applying LCA to agricultural products (LEI-DLO, 1996).

LCANET FOOD, the European Network for LCA Research and Development for the Food Chain, has been set up as a European Concerted Action (DG XII, 1996) and will start working by the end of 1997. It will be a platform for discussion on LCA work by exchange of information between the participating parties. The main objective is to evaluate and report the state of the art of present LCA-methodology with special emphasis on applications and knowledge gaps within LCA works dealing with the food chain. The project will initiate and promote the formation of a pan-European database for LCA within the food chain. Theme reports will be published on agriculture, food industry, consumer issues and data.

Towards environmentally responsible food chains

Food-related movements (e.g. vegetarianism) promote changes in our food habits, but have thus far not resulted in a global acceptance of more environmentally benign food patterns: the range of environmentally friendly foodstuff on the market is still limited. Quite often the existence of this market is associated with concerns about health and safety issues (e.g. the absence of pesticides, hormones, additives), not with considerations about the environmental effects throughout the food production chain. However, it is not always clear to the consumer what criteria are applied to food production patterns in order categorize it as 'environmentally friendly'. Consumers do not make automatically the link between food consumption and environmental issues. When the link is made, it is in most cases focused on the food packaging, the most visible and tangible aspect of environmental awareness.

The establishment of environmentally responsible food chains requires a concerted action of the different actors in the chain: farmers and food industry, distribution and retail, consumers and authorities. In the following paragraphs, some action points for those actors are highlighted.

Agriculture and the food-processing industry

Opportunities still remain for further optimization of agricultural production processes. There are different strategies which aim at an environmentally-friendly food production paradigm (e.g. by means of genetically modified organisms). Organic agriculture can be defined as a production system that relies on natural products and processes to foster crop growth, maintain or improve soil quality, control pests, and encourage biodiversity (AAFC, 1997). Because of its emphasis on soil health and prohibition of the use of certain chemical inputs, it is expected that organic agriculture can make an important

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A number of large scale projects have been set up which aim at the further improvement of LCA methodologies for agriculture and food production

Consumers do not make automatically the link between food consumption and environmental issues, they need more information about the real impact of production patterns

Food

Biotechnology and organic farming are two alternative approaches to optimizing agricultural production processes towards sustainability

Changes in food purchasing behaviour can only be achieved through effective and precise consumer information. The establishment of an ecolabel scheme may contribute in this communication process

Packaging has to be considered a critical issue by the food processing industry, since consumers often correlate the environmental friendliness of a food product with its packaging

contribution to sustainable agricultural production. Within the Codex Alimentarius Commission, international guidelines are under development for the production, processing, labelling, and marketing of organically produced foods.

Farmers may be confronted with additional costs when they have to produce in an environmentally more benign manner. This is regarded as a main obstacle to such foods obtaining a larger market share. However, the authorities might develop corrective measures to overcome this problem. On the other hand, foods produced in an environmentally conscious way have an added value compared to food which is produced in a traditional way. The issues 'health' and 'safety' might contribute to this added value (see the article 'From Alternative Agriculture to the Food Industry', in this issue).

Environmental issues are important to the food processing industry for both ecological and economic reasons. The key challenges are reduction of packaging wastes, efficient use of production inputs, and the minimization of pollutant discharges to air, water and land. The development and implementation of pollution prevention and cleaner technologies should be enhanced and environmental auditing and certification (e.g. EMAS) may be a way of stimulating this. Packaging in particular has to be considered a critical issue by the food processing industry, since consumers often correlate the environmental friendliness of a food product with its packaging.

Producers may develop strategies to increase consumer demand for environmentally friendly foods by influencing wholesaling and retailing. Strategic advantages for retailers are: broader consumer scope, better image, differentiation from other retailers. The environmental friendliness of food products has to be communicated to consumers. Proper communication strategies have to be worked out. The European ecolabel scheme could be used in this context since the recent review of the ecolabel regulation has broadened the scope of the scheme to foods and drinks.

Distribution and retailing

Minimization of packaging and packaging waste is a critical issue here too, for the same reasons as above.

A change in food purchasing behaviour can only be achieved through effective and precise consumer information. The establishment of an ecolabel scheme may contribute in this communication process. Credibility is considered a major concern by consumers. At this moment, there is little available for consumers to buy, and information is often contradictory.

Wholesale and retail companies can develop purchasing criteria for their suppliers. Products have to meet certain environmental performance criteria before they come on the shelf in a shop.

Consumers

The environmental impacts associated with food consumption are influenced by the consumers' behaviour during purchasing and food preparation.

A number of studies have been undertaken on how to influence consumers to purchase products which are environmentally more benign. A recent Dutch publication (NRLO, 1995) assessed existing and future strategies

and tools for steering consumers towards environmentally more benign food consumption patterns. A Canadian study (CRIAC, 1993) concluded that expressed willingness to buy environmentally friendly food products has not consistently led to actual sales. There is a remarkable difference between the consumer's attitudes and intentions and his/her actual behaviour. When choosing between food products, the environment is only one attribute among many. 'Green' food products will be bought only if they are convenient, of the same or better quality and at the same price as other products. Most consumers see environmentally friendly and body friendly ('healthy') as two sides of the same issue. The Canadian researchers concluded that there is a degree of confusion about what products are or are not environmentally friendly. The most common reasons given for purchasing food products which are not environmentally friendly are: convenience, the lack of alternatives, brand or taste preferences, and cost considerations.

Food preparation too may result in important environmental impacts. Key issues here are the consumption of energy (electricity, gas for cooking) and the production of wastes. Average food refuse fractions at the level of the consumer may vary between 10 and 20 % (16).

Authorities

The authorities play an important role in the establishment of environmentally responsible food production and consumption patterns because they have to develop the framework which guides producers and consumer in the right direction. Different tools can be used in this context, starting from the cradle (e.g. standards on organic farming), over the intermediate stages (e.g. implementation of EMAS in food processing industries, criteria on the environmental performance of food products) to the grave (e.g. directives on waste minimization). It depends upon the creativity of public decision makers what tools will be used to implement the principles of sustainability throughout the food chain.

In addition the authorities have an important educational role to play in the guidance of producers and consumers. Producers have to be informed about existing technologies for cleaner production of food. Consumers have to be informed about the environmental impacts which are associated with food products. Within the framework of this educational and communicative role, a database with relevant environmental information on the most relevant food chains would be a valuable support.

The proper information and education of both producers and consumers might be enhanced through the establishment of a harmonized legislative framework on food production and consumption throughout Europe. LCA can provide useful information since it approaches food production and consumption from a chain perspective. However, information on the environmental impacts of food chains is only one piece of the information which guides decision-makers. Other aspects have to be taken into account too: economics (e.g.; production costs) and social issues (employment, fair prices for farmers).

Conclusions

In order to support decision making processes in the area of sustainable food production and consumption, the combined application of LCA with other tools for decision support (economical balancing, social impact analysis, etc.) has to be advocated. This would lead to

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Consumers may favour environmentally benign food products in theory, but in will only tend to buy them in practice if they are of the same or better quality and at the same price as other products

The authorities have both a regulatory role and an informational role to play in guiding producers and consumers toward more environmentally responsible production and consumption patterns

LCA is useful in conjunction with other tools as a support to decision-making in the sustainable food production and consumption area

more meaningful results, better acceptance of the outcome by all actors involved and a centralized data availability since joint data usage will be required.

This paper has illustrated the usefulness of life cycle assessment (LCA) as a tool for producing information on the environmental impacts associated with food production and consumption. Notwithstanding the methodological problems which arise when LCA is applied to food chains, there is already some practical experience. However, more experience is needed to improve the methodology for assessing food chains. This will lead to an increased potential of LCA as a tool to achieve more sustainable food production and consumption patterns.

Keywords

LCA, life cycle assessment, sustainable food production, legislation, consumer information

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About the author

Dirk Ceuterick trained as an agricultural engineer at the State University of Gent, Belgium. In the past five years he has gained experience in the application of life cycle assessment (LCA) on different product systems at VITO, the Flemish Institute for Technological Research. In 1996, he organized an international conference on the application of LCA in agriculture, food and non-food agro-industry and forestry. He is member of LCANET-FOOD, a network of LCA practitioners focusing on the application of LCA in food production and consumption.

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A Comparison Between Functional Food Markets in the EU, U.S. and Japan

Simon Proops, *CEST*

Issue: Foods and drinks which claim to have positive health benefits have been in the European marketplace for a long time. However, the actual biochemical effectiveness of such products has not always been easily proved and until the recent advent of 'functional foods,' the claims made for most of these foods have tended to be spurious or at least not backed by firm scientific evidence.

Relevance: The mechanisms by which functional foods work are not clearly and completely understood by the medical or nutritional community, and this may pose regulatory problems for policymakers. However, the development of the market is still uncertain and several issues need to be addressed, such as consumer information or classification of products.

Functional foods are foods that feature functional compounds, such as vitamins, that have physiological benefits over and above basic nutritional value

Confusion may arise from the mistaken interpretation of such foods as having a curative or preventative function

Analysis: Definition and need for testing

Functional foods are foods that feature functional compounds (e.g. glutathione, vitamin A, etc.) that have physiological benefit for the consumer over and above basic nutritional value. Their aim is to prevent diseases like cancer and osteoporosis and maintain the body's natural balance of vitamins and electrolytes. They differ from neutraceuticals in that no additive pharmaceutical compound has been introduced into the food.

While there is world-wide agreement on the need to inform consumers on the benefit of the food and to protect the consumer from misleading information, the implementation of guidelines for labelling functional foods has stalled. One reason is that health benefit claims for products, such as the link between antioxidants and cancer prevention, represent a step beyond traditional nutritional claims for products. However, much of the confusion arises from the mistaken interpretation that functional foods 'cure' disease. In reality, most functional foods act as a preventative for certain conditions. In addition, while certain foods may be consumed for their physiological properties, this does not imply that they should be classified as a drug.

Table 1. Functional compounds and some of the conditions they address

Condition	Functional Compound	Action
Cancer	Antioxidants Beta Carotene Vitamin A Probiotics	Preventative
Osteoporosis	Calcium	Preventative
High Blood Pressure Bowel Cancer	Dietary Fibre	Curative
Poor Digestion Low Nutrient Bioavailability High Cholesterol Levels	Oligosaccharides	Curative
Neuro-Muscular Disease	Magnesium	
High Blood Cholesterol Levels Cardiovascular Disease	Causido Culture Soy Protein	Preventative
Cataracts Scurvy Hepatitis	Vitamin C Vitamin E	Preventative
Senile Dementia	Di- and Poly-amines	Preventative

The mechanistic, classical cause-and-effect model of the body cannot completely explain the efficacy of some of these foods, either as preventative or curative compounds. To some degree, a model of the body as a system in homeostasis must be adopted. However, there are senior figures in the medical and pharmaceutical communities who resist the promulgation of such a concept by the food industry. They insist that claims can be made for functional foods only after rigorous and independent testing has confirmed that there is statistical basis for believing in the efficacy of such foods.

Food and Nutrition Trends in the U.S.

In the U.S., healthy, natural and minimally-processes foods continue to grow in popularity, suggesting a reaction against the mass-produced and highly processed foods that, until recently, have comprised the typical U.S. diet. American foods have typically been among the most convenient in the world, with microwavable, instant foods such as popcorn and frozen dinners competing for shelf space with toaster-ready 'pop tarts,' frozen pizzas and hamburgers. However, this convenience has been won at the expense, say some, of nutritional completeness.

While the major food industry players like General Foods and General Mills responded by adding nutrients such as niacin and riboflavin to breakfast cereals, commentators insisted that 'organic' nutrients are better than artificial ones. While products such as V8 vegetable juice have been on the U.S. market for some time, more

Opinions differ regarding the level of proof of efficacy required before functional foods can be labelled as having certain health properties

In the US healthy, natural and minimally-processed foods continue to grow in popularity and have come to be a part of mainstream consumption

recently, natural products, those based on herbalism, beverages sourced from fungi, organic foods and products based on homeopathy have all gained significant popularity in the American diet.

Citizens for Health, a national consumer advocacy organization, has been formed for the protection and expansion of consumer natural health choices. Such companies as Celestial Seasonings have been offering natural, caffeine-free herbal teas to the U.S. marketplace for more than a decade, and soy-based foods like soy drinks and soy burgers have been a staple of the organic food community for many years. Other products recently on display at food exhibitions in the U.S. include a grape and elderberry juice-based wine substitute, sports water, fortified with potassium, calcium, magnesium, manganese and chromium aspartate/picolinate, a combination fruit and vegetable juice and a steeped herbal brew using minimally refined sweeteners.

Japan's fish and rice-rich diet is one of the healthiest, but is under attack from Western convenience foods

Food and Nutrition Trends in the EU

In the European marketplace, there seems to be a proliferation of extremes in food and drink; highly processed products from the major retailers such as Sainsbury, Tesco and Marks and Spencer, on the one hand, and health shops such as Holland and Barrett or Whole Foods Market, which still seem to have an 'alternative' or 'granola' aura about the products they sell on the other. European consumers are aware of the deficiencies in their food and are looking for alternative sources of nutritional value.

In the EU eating seems to be associated more with particular lifestyles (e.g. the Mediterranean diet) than particular products

While organic products offer this, they are not widely distributed in the EU, are often not known, or are not regarded as mainstream products in the way they are in the U.S. There is scope, therefore, to develop a no-nonsense, mainstream alternative to these extremes. This may take the form of minimally processed, healthy and fashionable foods and drink, such as the 'Mediterranean Diet', which includes lots of fish, fresh vegetables and olive oil.

Food and Nutrition Trends in Japan

The Japanese diet has improved tremendously since the end of the World War II, and with it has come a growing realization that more can be done to compensate for nutritional deficiencies. In general, the traditional Japanese diet, consisting mainly of soya, rice, fish and vegetables, is healthier than the western diet, being lower in animal fats and proteins.

This diet however is slowly being eroded by an influx of western dietary influences; hamburgers, pizzas and the like. A traditional Japanese breakfast used to consist of fish or egg, rice, miso soup, made from fermented soy bean and pickled vegetables. However, the breakfast of many Japanese today is virtually indistinguishable from that of many westerners, and is just as high in processed sugars and saturated fats.

Originally, food supplements in Japan, such as calcium, were designed to compensate for the poor nutrition of the basic foodstuffs available in the impoverished country. However, with the recent westernization of the Japanese diet, products such as vitamin C chewing gum, calcium-enhanced chocolate, and a host of drinks such as Pocari Sweat, Dekavita C and Orinamin V, which either contain ionic salts or purport to endow the user with enhanced energy, stamina and vitality, are being marketed as a way of supplementing the essentially poor nutritional content of many convenience foods.

Consequences, Conclusions and Recommendations

As life becomes more stressful and the pace of life increases, the need for food and drinks which are convenient and taste good while delivering nutritional benefits and positive physiological effects will probably increase. While business opportunities abound in improving the range of convenient yet nutritionally beneficial foods made available to the consumer, there persists in some quarters a lingering worry that public opinion will be swayed too easily by claims that are poorly scientifically substantiated, and that profit will be made at the expense of well-being.

However, these concerns are not internationally shared. In the EU, Canada and Australia, health claims are not permitted on foods, whereas in Japan and in the US, they are. In the U.S., claims concerning 'classical structure function' (such as calcium and bone health; iron and anaemia) are permitted. However, functional effects, such as antioxidants for cancer prevention, are not. The food industry is keen to stimulate debate on this topic, since personal health maintenance means greater potential revenues for them.

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The degree of concern over potentially misleading information on product labels varies greatly from country to country

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Food

Nutrition Policy as a means of health prevention

A. Schmitt, *VDI-TZ*

Issue: During the past two decades evidence has accumulated that prevailing dietary patterns are at the root of major mass diseases that are impediments to progress toward national and international health goals. With the changing nature of disease, the escalating cost of health care and treatment, and the move toward prevention rather than curative medicine, nutritional assessment has become an important topic on the health political agenda in many areas throughout the Western world.

Relevance: Nutritional surveillance has become an important topic on the health political agenda in the 5th framework program of the European Union. The intention of introducing a proper food policy was announced by the Commission's President, Jacques Santer to the European Parliament on 18 February 1997. Despite the complexity and the methodological challenges of a pronounced interdisciplinary approach, collaboration among different disciplines would bring about efficiency in time, money, research efforts and outcome.

The Role of Diet in the Aetiology of Diseases

The European Union is displaying accelerated changes in food culture which had previously remained very stable for centuries. There has been increasing recognition over the past 40 years that certain chronic, non-communicable diseases are closely related to diet and aspects of lifestyle. (Kushi, 1985). Overconsumption of certain dietary components is now a major concern for the population of the EU.

There has been increasing recognition over the past 40 years that certain chronic, non-communicable diseases are closely related to diet and aspects of lifestyle

There is a substantial body of evidence that the total amount and types of dietary lipids play a causal role in the aetiology and pathogenesis of obesity, cardiovascular diseases, hypertension, stroke, diabetes mellitus (non-insulin-dependent), various forms of cancer, liver diseases and gastro-intestinal diseases. Diseases of the circulatory system account for nearly half of all causes of death in the EU, and their highest risk factor is total fat consumption (Danforth, 1985; Romieu et al., 1988; Bouchard, 1991). The direct costs related to such inappropriate nutrition has been estimated to amount to over 5% of the total costs of Health Care in industrialised societies, for example, at about EU$ 50 billion per year for Germany. (Kohlmeier et al., 1993).

The Influence of Lifestyle and Socio-Economic Factors

The pattern of high food consumption in the EU, the lack of physical activity, and inappropriate eating patterns seem to mirror the transforming social environment. As the agrarian society became industrial, and industrial society became a service economy, convenience food became more attractive. Related to these changes are perhaps changes in the 'culture of food'. Particularly the aspects of pleasure, lifestyle, identity and

convenience are suggested to be important motivators for food choice. A recent EUROBUS survey on consumer attitudes in the European member states has shown that among 15 possible choices of perceived influences on food choice, 'healthy eating' (32%) is among the 4 most important in the EU. The three main influences on food choice have been perceived by Europeans to be 'quality' (75% of EU consumers) 'price' (43% of EU consumers) and 'taste' (38% of EU consumers).

A recent EUROBUS study has shown that healthy eating is a priority consideration in food choices for most Europeans

Table 1. Factors influencing the personal choice of foods (% of respondents*)

COUNTRY	QUALITY	PRICE	TASTE	HEALTHY EATING
AUSTRIA	90	54	25	50
BELGIUM	76	34	46	37
DENMARK	64	39	29	48
FINLAND	67	62	41	40
FRANCE	77	57	42	25
GERMANY	76	40	31	31
GREECE	75	18	47	32
IRELAND	49	30	45	35
ITALY	84	29	40	25
LUXEMBOURG	68	18	49	24
THE NETHERLANDS	73	36	41	28
PORTUGAL	66	38	40	34
SPAIN	80	52	22	32
SWEDEN	73	59	37	30
UNITED KINGDOM	59	43	49	40
EUROPEAN MEAN*	75	43	38	32

*weighted according to population size
Source Institute of European Food Studies, 1996.

The main perceived barriers to healthy eating also seem to be related to lifestyle (irregular working hours and busy lifestyle) even though one in five Europeans claim no difficulty in altering eating habits to achieve a healthy diet.

Table 2. Perceived barriers to healthy eating (% of respondents*)

COUNTRY	IRREGULAR WORKING HOURS	GIVING UP FAVORITE FOODS	WILLPOWER	BUSY LIFESTYLE	PRICE
AUSTRIA	31	52	24	13	19
BELGIUM	35	34	22	34	16
DENMARK	21	33	14	25	17
FINLAND	19	39	26	23	15
FRANCE	23	36	21	19	19
GERMANY	12	50	10	6	9
GREECE	13	39	13	15	13
IRELAND	17	49	31	19	17
ITALY	36	24	10	16	7
LUXEMBOURG	41	50	28	20	24
THE NETHERLANDS	27	32	17	27	16
PORTUGAL	27	33	13	21	21
SPAIN	30	22	25	18	16
SWEDEN	25	40	20	37	21
UNITED KINGDOM	25	48	27	24	23
EUROPEAN MEAN*	24	23	18	17	15

*weighted according to population size
Source: Institute of European Food Studies, 1996

Socio-economic, environmental, demographic, regional and cultural concerns all influence consumers' food choices

The Symbolic Meanings Associated with Food

The motivation behind consumers' different food choice tactics depend on the socio-economic environment, on demographic, regional, and cultural factors. They are influenced by food marketing strategies and by the importance attributed to different food characteristics. The influence of dietary beliefs and practices as an area for research has long been underestimated. It is not only what is consumed that is of importance, but rather how and why it is consumed.

Dietary Guidelines and Nutritional Advice

In most European societies nutrition has become a matter for government - not because of security of food supply, but rather because of various forms of inappropriate nutrition and the related costs of therapy and treatment. Most countries have launched dietary recommendations which have been widely employed in planning and establishing standards for food labelling. Food labelling has recently become mandatory on processed foods within the European Union (for instance, the EP/Council Regulation No 258/97 on Novel Foods). It is based on the premise that the information presented will help the consumers apply general nutrition principles when purchasing food. The limited impact of this information should be attributed to its technical nature, which may be more attuned to the needs of nutrition professionals rather than those of consumers.

The economic advantages of prevention rather than treatment have meant that nutrition has become a concern for government

Table 3. Sources of information on healthy eating (% of respondents*)

COUNTRY	TV/ RADIO	MAGAZINES	NEWSPAPERS	HEALTH PROFESSIONALS	LABELS	ADVERTISING	GOVERNMENT
AUSTRIA	34	32	37	31	23	26	4
BELGIUM	37	36	34	39	16	29	16
DENMARK	35	26	32	15	22	23	17
FINLAND	47	43	36	32	14	29	3
FRANCE	17	19	19	32	28	13	4
GERMANY	39	35	40	23	20	17	7
GREECE	18	17	18	27	9	11	4
IRELAND	24	20	23	18	11	12	8
ITALY	26	21	19	26	21	15	9
LUXEMBOURG	48	49	40	45	30	32	21
THE NETHERLANDS	24	29	27	18	28	26	16
PORTUGAL	27	14	16	39	27	13	23
SPAIN	26	12	13	26	23	21	11
SWEDEN	35	30	46	25	35	30	10
UNITED KINGDOM	30	37	28	19	20	15	8
EUROPEAN MEAN*	29	27	27	26	23	19	9

*weighted according to population size
Source: Institute of European Food Studies, 1996.

Much of the information made available is too technical to have an impact on the average consumer

Whereas nutritional quality awareness has increased over the last decades, it seems that the volume of disseminated nutritional information has tended to confuse rather than inform consumers.

Advertising and media influence provide an important source of information on nutrition which effects the legitimization of cultural norms, values, innovations, and pressures.

Professional and governmental information on diet and nutrition has been regarded with 'trust'. Government agencies' information on healthy eating, however, is used by less than 10 % of Europeans, indicating the need for information dissemination.

Table 4. Trust in information on healthy eating (% of respondents*)

COUNTRY	TV/ RADIO	MAGAZINES AND JOURNALS	HEALTH PROFESSIONALS	LABELS	ADVERTISING	GOVERNMENT
AUSTRIA	49	46	95	48	15	80
BELGIUM	50	50	90	58	18	76
DENMARK	60	52	87	64	20	87
FINLAND	81	81	96	86	47	79
FRANCE	54	53	92	74	24	53
GERMANY	55	51	80	41	13	67
GREECE	50	52	81	56	19	71
IRELAND	65	53	95	54	27	86
ITALY	65	60	86	63	26	65
LUXEMBOURG	46	34	90	47	25	80
THE NETHERLANDS	66	64	93	81	39	88
PORTUGAL	51	44	92	58	25	91
SPAIN	45	34	90	61	18	79
SWEDEN	65	56	92	71	19	86
UNITED KINGDOM	65	53	94	67	32	69
EUROPEAN MEAN*	58	52	88	61	23	69

*weighted according to population size
Source: Institute of European Food Studies, 1996.

Nutrition and Health Initiatives in the Commission Union

Since the Common Agricultural Policy is a farm- rather than a food-orientated policy, and since nutritional recommendations alone have failed to build a supportive holistic environment which enables people to practice a healthy food choice, most EU Member States (haltingly following the United States) are establishing a nutritional policy as an independent field of multidisciplinary research (WHO, 1995). Their experiences prove that public health authorities can mobilize resources in fighting improper nutrition and associated diseases (as they were fighting cancer, the use of alcohol, smoking, and recently AIDS).

With the potential recognition and acceptance of a healthy nutrition as a means of improving the well-being of the population and of reducing the cost of health care, nutritional surveillance has become an important topic on the agenda in the European Union.

In their health promotion and disease prevention plan -Community Action on Health Promotion, Information, Education and Training within the Framework for Action in the Field of Public Health (CEC, 1994)[1] and Integration of Health Protection Requirements in Community Policies (CEC, 1995)[2] - European policy makers have articulated a holistic approach towards a comprehensive health policy. In the light of this initiative a nutrition promotion program has prominently featured in the fifth framework research program of the European Commission (FP5). Its key action plan on health and food states that: "The aim of this key action is to promote the development of knowledge, technologies and methods, based on biotechnology, for example, to produce a safe,

Advertising and media influence provide an important source of information on nutrition which effects the legitimization of cultural norms, values, innovations, and pressures

With a view to improving the well-being of the population and reducing the cost of health care, nutritional surveillance has become an important topic on the agenda in the European Union

Consumption patterns are affected by food-processing techniques and food marketing. However, the ability of the market to provide adequately for the nutritional well-being of the population has been questioned

In order to promote better eating habits consumers need accurate information as to what constitutes a healthy diet as well as access to a variety of safe and affordable foods

healthy, balanced and varied food supply for consumers. This requires as a priority: the development of new processing methods to improve food quality; the development of tests to detect and processes to eliminate infectious and toxic agents; study of the role of food in preserving health, in particular from the point of view of nutrition, epidemiology and public health".

The immediate concerns of food safety have been a significant feature in the Community's research plan, which, however, could emphasize improved access to safe and nutritious food for maintaining a healthy and active life, overcoming the increasing uncertainty and confusion about food-related health risks, and improving dietary knowledge.

The Multi-Sectoral Nature of a Nutrition Policy Concept

The consumption patterns of the population are often more profoundly affected by food processing techniques and food marketing and by decisions taken within the ambit of the Common Agricultural Policy (CAP) than by decisions taken as a part of the European food and health policies. This multi-sectoral status of diet, nutrition and food consumption has been the cause of much conflict where the ability of the market to adequately provide for the nutritional well-being of the population is drawn into question. A challenge for European Nutrition Policy will be the integration and co-ordination of EU policies, including food industry policies, since the preparation of meals is moving increasingly from the kitchens into food industry, and the CAP, since farmers are the ultimate victims of the over-production of food. A reorientation of the export policies towards the World Markets could help European farmers to plan production and processing in a rational way and could help satisfy increasing food needs in areas of the world where food needs exceed food production capacities. By this it will touch the GATT discussion and the ultimate questions of development aid.

The Challenge for the European Commission

Legislation needs to tread a fine line, balancing possible economic disadvantages against the hoped-for health benefits. It is extremely difficult to achieve objectives relating to widely different aspects of the economic and social system simultaneously.

The health initiatives of the European Commission coupled with the Fifth Framework Programme for research could serve as an exploratory tool providing fresh leads for future research in nutrition matters. The challenge for the health policy makers in Europe in advancing the agenda of a Nutrition Policy is to point out the health implications of economic policies by identifying the potential health gains and losses from different socio-economic policies on the one hand, and on the other hand to influence the development of these policies so that avoidable consequences can be prevented. A critical task will be to set up nutritional intervention strategies, that can adequately take account of the prevailing public health problems on the one hand, and the wide range of economic interests involved in the food system on the other hand.

Promoting better eating habits and positive health behaviour is one of the most challenging tasks in overall efforts to improve nutrition. In addition to access to a variety of safe and affordable foods, people need accurate information as to what constitutes a healthy diet and how to meet their nutritional needs. Besides

education, strategies to promote healthy diets must include providing motivation and creating opportunities for people to change their behaviour while recognizing individual preferences, lifestyles and time constraints (FAO/WHO, 1992).

Conclusions

The conclusions pertaining to these observations can be summarized as follows:

- Clear risk-relationships between diet, nutrition, and the aetiology of diseases of the circulatory system have been established. They indicate that good health is the product of complex interactions among environmental, behavioural, social, political and economic factors.
- Resources and policies will determine how the organization of the market will affect consumers' behaviour.
- In order to counteract the spiralling costs of health care in Europe, and based on the assumption that prevention is more effective than treatment, the Fifth Framework Programme will provide the European Commission with a mandate for action in this field.
- Research and information on appropriate food technologies require new forms of co-operation between public and private actors, as the opportunities provided by biotechnology are growing.
- The objective of a European Food and Nutrition Policy would imply a strengthening of the institutional capacity of the Commission with the ultimate goal of improving the quality of disease prevention in all age groups.
- A European Nutrition Policy should give a collective, multifaceted response to the diverse influences on diet, nutrition, food choice and eating behaviour, by taking a holistic look to food consumption and the social and economic networks in which consumption takes place.

Keywords

nutrition, lifestyle, eating habits, health prevention, community action, interdisciplinary approach

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