DOI: 10.7251/QOL1001026G UDC: 613.2
Review paper

Science for Food Safety, Security and Quality: a Review - Part 1

Enne Giuseppe[1]
Serrantoni Monica
Istituto Sperimentale Italiano "Lazzaro Spallanzani" Milan- Italy
Greppi GianFranco
Dip. Scienze Zootecniche- Laboratorio di Bionanotecnologie –Università degli Studi di Sassari Sassari- Italy

Abstract: Modern food science is providing ever more information on the functions and mechanisms of specific food components in health promotion and/or disease prevention. In response to demands from increasingly health conscious consumers, the global trend is for food industries to translate nutritional information into consumer reality by developing food products that provide not only superior sensory appeal, but also nutritional and health benefits. Today's busy life styles are also driving the development of healthy convenience foods.

Recent innovations in food sciences have led to the use of many traditional technologies, such as fermentation, extraction, encapsulation, fat replacement, and enzyme technology, to produce new health food ingredients, reduce or remove undesirable food components, add specific nutrient or functional ingredients, modify food compositions, mask undesirable flavours or stabilize ingredients. Modern biotechnology has even revolutionized the way foods are created. Recent discoveries in gene science are making it possible to manipulate the components in natural foods. In combination with bio-fermentation, desirable natural compounds can now be produced in large amounts at a low cost and with little environmental impact.

In this paper authors analyzed effect new technology on food safety, food quality and food security.

Key words: food, safety, security, quality.

Food science is a discipline concerned with all technical aspects of food, beginning with harvesting or slaughtering, and ending with its cooking and consumption. It is considered one of the agricultural sciences, and is usually considered distinct from the field of nutrition.

It is a highly interdisciplinary applied science and incorporates concepts from many different fields including microbiology, chemical engineering, biochemistry, and many others.

Some of the sub-disciplines of food science include: -food physics - the physical aspects of foods (such as viscosity, creaminess, texture...); -food chemistry - the molecular composition of food and the involvement of these molecules in chemical reactions; -food technology - the technological aspects; -food microbiology - the positive and negative interactions between micro-organisms and foods; -food preservation - the causes and prevention of quality degradation; -food engineering - the industrial processes used to manufacture food; -product development - the invention of new food products; -sensory analysis - the study of how food is perceived by the consumer's senses; -food packaging - the study of how food is packaged to preserve the food after it has been processed; -molecular gastronomy - the application of science to culinary practice and more generally gastronomical phenomena.

Modern food science is providing ever more information on the functions and mechanisms of specific food components in health promotion and/or disease prevention. In response to demands from increasingly health conscious consumers, the global trend is for food industries to translate nutritional information into consumer reality by developing food products that provide not only superior sensory appeal, but also nutritional and health benefits. Today's busy life styles are also driving the development of healthy convenience foods. Recent innovations in food sciences have led to the use of many traditional technologies, such as fermentation, extraction,

[1] Correspoding author: Phone: + 39- 02-76111101-76110935; E-mail: giuseppe.enne@istitutospallanzani.it

encapsulation, fat replacement, and enzyme technology, to produce new health food ingredients, reduce or remove undesirable food components, add specific nutrient or functional ingredients, modify food compositions, mask undesirable flavours or stabilize ingredients. Modern biotechnology has even revolutionized the way foods are created. Recent discoveries in gene science are making it possible to manipulate the components in natural foods. In combination with bio-fermentation, desirable natural compounds can now be produced in large amounts at a low cost and with little environmental impact.

Nanotechnology is also beginning to find potential applications in the area of food and agriculture. Although the use of new technologies in the production of health foods is often a cause for concern, the possibility that innovative food technology will allow us to produce a wide variety of food with enhanced flavour and texture, while at the same time conferring multiple health benefits on the consumer, is very important.

A variety of foods are now manufactured that provide specific nutrients or functional ingredients to improve nutrition, boost the immune system, prevent chronic diseases, and delay the aging process. Various traditional food technologies have been advanced and new technologies developed in order to efficiently produce nutritious food and food ingredients for health food formulations. Today, innovation in food technology plays a crucial role in translating nutrition information into consumer products. Scientific evidence has prompted consumers to increasingly opt for low calorie and low fat foods, as well as other foods that hold out the promise of health benefits (Lin and Zhao, 2007).

In a modern society, people desire both good health and longevity and hence demand nutritious and functional food that promotes their wellbeing, enjoyment, and active life style. Convenient health foods or foods that impart extra value in the form of health benefits are now the highest priority for product development in the food industry.

Paralleling the increasing varieties of dietary supplements appearing on the shelves in health stores every year, these supplements are also gradually finding their way into new food formulation. Modern food technology thus provides an alternative health pathway for individuals who are unable to prepare their own healthy foods to conveniently obtain desired supplements or special nutrients from prepared foods and beverages of their choice.

Food Safety

Food safety is a scientific discipline describing the handling, preparation, and storage of food in ways that prevent food-borne illness. It is an increasingly important public health issue. Governments all over the world are intensifying their efforts to improve food safety (FAO, 2002; Food Safety Authority of Ireland, 2005). These efforts are in response to an increasing number of food safety problems and rising consumer concerns.

Food-borne illnesses are defined as diseases, usually either infectious or toxic in nature, caused by agents that enter the body through the ingestion of food, it could be micro-organisms or other agents (included chemical products). They represent a widespread and growing public health problem, both in developed and developing countries (National Center for Food and Agricultural Policy, 2005).

The global incidence of food-borne disease is difficult to estimate, but it has been reported that in 2005 about 1.8 million people died from diarrhoeal diseases (FAO, 2007). A great proportion of these cases can be attributed to contamination of food and drinking water.

In industrialized countries, the percentage of the population suffering from food-borne diseases each year has been reported to be up to 30.

While less well documented, developing countries bear the brunt of the problem due to the presence of a wide range of food-borne diseases, including those caused by parasites. The high prevalence of diarrhoeal diseases in many developing countries suggests major underlying food safety problems.

While most food-borne diseases are sporadic and often not reported, food-borne disease outbreaks may take on massive proportions.

Some foodborne diseases are well recognized, but are considered emerging, because they have recently become more common (Sudhakar et al., 1988). For example, outbreaks of salmonellosis have been reported for decades, but within the past 25 years the disease has increased in incidence on many continents. In the Western hemisphere and in Europe, Salmonella enteritidis has become the predominant strain. Investigations of SE outbreaks indicate that its emergence is largely related to consumption of poultry or eggs.

While cholera has devastated much of Asia and Africa for years, its introduction for the first time in almost a century on the South American continent in 1991 makes it another example of an infectious disease that is both well-recognized and emerging. While cholera is often waterborne, many foods also transmit infection. In Latin America, ice and raw or underprocessed seafood are important epidemiological pathways for cholera transmission.

Other foodborne pathogens are considered emerging because they are new microorganisms or because the role of food in their transmission has been recognized only recently. Infection with Escherichia coli was first described in 1982. Subsequently, it has emerged rapidly as a major cause of bloody diarrhoea and acute renal failure. The infection is sometimes fatal, particularly in children. Outbreaks of infection, generally associated with beef, have been reported in Australia, Canada, Japan, United States, in various European countries, and in southern Africa. Outbreaks have also implicated alfalfa sprouts, unpasteurized fruit juice, lettuce, game meat and cheese curd.

Listeria monocytogenes is considered emerging because the role of food in its transmission has only recently been recognized. The disease is most often associated with consumption of foods such as soft cheese and processed meat products that are kept refrigerated for a long time, because Lm can grow at low temperatures. Outbreaks of listeriosis have been reported from many countries, including Australia, Switzerland, France and the United States.

Foodborne trematodes are also emerging as a serious public health problem, especially in south-east Asia, but also in Latin America, in part due to a combination of increased aquaculture production, often under unsanitary conditions, and of consumption of raw and lightly processed fresh water fish and fishery products. Foodborne trematodes can cause acute liver disease, and may lead to liver cancer. An estimated 40 million people world wide are affected.

Bovine Spongiform Encephalopathy (BSE), a fatal, transmissible, neurodegenerative disease of cattle, was first discovered in the United Kingdom in 1985. At this time, 19 countries have reported endemic BSE cases and the disease is no longer confined to the European Community: a case of BSE has been reported in the cattle herd of Japan.

New foodborne disease threats occur for a number of reasons. These include increase in international travel and trade, microbial adaptation and changes in the food production system, as well as human demographics and behaviour.

Food-borne diseases pose a considerable threat to human health and the economy of individuals, families and nations. Their control requires a concerted effort on the part of the three principal partners, namely governments, the food industry and consumers.

Recent trends in global food production, processing, distribution, and preparation are creating an increasing demand for food safety research in order to ensure a safer global food supply. Most food safety research has focused on improving detection of foodborne hazards and understanding how they can be prevented and controlled (Beier and Pillai, 2007; European Commission, 2000).

The “farm to fork” approach has been adopted in order to identify and focus efforts on those points of the food production chain where contamination of food is most likely to occur or most likely to be prevented.

To reduce the burden of foodborne diseases, the research is working to build and strengthen national food safety systems in order to effectively manage their food supply.

To improve food safety, hundred of research programs are developed in partnership with producers and other agencies (Buzby and Roberts, 1996) . The research priorities include applied research and field studies related to physical, chemical, and biological hazards, such as the development and evaluation of better methods for testing individual animals, herds, and farm environments for the presence of traditional and emerging pathogens, the epidemiologic studies to determine critical control points where pathogens can be prevented from entering the food chain, the evaluation of the effectiveness of best management practices and HACCP (hazard analysis and critical control points) systems to reduce the risk of microbial contamination of food products, the development of new diagnostic techniques for use on farms or in farm environments, the development of new methods to prevent, control, reduce, or eliminate pathogens in food animals, the risk assessment and benefit/cost studies to determine feasibility and effectiveness of prevention activities at the farm level.

It is clear that engineering should be an integral component of food safety research. Engineering is necessary to develop physical and chemical mechanisms for detection of microbial and chemical hazards to the food supply. All foods are subject to several different processes from the farm gate to consumption. Each process affects food safety and quality. Engineers help to measure important parameters of process control and predict and/or control the effect of the processes on food safety and quality.

Tracebility

Food safety is the fundamental factor in the food sector that is making traceability relevant as recent studies on food safety show that approximately seven million people a year are affected by food borne illness. Only with an efficient tracing system is it possible to have a prospective product recall (for safety), and effective research into what caused the problems.

According to Webster’s Dictionary, “Traceability is the ability to follow or study out in detail, or step by step, the history of a certain activity or a process”.

Thus traceability can be defined as the history of a food product in terms of the direct properties of that product and/or properties that are associated with that product once these products have been subject to particular value-adding processes using associated production means and in associated environmental conditions (Thompson, 2003a). The information concerning relationships at origin may be used upstream in the supply chain (e.g., in the ordering process to define the requirements of an ordered product), or downstream (e.g., in delivery processes to specify the characteristics of products) (Miotrag, 2001). Additionally, the information can be used for reporting purposes, either in the supply chain or for third parties (European Commission, 2007; UNI, 2001; UNI, 2002).

A targeted and more rigorous definition of food supply chain was provided by the International Organization for Standardization in 1994 (ISO, 2010) as ISO standard 8402:1994 and supported by EC regulation 178/2002 (European Parliament, 2002). This defines “Traceability as the ability to trace and follow a food, feed, food producing animal or ingredients, through all stages of production and distribution” (USDA, 2002).

An efficient and effective system transmitting accurate, timely, complete, and consistent information about products through the supply chain can significantly reduce operating costs and can increase productivity. At the same time, such a system contains many product safety elements: it makes consumers safer by providing detailed information about where an item comes from, what its components and origin are, and about its processing history.

An important related question deals with genetically modified organism (GMO). Genetic modification is being applied to develop new and beneficial characteristics such as increased shelf life or greater resistance to pests (Genetic Modification Advisory Committee, 2002). However, little is known about the long-term health and environmental effects of GMO. There was no real international agreement on either the principles of GMO or the testing methods and thus safety evaluation (WHO, 2002). As a result, customers require suitable information showing whether or not a product contains GMO components, which can only be guaranteed by an efficient tracking–tracing system.

The International Organization for Standardization (ISO) has released a new standard: ISO 22005:2007 - Traceability in the feed and food chain - General principles and basic requirements for system design and implementations. The addition to the ISO 22000 series on food management systems is intended to further ensure the safety of food products for consumers.

According to ISO, the new standard establishes the principles and requirements for the design and implementation of a feed and food traceability system and will allow organizations operating at any step of the food chain to:

- Trace the flow of materials (feed, food, their ingredients and packaging).
- Identify necessary documentation and tracking for each stage of production.
- Ensure adequate coordination between the different actors involved.
- Require that each party be informed of at least his direct suppliers and clients, and more.

As safety hazards can enter the food chain at any stage, adequate control and communication throughout the process is essential, continued an ISO statement. “One weak link in the supply chain can result in unsafe food, which can present a serious danger to consumers and have costly repercussions for suppliers. Food safety is therefore the joint responsibility of all actors involved.”

ISO went on to note how the diversity of retail and private quality schemes in the food industry generates uneven levels of safety, confusion over requirements and increased cost and complication for suppliers obliged to conform to multiple programs. ISO 22005, it claims, “offers a unique solution for good practice on a worldwide basis and thus contributes to lowering trade barriers”.

Food Biotechnology

According to the Codex Alimentarius Commission, biotechnology is defined as the application of 1) in vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and the direct injection of nucleic acid into cells or organells, or 2) the fusion of cells beyond the taxonomic family that overcomes natural physiological reproductive or recombination barriers and is not a technique used in traditional breeding and selection.

The entry of genetically modified organisms (GMO) into the food supply offers the potential for increased crop productivity and improved nutritional value that directly benefits human health and well being. Genetically modified (GM) foods also indirectly benefit human health by minimizing the impact of food production on the environment (Istitute Food Technoligists, 2000; American Medical Association Council, 2000).

Modern biotechnology refers to various scientific techniques used to produce specific desired traits in plants, animals, or micro-organisms through the use of genetic knowledge (Yun-Hwa et al., 2007). Since its introduction to agriculture and food production in the early-1990's, biotechnology has been utilized to develop new tools for improving productivity. In 2005, twenty-one countries planted biotech crops covering a total of 222 million acres. These crops include soybeans, corn, cotton, canola, papaya, and squash that are improved versions of the traditional varieties. In addition, rapid-rise yeast and an enzyme used to make cheese are both commonly produced through biotechnology (ISAAA, 2005).

Biotechnology is a broad term that applies to the use of living organisms and covers techniques that range from simple to sophisticated (Zhao and McDaniel, 2005). For centuries people have crossbred related plants or animal species to develop useful new varieties or hybrids with advantageous traits, such as better taste or increased productivity. Traditional crossbreeding produces changes in the genetic makeup of a plant or animal. The process can be very time-consuming as it is necessary to breed several generations in order to not only obtain the desired trait, but also remove numerous unwanted traits.

In contrast, modern agricultural biotechnology techniques, such as genetic engineering, allow for more precise development of crop and livestock varieties (International Food Information Council, 2004).

The genes that directly express desired traits, such as agronomic performance, are identified more readily. Therefore, the genetic makeup of food-producing crops and livestock can be improved more efficiently.

Gene technology not only provides the potential to select the exact characteristics desired, but it also enables us to transfer genes for desired traits more precisely.

There are three main categories of biotechnology-enhanced crops in use or development.

Enhanced input traits, such as herbicide tolerance, insect and virus protection, and tolerance to environmental stressors such as drought.

- Value-added output traits, such as corn with higher amounts of lysine for animal feed, or vegetable oils with increased levels of omega-3 fatty acids.
- Crops that produce pharmaceuticals or improve the processing of bio-based fuels.

Today, crops in production are primarily those with enhanced input traits.

The use of genetic information to improve livestock selection and breeding, referred to as animal genomics, is an important tool in agriculture today (American Medical Association Council, 2000).

Genomics information can also help in determining optimum nutritional needs for animals. This aids in consistent production of high-quality meat, eggs, or milk.

Cloning is another modern technology that facilitates breeding of the healthiest and most productive livestock. The genetic makeup of the animal is not changed in any way. In fact, this form of assisted reproduction allows livestock breeders to produce an identical twin of the best available animals, which is itself used to breed future generations. As of 2005, foods produced from cloned animals or their offspring were not yet commercially available.

Genetic engineering is another potential tool being explored in breeding programs for food-producing animals. Potential benefits of such advances may include animals that mature more quickly or have enhanced nutritional characteristics, such as pigs that produce pork higher in omega-3 fatty acids.

The product that would most likely be ready for commercialization in the near future is a variety of salmon, currently under regulatory review, that grows to maturity more quickly than its non-biotech counterpart.

The application of modern biotechnology to food production presents new opportunities and challenges for human health (Hsich and Ofori, 2007). The potential benefits to the public health sector include altering the nutrient content of foods, decreasing their allergenic potential, and improving the efficiency of food production systems. On the other hand, the potential effects on human health of the consumption of food produced through genetic modification must be carefully examined. Modern biotechnology must be thoroughly evaluated if it is to bring about a true improvement in our way of producing food.

In the area of food manufacturing, the use of biotechnology falls into 4 main categories, namely: 1) foods consisting of or containing viable organisms; 2) foods obtained from or containing ingredients obtained from GMOs; 3) foods containing single ingredients or additives produced by genetically modified micro-organisms (GMMs); and 4) foods containing ingredients processed by enzymes produced by GMMs. A number of amino acids, enzymes, gums, and other additive ingredients used in food production have been produced by GMMs in combination with bio-fermentation in large quantities at a low cost and with little environmental impact. In the area of enzyme technology, enzymes derived from plants, animals and micro-organisms are used as processing aids for specific functions. While natural enzymes may not survive the processing that the product is subjected to, it is possible to manipulate enzymes obtained from GMMs to boost their thermal stability, thus enabling them to withstand severe processing conditions. GMMs are also used for the production of micronutrients such as vitamins and amino acids for food dietary supplement purposes.

One example of this is the production of carotenoids for use as a dietary supplement to address vitamin A deficiency.

There are multiple benefits of modern food biotechnology (American Dietetic Association, 2006). One benefit is healthier and higher yielding crops. This can mean lower production costs for the farmer. An example is the enhancement of some varieties of corn to contain a common soil bacterium called Bacillus thuringensis (Bt). This allows the corn to protect itself from some insects that can destroy plants and that can reduce the use of insecticides. Other crops are being developed to resist plant viruses and other diseases. Plants naturally have the ability to produce compounds to protect against invading organisms. Natural toxins are found in many foods, and scientists can identify the genes that produce natural toxins.

Another benefit of genetically improved crops is weather-resistance. This can enable some crops to withstand severe weather, extending the growing season and growing regions to make more fruits, vegetables and grains available throughout the year. Regions with poor soil conditions or poor climates can become productive agriculture land. This can also reduce crop loss for farmers. Food biotechnology can develop ways for more food to be grown on less land.

Transferring specific genetic traits in plants can produce fruits and vegetables with ripening qualities that allow them to be shipped farther and longer without spoilage for the arrival of fresher produce with better flavour. Produce can also be grown to resist mold. Modern food technology could make foods safer by detection of food-borne bacteria and viruses. This could result in a decline of food-borne illness.

Some vegetable oils have been enhanced to have less saturated and more monounsaturated fatty acids. Soybeans, canola and other seeds providing oil have been enhanced to have less saturated fat and more oleic acid, is a beneficial fatty acid.

Modern food biotechnology can allow for more advanced crossbreeding of foods, yielding new varieties of foods.

Food biotechnology is developing in many parts of the world and offers great promise for feeding the world. There are many potential benefits of food biotechnology, and as research continues, more benefits will be discovered. Food biotechnology is an approach for producing a high-quality, abundant, healthful and less expensive food supply for the world and for protecting the environment. Nutrient-enhanced crops could help address problems of malnutrition in various parts of the world.

Different GM organisms include different genes inserted in different ways. This means that individual

GM foods and their safety should be assessed on a case-by-case basis and that it is not possible to make general statements on the safety of all GM foods.

GM foods currently available on the international market have passed risk assessments and are not likely to present risks for human health (Society of Toxicology, 2002). In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved. Continuous use of risk assessments based on the Codex principles and, where appropriate, including post market monitoring, should form the basis for evaluating the safety of GM foods.

The safety assessment of GM foods generally investigates: (a) direct health effects (toxicity), (b) tendencies to provoke allergic reaction (allergenicity); (c) specific components thought to have nutritional or toxic properties; (d) the stability of the inserted gene; (e) nutritional effects associated with genetic modification; and (f) any unintended effects which could result from the gene insertion.

The GM Food Regulation

The authorisation and labelling of GM food within the EU is governed by the GM Food and Feed Regulation - EC No. 1829/2003 - and also by the Traceability and Labelling Regulation - EC No. 1830/2003 (Grujc and Blesic, 2007).

A GM food must not have adverse effects on human or animal health or on the environment, must not mislead the consumer and must not differ from the food it is intended to replace to such an extent that its normal consumption would be nutritionally disadvantageous for the consumer. The authorisation process for GM food is set out in Articles 5 to 7 of the GM Food and Feed Regulation (EC No. 1829/2003) while information to assist in the preparation of the application dossier is detailed in Regulation EC No. 641/2004.

The labelling requirements for food or food ingredients containing or produced from GMOs are detailed in Articles 12 and 13 of the GM Food and Feed Regulation. Specific GM labelling is required where more than 0.9% of a food or ingredient is produced from, or contains a GMO, and this requirement is not dependent on the presence of GM DNA or protein. Specific GM labelling is not required if the GM content is no more than 0.9% of the food or ingredient and provided its presence is adventitious or technically unavoidable. The threshold applies to the ingredients considered individually, or to the whole food where a food comprises a single ingredient. To avail of this exemption, operators must be able to show that they have taken appropriate steps to avoid the presence of GM ingredients. Like all food, GM food is also subject to the general food labelling Directive (2000/13/EC, SI No. 92 of 2000) which is based on the principle that labelling must not mislead the purchaser.

GM ingredients authorised for food use are listed on the European Commission website.

Currently, 1 GM soya bean variety, 12 GM maize varieties, 6 GM oilseed rape varieties and 5 GM cotton varieties are authorised for food use in the EU. Most of these crops have been genetically altered to tolerate the application of specific herbicides or resist attack by certain pests.

The terms “GM free”, “Non-GM”, “Made with no GM ingredients” etc. have no legal definition. However, consumers are likely to interpret such declarations to mean that a food carrying any of those claims does not contain any GM ingredients. It is now apparent that some sections of the food industry voluntarily apply these labels to food without ensuring that the food actually does not contain GM ingredients. Many EU Member States, do not recommend “GM free” type labelling as is not required by law, is difficult to validate and is frequently misused by the industry.

The GM labelling threshold provided for in the GM Food and Feed Regulation (EC No. 1829/2003) requires that a food or ingredient be labelled if it has a GM content of more than 0.9%. This "labelling threshold" is intended to cater for adventitious contamination that may occur as a result of mixing during production, processing, storage or transport. However, this does not mean that foods with a GM content of less than 0.9% are considered "GM free". The voluntary labelling of food as "GM free" or words to that effect is covered by the general food labelling legislation and, as with all labels, its accuracy is the responsibility of the operator. A food that contains any level of GM ingredient should not bear a GM free type label as it is clearly misleading to the purchaser in breach of the general food labelling Directive (2000/13/EC).

The general food labelling Directive clearly states that labelling should not mislead consumers by associating special characteristics with a food when all other similar foods possess the same characteristics. For example, to label milk as "GM free" could mislead consumers to believe that GM milk is available on the market when as yet there is no such product available.

Food Security

Food security describes a situation in which people do not live in hunger or fear of starvation. World-wide around 852 million men, women and children are chronically hungry due to extreme poverty; while up to 2 billion people lack food security intermittently due to varying degrees of poverty (FAO, 2003/2004; FAO 2007; United Nations Population Division, 1998).

A direct relationship exists between food consumption levels and poverty. Families with the financial resources to escape extreme poverty rarely suffer from chronic hunger; while poor families not only suffer the most from chronic hunger, but are also the segment of the population most at risk during food shortages and famines (FAO, 1999; WHO, 1998; WHO, 2007).

Two commonly used definitions of food security come from the UN's Food and Agriculture Organization (FAO) and the United States Department of Agriculture (USDA, 2000; USDA 2002):

- Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.
- Food security for a household means access by all members at all times to enough food for an active, healthy life. Food security includes at a minimum the ready availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in socially acceptable ways (that is, without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

The stages of food insecurity range from food secure situations to full-scale famine. Famine and hunger are both rooted in food insecurity. Food insecurity can be categorized as either chronic or transitory. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger; ensuring food security presupposes elimination of that vulnerability. Chronic hunger is not famine. It is similar to undernourishment and is related to poverty. It exists mainly in poor countries.

In 2006, USDA introduced new language to describe ranges of severity of food insecurity. USDA made these changes in response to recommendations by an expert panel convened at USDA's request by the Committee on National Statistics (CNSTAT) of the National Academies.

Even though new labels have been introduced, the methods used to assess households' food security have remained unchanged, so statistics for 2005 are directly comparable with those for earlier years for thecorresponding categories (Table 1).

Table 1. USDA's revised labels describe ranges of food security

General categories (old and new labels are the same)			Detailed categories
	Old label	**New label**	**Description of conditions in the household**
Food security	Food security	**High food security**	No reported indications of food access problems or limitations
		Marginal food Security	One or two reported indications— typically of anxiety over food sufficiency or shortage of food in the house. Little or no indication of changes in diets or food intake
Food insecurity	Food Insecurity without hunger	**Low food security**	Reports of reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake
	Food insecurity with hunger	**Very low food security**	Reports of multiple indications of disrupted eating patterns and reduced food intake

Availability of food, access to food, and risks related to either availability or access are the essential determinants of food security. National food security implies that within a country the amount of food available, if evenly distributed, is enough to meet people's food needs. At the household level, "a household is food secure when it has access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, safety, and culturally acceptable), and when it is not at undue risk of losing such access".

The broad area of food security may be usefully disaggregated into questions relating to adequacy of food availability and stability of both food availability and access.

This approach focuses on conditions necessary to achieve food security and highlights the need to consider both the nature of the food itself and the range of factors determining security of food availability and access.

Adequacy of food availability means that the overall supply should potentially cover overall nutritional needs in terms of quantity (energy) and quality (providing all essential nutrients); furthermore, it should be safe (free of toxic factors and contaminants) and of good food quality (taste, texture, and so on). Last but not least, the types of foodstuffs commonly available (nationally, in local markets, and eventually at the household level) should be culturally acceptable.

Stability of the food supply and of access to food presupposes environmental sustainability, implying that there is a judicious public and community management of the natural resources that have a bearing on the food supply; and also presupposes economic and social sustainability in terms of conditions and mechanisms securing food access (FAO, 2003).

An important condition for nutrition security is health, which is largely a consequence of adequate prevention and control of diseases.

Health is determined by a series of factors that act at three levels. At the community level, factors such as the quality of the overall environment (biological pathogens and chemical pollutants in air, food, and water), and the availability, cost, and quality of services such as water, electricity, sewage, refuse disposal, and health services are important health determinants. At the household level, the most important factors include the general conditions of the household, including the type of housing, the availability and cost of water and hygienic facilities, and the number of rooms per household member (an indicator of crowding); the availability of food; and household caring behaviours related to the use of preventive and curative health services, the use of water and hygienic facilities to provide a healthy, hygienic, and safe environment, and food-related behaviours such as the acquisition of food, the intra-household allocation of resources, feeding practices (including breast-feeding), and food preparation methods. At the individual level, the determinants of health relate to the interactive mechanisms among an individual's food and nutrient intake, nutritional status, and health status.

Around the world and across ethnic groups, food security greatly influences the meanings, values, and benefits a family associates with food. A family who has food security is able to obtain enough food to avoid hunger. As income rises, a smaller percent of the income is used for food. Families with lower incomes spend a higher proportion of their incomes on food. Throughout the world, more money is spent on food than on other categories of activities. Sometimes families experience food insecurity; for those families, the primary role of food becomes satisfying hunger.

Hunger has negative consequences for children, including anemia, developmental and behavioral problems, and learning difficulties. Under-nourished pregnant women are more likely to have low-birthweight infants who are more likely to experience health and behavior problems. Food insecurity also causes anxiety for parents and children.

Because food is connected with so many social benefits, families who face long-term food insecurity are likely to experience more than physical suffering. Social relationships may be impaired; verbal abilities developed through family mealtime interactions might be less developed; the opportunities to negotiate and compromise food choices may be fewer. Families who are not able to be hospitable may lose social status. Therefore, the impact of food insecurity has far-reaching social, emotional, and developmental consequences for families and children.

Food is part of everyone's life. It affects the structure of family schedules and enhances relationships among family members and between families. Food may be a mark of cultural and religious identity. Culture shapes families' food attitudes and behaviors, and families' needs, beliefs, and behaviors impact culture. Because food is an essential part of families' physical and social lives, examining its role in families helps us to understand families in the context of their cultures.

Food Security Initiatives

Informal and formal security nets are important elements of a comprehensive social strategy. The design of effective formal safety nets depends on external government, donor, or NGO assistance and must take into account the nature and determinants of poverty and food and nutrition insecurity in urban areas. Formal safety nets must also ensure that they do not undermine the household's own private logic and response as it deals with falls in income or threats to food and nutrition security.

A number of safety net programs exist, ranging from general price subsidies to cash transfers to specific nutrition interventions. Some general principles about what kinds of programs work best under what conditions do exist, but they are few and in most cases have not been adequately studied. Information on how programs work together to form a complete antipoverty or food and nutrition strategy is lacking. In any case, programs will have to be adapted to local conditions, so situation-specific information is critical to the process of program choice and design (FAO, 2006).

Community involvement in such identification of priorities and appropriate design and implementation is critical to sustainability and success. External support of a process through which the poor can redefine the relationships among themselves and with local authorities may be just as important as support of a specific project intervention.

In February 1999 USDA launched the Community Food Security Initiative. This nationwide initiative seeks to forge partnerships between USDA and local communities to build local food systems, decrease need, and improve nutrition.

Community food security is a relatively new concept with roots in a variety of disciplines, including community nutrition, nutrition education, public health, sustainable agriculture, and community development.

Community food security programs encompass a wide variety of community-based efforts to increase the quantity, quality, and affordability of food for local residents, especially for low-income residents.

Some of these programs improve food access for low-income households and support rural communities by strengthening traditional ties between farmers and urban consumers.

Examples of community food security programs include the following:

- *Food stamp outreach programs* help increase the number of eligible households that participate in the Food Stamp Program and reduce dependence on emergency food assistance providers.
- *Farmers markets* boost incomes of small, local farmers and increase consumer access to fresh produce.
- *Community gardens* help public housing residents and other low income consumers supplement their diets with home-grown produce.
- *Food buying cooperatives* help families save money by pooling food purchases.
- *Community-supported agriculture programs* help provide small farmers with economic stability and consumers with high-quality produce, often at below-retail prices.
- *Farm-to-school initiatives* help local farmers sell fresh fruits and vegetables directly to school meal programs.
- *Food recovery programs* rescue wholesome food that would otherwise be thrown away and provide the food to groups that serve the needy.

Food Quality

Food quality is the quality characteristics of food that is acceptable to consumers. This includes external factors as appearance (size, shape, color, gloss, and consistency), texture, and flavour; and internal (nutritional, chemical, physical, microbial) (Perez-Gago et al., 2006).

Food quality is an important food manufacturing requirement, because food consumers are susceptible to any form of contamination that may occur during the manufacturing process. Many consumers also rely on manufacturing and processing standards, particularly to know what ingredients are present, due to dietary, nutritional requirements (kosher, halal, vegetarian), or medical conditions (e.g., diabetes, or allergies).

Besides ingredient quality, there is also sanitation requirements. This is important to ensure the food processing environment is as clean as possible in order to produce the safest possible food for the consumer.

Food quality also deals with product traceability, in terms of ingredient and packaging suppliers in the need for a recall of the product. It also deals with labeling issues to ensure there are correct ingredient and nutritional information as well.

Food quality has become a central topic in agriculture and food industry; a complex scientific and technological debate aimed at the definition of quality concept is at the moment in progress. Dramatic events such as BSE, dioxin, pesticides and hormones contaminants, and the increasing number of pollution-related cancers, focus consumers and industry attention on safety.

Respect to the past a different idea of quality is gaining ground. The modern concept is summarised in the "quality profile" of a product that include different aspects of its value. In addition to that, a specific request for effective guarantees and product certification is performed by producers and consumers.

Quality involves a deep re-organization of farms and production technologies. Control systems, certification standards, the whole business management have to be checked in function of the new point of view.

Scientific institutions can support producers by setting up new technologies (biological, organizational and computerized), according to criteria of quality and safety.

Food composition assessment and new technologies for food production are the focal points in the modern approach. It should be pointed out that substantial changes occurred over the past few years in the production and processing of certain classes of food (organic foods and light products).

In order to increase competitiveness on the world market, farmers have addressed their efforts towards the achievement of qualitative targets aimed to meet both the needs of technological processes and safety requirements. The selection of crop strains and the use of new techniques for growing and preserving food (e.g. integrated pest control, preservation of cereal grains by refrigeration) are examples of this trend.

As far as food processing and preservation techniques are concerned, production is increasingly oriented towards the use of mild technologies characterised by extremely selective and minimal treatments. The global effect is a reduction of thermal and mechanical damage as well as chemical and biological contamination. This approach has been extensively applied in the manufacturing of fat containing foods, with particular regard to products containing saturated fatty acids and cholesterol. Manipulation of composition was traditionally performed in the sector of meat production even though dairy products are a group of food in which changing of composition is becoming more and more frequent. The fastest-growing products in this sector are the low-fat or "light" foods. In this case, modification of legislation was necessary in order to provide consumers with a an adequate information.

The increasing consumption of functional foods and herbal products is another characteristic of the modern request in industrialised countries. The inclusion of these products in a normal diet was considered, in the traditional definition, to promote well-being and health.

Functional foods are defined as products in which key nutrients had been added in order to increase their intrinsic health benefits. This category include a wide range of products in which the original matrix is modified by the addition of vitamins or minerals or other bioactive compounds. This large group include also probiotics, prebiotics, symbiotics, bioactive peptides and lipids, fibre and vegetable extracts. A different category of products are dietary supplements composed by purified form of multimicronutrients and distributed in form of pills or other pharmacological preparations. This group comprises also the large category of herbal products.

In the same way, the market shares of cereal grains, and the so-called "wholemeal" products (biscuits, crackers, etc.) are increasing steadily since consumers appreciate the physiological and metabolic benefits of their higher fibre content.

Data on the composition of foods commonly consumed are provided in tables, but the growing number of foods on the market and their continuous evolution makes it essential to update the nutrient composition reported in the tables, especially regarding to micronutrients (vitamins and trace elements) and other components that are recognised to play a role in the prevention or control of a number of pathologies.

Traditionally the relationship between nutrition and health was attributed to food composition in term of macronutrients. In the modern context, a relevant role is now ascribed to minor compounds such as fibre, antioxidants, vitamins and other bioactive substances.

The role of bioactive compounds in preventing chronic metabolic diseases such as cardiovascular affections is largely recognised. The promotion of typical products (controlled and certified in EU legislation), and the protection of traditional foods, often out of the rules but with an intrinsic guarantee of quality are an added value.

REFERENCES

American Dietetic Association (ADA). (2006). Agricultural and Food Biotechnology, http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/advocacy_abiotechnology_ENU_HTML.htm

American Medical Association Council on Scientific Affairs Report. (2000). Genetically Modified Crops and Foods, http://www.amaassn.org/ama/pub/category/13595.html

Beier, R.C., Pillai, S.D. (2007). Future directions in food safety. In: Shabbir, S., editor. Foodborne Diseases. Totowa, NJ: Humana Press. p. 511-530.

Buzby J.C., Roberts T. (1996). ERS Updates US Foodborne Disease Costs for Seven Pathogens. Food Review, 19:3 20-25.

European Commission. (2007). Health and Costumer Protection- Food traceability. Direcotorate-General for Health and Consumers, Brussel

European Commission. (2000). The European White Paper on Food Safety. COM (1999) 719 Final, Brussel

European Parliament. (2002). Regulation (EC) No. 178/2002 of the European Parliament and of the Council. Official Journal of the European Communities, L31/1–L31/24.

FAO. (1999). Food and Agriculture Organization of the United Nations Understanding the Codex Alimentarius. ISBN 92-5-104248-9.

FAO. (2003-2004) The State of Food and Agriculture: Agricultural Biotechnology Meeting the Needs of the Poor?

FAO. (2006). Climate change will affect future food availability.Adapting agriculture, forestry and fisheries policies and practices to climate variability, Nairobi/Rome,

FAO. (2007). Countries urged to be more vigilant about food safety. ROME/GENEVA.

FAO/WHO. (2002). PAN-European Conference on Food Safety and Quality. Budapest.

Food Safety Authority of Ireland. (2005). GM Food Survey. Dublin. www.fsai.ie

Genetic Modification Advisory Committee (GMAC). (2002). Biosafety guidelines. Electronic citation from www.gmac.gov.sg

Grujic S., Blesic M. (2007). Food Regulations; Banja Luka: Faculty of Technology

Hsich Y.H.P., Ofori J.A. (2007). Innovations in food technology for health. Asia Pac. J. Clin. Nutr., 16 (suppl. 1) 65-73.

http://ec.europa.eu/dgs/health_consumer/library/pub/pub06_en.pdf.

http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/006/Y5160E/Y5160E00.htm

http://www.toxicology.org/ai/gm/gm_food.asp

Institute of Food Technologists. (2000). IFT Expert Report on Biotechnology and Foods. http://members.ift.org/IFT/Research/IFTExpertReports/

International Food Information Council (IFIC). (2004). Food Biotechnology.

International Service for the Acquisition of Agri-Biotech Applications (ISAAA) (2005). Global Status of Commercialized Biotech/GM Crops www.isaaa.org

ISO, International Organization of Standardization, (2010). http://www.iso.org

Lin D., Zhao Y. (2007). Innovations in the Development and Application of Edible Coatings for Fresh and Minimally Processed Fruits and Vegetables. Comprehensive Reviews in Food Science and Food Safety, 6 (3) 60-75

Miotrag, M. (2001). Food safety – Using technology to improve traceability. In: Proceedings of CIES convention. Amsterdam. 21–34.

National Center for Food and Agricultural Policy (NCFAP). (2005). Plant Biotechnology: Current and Potential Impact for Improving Pest

Management in U.S. Agriculture. http://www.ncfap.org/whatwedo/pdf/2004biotechimpacts.pdf

Perez-Gago MB, Serra M, del Rıo MA. (2006). Color change of fresh-cut apples coated with whey protein concentrate-based edible coatings. Postharvest Biol Technol., 39,84–92.

Society of Toxicology Position Paper. (2002). The Safety of Genetically Modified Foods Produced Through Biotechnology. Toxicological Science, 71, 2-8

Sudhakar P., Nageswara R. R, Ramesh B., Gupta C.P.(1988). The economic impact of a foodborne disease outbreak due to Staphylococcus aureus. Journal of Food Protection, 51, 11

Thompson AK. (2003 a). Preharvest factors on postharvest life. In: Fruit and vegetables. Ames, Iowa: Blackwell Publishing Ltd. p 1–8

Italian Standards Institute (UNI). (2001). Traceability system in agricultural food chain – General principles for design and development. Norma UNI 10939:2001, www.uni.com.

Italian Standards Institute (UNI). (2002). Traceability system in agrofood industries – Principles and requirements for development. Norma UNI 11020:2002, www.uni.com.

United Nations Population Division. (1998). World Population Prospects: The 1996 Revision. New York.

United States Department of Agriculture. (2000). Food and Nutrition Service. The National Nutrition Safety Net: Tools for Community Food Security, Food and Nutrition, 314,

USDA (United States Department of Agriculture). (2002). Traceability for Food Marketing & Food Safety: What's the Next Step? Agricultural Outlook/January–February 2002, pp21–25.

WHO. (1998). Food Safety- a world-wide public health issue. Internet WHO Homepage http// www.who.ch/.

WHO. (2002). Food safety programme. Electronic citation from the World Health Organization at http://www.who.int/fsf.

www.ific.org/food/biotechnology/index

Yun-Hwa Peggy Hsieh, Jack Appiah Ofor. (2007). Innovations in food technology for health. Asia Pac J Clin Nutr 16 (Suppl 1):65-73.

Zhao Y., McDaniel M. (2005). Sensory quality of foods associated with edible film and coating systems and shelf-life extension. In: Han JH, editor. Innovations in food packaging. San Diego, Calif.: Elsevier Academic Press. p 434–53.

Recived: 10.04.2010.
Accepted: 17.07.2010.