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REVIEW PAPER

641.3.002.2:664.001.76

THE SIGNIFICANCE AND POSSIBILITY OF FUNCTIONAL FOOD PRODUCTION

Abundant knowledge of the significance of food quality for all human living functions as well as growing human population and the occurrence of world "hidden hunger", directed food producers toward new production processes of and new product development that must satisfy the specific needs of different categories of consumers. The differences are reflected in sex, age, religious affiliation, activity, health, social status etc. "Organic", "natural", minimal processing, functional (and often called "therapeutical") food nowadays represents the key interest of nutritionists, physicians and food producers. Such food should have a beneficial influence on human health, besides satisfying the nutritive and energetic necessities, by protective, prophylactic and healing performance. This paper discusses facts about the influence of food on human health, problems of malnutrition in developing and developed countries, presents states of food production in the world and in Yugoslavia, legislation and regulations on nourishment and food production, the disadvantages of former concepts of development of this production and possible directions of future trends with a particular review on functional food production.

FOOD AND HEALTH

There are many factors that influence human health, but nourishment is one of the more significant ones. This is confirmed by many new scientific investigations in the field of medicine that indicates the beneficial or detrimental effects of some food ingredients. The influence of nourishment begins in the intrauterine period when necessary nutrients are transported by the mother's blood. The nutritive status of the mother before and during pregnancy can influence the fertility, pregnancy and possibilities of complication, as well as the general health of the baby. Some ingredients of food substantially affect the development of some tissue and systems, as well as their physiological functions during growth. Many chronic diseases such as hypertension, obesity, hipercholesteremia, cardiovascular disease, cancers, etc. are results of nutrition beside stress and other states that influence the physiological and mental state of organisms.

The two main functions of nourishment are to provide substances for growth and energy requirements of an organism at the physiological-biological level. Through metabolic and chemical reactions nutrition also contributes to the emotional and mental state of organisms. Additionally, some nutrients with special functional activity prevent and reduce the detrimental effect of food and the environment. The mechanisms of their effect are different but they can be generally related to the evolution and functioning of the gastrointestinal (GI) tract, immune system functions and the evolution of neurological functions and behavior, as well as the evolution of bones [1].

ACTUAL NOURISHMENT PROBLEMS

There are over one billion people in the world, especially in developing countries, that are starving

because there is not enough food for daily nutrition. Halve of them are seriously compromised by the consequences of malnutrition. Besides the lack of satisfying energy requirements, there is a wide prevalence of micronutrient malnutrition such as vitamins and minerals. Daily doses of vitamins, minerals, proteins, lipids etc. are recommended by government health authorities in order to prevent the symptoms caused by their deficiency. The estimate is that the necessary amount of vitamins and minerals can be obtained by fresh, unprocessed food such as fruit, vegetables, cereals etc. [2]. However, the main nutrient content in these foodstuffs can be varied depending on the soil, as well as on the conditions of their growth.

Many micronutrients cannot be resorbed entirely from foods. For instance, cereal fibers bind minerals that might contribute to their deficiency. Refined foods contain only part of the nutrients compared to raw food. During cooking, part of the water soluble vitamins are destroyed and minerals and residual vitamins remain in the cooking water. Organic food (food that does not contain residual pesticides and chemicals or additives) contains almost ten fold more vitamins and minerals compared to plants from chemically treated soil. Antioxidants such as β -carotene, vitamins C, E and A are also deficient in normal nutrition. As antioxidants, they prevent the rapid aging process since they have a notable role in the prevention of oxidative damage of cell structures and sensitive biomolecules [3].

The rapid growth of the human population during the last three decades and the necessities for sufficient food supply led to the "green revolution" cropping system in agriculture, especially in developing countries. The significant increase of soil productivity by modern agricultural efforts led to increased yields of crops (high-yield sorts, mineral fertilizer without microelements, chemical protection) but decreased nutritive values of food. So the "green revolution" led to a new dangerous crisis that can be prevented by developing new agricultural programs. These programs must no longer focus the agricultural community only on staple food production as the primary goal. They must

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Paper received: December 26, 2001
Paper accepted: March 4, 2002

recognizes the urgent need for agriculture to concentrate on producing enough food of high nutritional quality and diversity to satisfy a balanced diet for all people thereby insuring healthy and productive lives [4,5,6].

The negative consequence of "*green revolution*" cropping systems is micronutrient malnutrition the so called "*hidden hunger*", clearly demonstrated in several world regions especially in poor nations. For example, in South Asia, the introduction of modern wheat and rice production practices (which resulted in about a 200% increase in rice production and a 400% increase in wheat production over the past 30 years) is associated with trends in the growth of iron deficiency anemia among non-pregnant, premenopausal women, and negatively related to trends in the iron density (mg Fe per kJ of available food) of diets. The same types of negative associations are also found in data collected from China, Sub-Saharan Africa, South America, Middle America/The Caribbean, and Southeast Asia [7].

Thus, the use of modern cereal cropping systems (wheat, corn, rice) in many developing countries has been paralleled by a decreased per capita production of traditional foods having a higher micronutrient density such as legume seeds and pulses (beans, lentil, peas, etc). This has resulted in the lower availability of foods rich in micronutrients and micronutrient malnutrition especially in developing countries.

The former text could mislead the readers that micronutrient malnutrition and "*hidden hunger*" are not present in developed countries. In developed countries the "*green revolution*" has not emerged in the same form in the global plan of crops, but among poor people that are one third of the population. However, some factors have led to "*hidden hunger*" among wealthy people such as the commercialization of food. Present food producers prefer the sensory characteristics (flavor, aroma etc.) that make food favorable and more profitable. This is attained by some processing methods and additives that are often not natural, but natural identical or synthetic. There is no doubt that "*natural identical*" is an expression that is a marketing characteristic. The goal is to obtain inexpensive products that look like natural ones, which provide higher prices and bear more profits. Those approaches to food production led to similar effects in developed countries such as the "*green revolution*" effects in developing countries.

It is obvious that the consequences of food production and processing are global, deep and deceitful. The health condition of the population will decrease and thus reduce the productivity and stability of society [5,6]. The magnitude and profound consequences of micronutrient malnutrition to human health and well being require a new "*greener*" revolution. This new revolution should explicitly link agricultural production to human nutrition and health with the goal of eliminating "*hidden hunger*" globally and providing dietary nutritional balance to all in sustainable ways.

Factors contributing to the required reshaping of nutrition include:

- an aging population,
- increased health care costs,
- advancing scientific evidence that diet can alter disease prevalence and progression [8].

THE ARRIVAL OF A "GREENER" REVOLUTION

Even 400 years before Christ Hippocrates claimed that food could be a remedy. Such an opinion still remains up to date and exists among all world cultures. Thus, for example in the Indian subcontinent food healing was often practiced and in the Muslim region called "*Hikmet*", and in Hindu/Buddhists regions "*Ayurveda*". There is the firm opinion in our ethnics that some food can heal or prevent disease. There is the saying: "An apple a day keeps the doctor away".

However, at the same time as formal medicine developed the traditional insight into food healing properties faded. "*Hidden hunger*" and the "*green revolution*" led to increased interest in the investigation of food health effects among the public, as well as the scientific society. In the mid-seventies of the twentieth century Japanese scientists established that some food components have a significant effect on health maintenance, strengthening immunity and modulating the human physiological system.

In Japan three functions of food were reported by the Japanese authorities:

1. nutritional value
2. good sensory quality
3. activity on the physiological system – to strengthen and modulate the physiological system.

The first two characteristics of food are well accepted because: the primary function of food is to help the body to keep alive and the second is to satisfy the sensory flings of consumers (taste, aroma, color etc.).

The third function of food is to demonstrate the special physiological performance in regard to strengthening and modulating the physiological system. This function is the result of new demands of nutritionists and consumers. The first legalized form of "functional food" was introduced in Japan in the mid-nineties grouped under FOSHU (Foods for Special Health Uses). After that functional food production was firmly accepted in the USA and in other developed countries.

There is no universally accepted definition of functional foods; however, several organizations have attempted to define this emerging food category. According to one definition functional food is the normal daily intake that has a health supporting activity beside the nutritive value. The Institute of Medicine of the National Academy of Sciences (USA) limits functional foods to those in which the concentrations of one or more ingredients have been manipulated or modified to enhance their contribution to a healthful diet [9].

According to these definitions, unmodified whole foods such as fruits and vegetables represent the simplest example of a functional food. For example, broccoli, carrots, or tomatoes would be considered functional foods because they are rich in such physiologically active components such as sulforaphane, beta-carotene, and lycopene, respectively. Modified foods, including those that have been fortified with nutrients or enhanced with phytochemicals or botanicals, also fall within the realm of functional foods.

Although the term "*functional foods*" may not be the ideal descriptor for this emerging food category, recent American market research showed that this term was recognized more readily and was also preferred by consumers over other commonly used terms such as "*nutraceutical*" or "*designed foods*" [10]. Recent broad use and acceptance of the term "*functional foods*" by media, scientists, and consumers has led dietetic organizations to work within this framework rather than introduce a new, more descriptive term, because of concern that new terminology could lead to further confusion among consumers. As the many organizations of dietetic professionals, classify all foods as functional at some physiological level, the term functional food should not be used to imply that there are good foods and bad foods. All foods can be incorporated into a healthful eating plan—the key being moderation and variety [11].

Functional foods can be observed as the *third generation* of food according to beneficial health effects, so called "*health foods*". The foodstuffs of the *first generation* were fruit juices, yogurt, and whole grain breads etc. that were produced in the mid-seventies. The second generation of health food appeared in the mid-eighties and reflected the increased worry of consumers about some ingredients of food such as lipids and sugars, thus the market offered foodstuffs with reduced contents of these ingredients. The *third generation* of foodstuffs – functional foods are the result of a decreased conscience of consumers and scientific knowledge about the causality of some food ingredients and disease prevention. The further development of health and nutrition sciences has lead to the *fourth generation* of foodstuffs based on improved agriculture products (organic food) and their processing by modern treatment processes.

SOME ASPECTS OF FUNCTIONAL FOODS HEALTH EFFECTS

The scientific evidence for functional foods and their physiologically active components can be categorized into 4 distinct areas:

- (a) clinical trials,
- (b) animal studies,
- (c) experimental *in vitro* laboratory studies, and
- (d) epidemiologic studies.

Much of the current evidence for functional foods lacks well-designed clinical trials; however, the

foundational evidence provided through other types of scientific investigation is substantial for several of the functional foods and their health-promoting components.

For the *first group of foods* the definite scientific evidence of positive health effects exists. The strongest scientific evidence of clinical efficacy is for functional foods that are available or have been developed in accordance with the NLEA guidelines (Nutrition Labeling and Education Act, 1990) for preapproved health claims. For such foods, there is substantial scientific agreement among scientists that a diet-disease relationship exists. Scientific support under the NLEA includes all types of research from *in vitro* to randomized, controlled clinical trials and focuses on the reduction of common chronic diseases in the United States. The NLEA act is presented in Table 1.

Table 1. The NLEA act of the FDA contains the definition of model claims for functional foods [12]

Nutrient-relation to disease	Model claim
Fat and heart disease	Diets low in saturated fat and cholesterol may reduce the risk of heart disease
Calcium and osteoporosis	Regular exercise and a healthy diet with enough calcium helps teen and young adult white and Asian women maintain good bone health and may reduce their high risk of osteoporosis
Sodium and hypertension	Diet low in sodium may reduce the risk of blood pressure, a disease associated with many factors.
Dietary fiber and cancer	Low-fat diets rich in fiber—contain grain products, fruits, and vegetables may reduce the risk of some types of cancer, a disease associated with many factors.

Basic examples of functional foods that fall into this realm are foods naturally rich in soluble fiber, such as oat bran or psyllium, which have been associated with reduced incidence of coronary heart disease and cancers [13]. Another example would be fruits and vegetables and the association between increased consumption and reduced risk for cancer [14] or coronary heart disease [15]. Soy protein is an additional example; however, a final regulation authorizing a health claim related to soy protein intake and reduction of risk for coronary heart disease has yet to be issued by the FDA [16].

The *second group* of functional foods has substantial scientific support, but currently lack a FDA-approved health claim because the food industry has not yet petitioned the FDA. Examples would be garlic [17] and n-3 fatty acids found in fish [18], which have been shown in clinical trials to reduce serum

cholesterol levels in persons with elevated levels. This group of functional foods might also include new products such as the plant sterol-enriched table spreads that have been shown in clinical trials to significantly reduce serum cholesterol levels in persons with mild to moderate hyperlipidemia [19].

A *third category* of functional foods are those that have been fortified to enhance the level of a specific nutrient or food component that has been associated with the prevention or treatment of a disease or other clinical condition. Many of these products bear authorized health claims for product marketing. This category would include products such as calcium-fortified orange juice, pasta, or rice marketed to maintain good bone health and reduce osteoporosis risk, as well as fiber-supplemented snack bars or folate-enriched cereals. Many other functional foods in this category may lack sufficient evidence to warrant an authorized health claim at this time. This would include, for example, beverages with added vitamin E for reduced heart disease risk and salad dressings with n-3 fatty acids to reduce the inflammatory response of rheumatoid disease.

A *fourth category* of functional foods includes whole foods that have been associated with reduced risk of disease. For these whole foods, *in vitro*, *in vivo*, or epidemiologic research is available to support the health benefits of these whole foods; however, no health claim exists, partially because of the limited or improperly designed clinical trial data or lack of scientific agreement as to the strength of the evidence. This category includes:

- tomato products rich in lycopene, a carotenoid, the consumption of which is associated with reduced cancer rates in epidemiological studies [20];
- eggs with n-3 fatty acids, which may potentially reduce cholesterol levels [21];
- black and green tea, which are rich in polyphenols, has been associated experimentally and in human studies with cancer prevention and control [22];
- non-digestible oligosaccharides (prebiotics), especially fructans, which may potentially provide health benefits for cardiovascular disease, type 2 diabetes, and intestinal infectious diseases [23, 24];
- fermented dairy products (probiotics), which have been shown to improve gastrointestinal health [25] and
- dairy products and red meat with conjugated linoleic acid, which may alter cancer carcinogenesis [26].

For each of these, an association with reduced disease risk has been observed but has not reached scientific consensus.

Finally, there exists a growing selection of functional food components marketed under the umbrella of dietary supplements. For the majority of these products, the evidence for their structure/function claims is currently limited, incomplete, or unsubstantiated. Examples include antioxidant-enriched

beverages or candies, chewing gum with phosphatidylserine, and snack bars with chromium. This category also includes a large number of herbal-enriched products that make a variety of structure/function claims. Examples include cereal fortified with *ginkgo biloba*, which is marketed as reducing symptoms of dementia, or juices with *echinacea*, which are marketed for boosting the immune system. Both claims do have support in controlled clinical trials [27,28]. Other evidence for botanical-enriched products have shown conflicting results in clinical trials such as the use of *echinacea* to reduce cold and flu symptoms [29] or kava to reduce anxiety [30]. Still other structure/function claims have no clear therapeutic efficacy, such as the use of *ginseng* for energy or enhanced physical performance [31]. It was found that some herbals that are used for therapies (for example *ma huang*) might be harmful [32]. Historically, evidence for the clinical efficacy of select botanicals was limited primarily because of poor research design (eg, inconsistency in dosage form or amount, small sample size, and frequently the lack of a placebo control, in part resulting from insufficient funding for research in this area). Yet many of these botanicals are being introduced into our food supply, sometimes irresponsibly, in the form of functional foods that point out the need for additional research in this emerging area.

Evaluation of the efficacy of individual functional foods must be completed using a scientifically valid risk-benefit model that clearly assesses all physiological effects, both positive and negative. Review of the *in vitro*, animal, epidemiological, and clinical data is essential before functional foods are marketed to consumers for their health-promoting qualities [33].

The idea behind functional foods is to make foods suited to avoid undernourishment, especially "*hidden hunger*", with some special ingredients or to prevent against diseases such as cancer or heart attack. Functional foods always address certain groups of persons which have specific problems as they cover only one or at best a few of all specific dietary needs. They cannot substitute natural healthy foods. In addition, functional foods do not help in the case of acute diseases.

TECHNOLOGICAL ASPECTS OF FUNCTIONAL FOODS PRODUCTION

Food technology as a profession is responsible for the technical aspects of the development of food products, food processes and the distribution of these products to consumers. The task of the food technologists was always that raw materials be processed in such a way that food be more digestible, sensory (organoleptical) acceptable, safe, eye-catching, and commercially acceptable for producers and consumers.

Each of these tasks is still imperative for food technology but even stronger nowadays. The global

nutrition problems presented in the former text and consumer demands for functional foods assign new tasks for food technology. The major ones are:

- less processing with the goal of maintaining the nutritive and functional value of food, as well as reducing expenses of production in regard to reducing market costs,
- enriching the nutritive and functional values of foods, and
- reducing the harmful influence on the environment.

The most important is that food technology cannot be considered as a separate part of food supply but as an integral part of the new European "farm to table" approach. Food technology as a profession is responsible for the technical aspects of the development of food products, food processes and distribution of these products to consumers. The ultimate target of these efforts is the satisfaction of objective consumer needs (e.g., nutrition, safety, affordability) as well as subjective aspects of consumer satisfaction (e.g., organoleptic properties and consumer attitudes) for a broad spectrum of consumers: younger, older, with different religious affiliations and limitations, different economic status or energetic requirements, etc. All of that must be in the context of foods that are nutritive, valuable, dietetic, healing-preventing etc. The quoted demands the food industry must be fulfilled when many false development directions for sufficient foods supply have been established with the main goal of greater profits. These directions led to dramatic situations, as well as to general hysteria ("*hidden hunger*", mad cow disease, cattle fodder contaminations, *Listeria* outbreaks, etc.) that undermined consumer confidence in food producers. The food industry must reply to the demands for the production of totally safe food for restoring consumer confidence. Thus it must adhere only to the right solutions for food production according to the concepts "*farm to table*" (because of sanitary aspects) and "*sustained development*" (because of environment protection).

These new concepts require the rigorous establishment of analytical control of raw materials, processing and engineering, packaging and delivery and avoid the "*critical hazards point*" (which require the development of faster analytical techniques) and avoid microbiological and chemical contamination. Beside that the phenomenon of foods from GMO (genetically modified organisms) in world market that provoke distrust and potential hazards, require the introduction of specific techniques of quantitative detection, as well as precise and universal legislations for food production (see below). Food technology must find the answers to all of these challenges. This can be achieved by a systematic, multidisciplinary approach with biological and medical knowledge along with the introduction of modern technology and intensive development.

The former text demonstrates that complete functional foods are rare. Some native groceries fulfill

functional food demands more or less so that for obtaining complete functional foods some processing is indispensable. This is one of the assignments of food technology.

No matter in which form foods are delivered from producers to consumers (semifinished or finished – so call *convenience food*), the goal is for it to be more functional. A food can be made "functional" by:

1. applying any technological or biotechnological means to maintain or increase the concentration of, add, remove or modify a particular component as well as to
2. improve its bioavailability.

Certainly that the imperative of food technology is to maximally maintain the nutritive and functional ingredients content during the processing of raw materials. Food processing encompasses the following operations: mechanical grinding, separation (edible from non edible parts), composition (combination of nutritive and functional ingredients quality and quantity) thermal and diffusion operations, many chemical and microbial, as well as enzymatic reactions (chemical and biotechnological transformations), canning, as well as packaging, storage and delivery. Many of these processes can influence the nutritive and functional value of food either positively or negatively. Diffusion and especially thermal processes can cause negative changes. They are necessary in some cases to increase digestibility, reduce undesirable ingredients, as well as conserve foods. Consequently, the improvement or replacement of these processes is the subject of many studies. Investigations of the application of new technological processes such as: high-pressure processes, new electromagnetic and separation techniques, synergy-based techniques make technological treatments more efficient with maximal maintenance of food quality. At the same time new fast analytical techniques and biosensors can ensure the precise qualitative and quantitative measurements of ingredients, microbial and chemical contaminants, as well as reaction products from food processing.

Since there is limited space in this study, we shall turn to thermal and biotechnological processes as we have sufficient personal experience.

Although they can be the cause of undesired changes, thermal operations are some times unavoidable for increasing digestibility, thermal destroying undesired ingredients, drying or concentrating, as well as for preserving food.

Several industrial techniques can be applied for concentrating and drying foodstuffs such as drum and spray dryers, as well as vacuum dryers. Lyophilization as a top-quality drying technique is unattainable for industrial scale food production because of high costs. During the last two decades many attempts have been made for developing fluidized or spout-fluid-bed layer drying techniques [34]. The latter technique is of special interest for the food industry because of many advantages such as low drying temperature (below 100°C), short retention time (below one minute), smaller

dimensions, completely automatic control and regulation possibilities, etc. Our own investigations of the spout–fluid–bed layer drying of food showed that this technique ensures moisture decrease to 5% with the maintenance of nutritive and functional ingredients of food [35, 36]. In addition, a high degree of maintaining probiotic bacteria viability (*Bifidobacterium* sp. and *Lactobacillus* sp.) was achieved during the drying of multicomponent products that can be functional food [37,38].

Some foodstuffs may have unbalanced concentrations of functional ingredients that also may differ from the optimal concentration established in scientific investigations. Some ingredients isolated from foods alone may have harmful effects for specific population groups. For example, isolated or synthetic β -carotene preparations increased lung cancer incidence in smokers. On the other hand, β -carotene as a natural food ingredient decreased lung cancer occurrence in the same population [39]. Such harmful effects of nutrients are rare but it is undoubtable that they must be considered for the future design of investigations, as well as for recommendations for their use as preparations or food additives.

Another advantage of for complete foods is that the dietary constituents appear to act synergistically to improve the absorption of nutrients or physiologically active dietary components. One example is lycopene in tomatoes and the enhancement of its absorption when consumed along with fat [40]. Since they are natural foodstuffs that obey functional food claims more or less, it is obvious that their combinations in a unique product with technological operations that can improve and maintain the nutritional and functional quality, may be an approach in functional food formulation. However, a food combination in itself, even in optimal relations, does not always mean optimal results. In some cases quality improvement requires specific technological processing such as, for example, biotechnological transformations.

Many microbiological or enzymatic process as can be used for biotechnological transformations for the improvement and/or conservation of food. One of the microbial processes for specific nutritive and functional effects is fermentation by various microorganisms (bacteria, yeast, and fungi). The content of some beneficial ingredients of food, especially vitamins, can be increased by fermentation process. For example, a product fermented with the yeast *Saccharomyces cerevisiae* contains more thiamin, biotin and nicotine acid. It has been noticed that the South African population that consumed African bear was less afflicted with pellagra (a disease based on vitamin deficiency). Idly, the plant-based product from India that is fermented with lactic acid bacteria is rich with thiamin and riboflavin [41]. Fermented cow milk (yogurt, cheeses, etc.), as well as plant beverages (soymilk, vegetable juices, etc.) fermented with probiotic lactic acid bacteria was presented on the market as functional

foods almost a decade ago. According the FAO (Food and Agriculture Organization of the United Nations), fermentation has a notable role in safe food supply for a billion people in the world. The functional value of fermented food is achieved throughout prolonged duration, nutritive value enrichment and antinutrient elimination. In addition, fermented food is often more digestible compared to non-fermented, because the microbial enzymes decompose the polymeric ingredient of food during fermentation (starch, cellulose, proteins etc.) [42]. For example, lactic acid bacteria degrade the starch molecules from oatmeal to smaller oligosaccharides that decrease the viscosity and increase the energetic value of the meal.

In the past decade there have been many investigations at the Faculty of Technology and Metallurgy, University of Belgrade in the field of biotechnological improvement of the functional value and quality of food and food additives. As a result of these investigations a multicomponent additive to functional foods was obtained based on soymilk, brewery yeast autolyzate and beetroot and carrot juices. The results have been published in several publications [38,43–46] and presented at scientific conferences [47–51]. The characteristics of this product are high nutritional value (the base ingredients are proteins, lipids and carbohydrates), a high content of micro- and macronutrients and vitamins and pre- and probiotics. Additionally, investigations at a meat product showed that a probiotic culture from a powdered product retain the viability and antibacterial activity against some pathogenic bacteria that could contribute to the prolongation of the shelf life of the meat product [52].

Cattle and crop productions and their improvement from a viewpoint of nutritive and functional components content, as well as environmental protection, is also very important for functional food production. There are several ways for the agricultural improvement of the nutritive value of crops. For example, the use of organic fertilizers with both macronutrient (N, P, K, and S) and certain micronutrient (Zn, Ni, and Se) contents can have significant effects on the accumulation of micronutrients in edible plant products [53, 54]. Crop management is another tool that can be used to improve the micronutrient output of farming systems. For example, using certain legume crops in rotation with cereal crops can result in substantial increases in the concentration of Zn in cereal grain in areas where soil-Zn is currently limiting wheat production [55].

The basic agricultural productions, both farming and cattle breeding, are essential for functional food production. The obligation of the food industry is to be the initiator and active participant of implementing changes according to the concept "*farm to table*".

Foremost is the improvement of productivity and farming land quality, 37% of the soil surface is utilized for farming in attendance. A significant area (about 100.000 ha in Vojvodina) of remaining soil is rarely suitable for

agriculture or exploited for other existential purposes. An increasing population and industrial expansion will occupy new areas of fertile land in the future that may affect hunger in the world. Consequently, it is necessary to improve the fertility of farming land or transform non-fertile land to farming land. Several possibilities are possible. For example, the use of organic fertilizers (in combination with minerals), crop rotation, the use agro biochemicals (biopesticides, bioinsecticides, biofertilizers), the utilization of bred or GMO crops, etc. The details surpass the scope of this review a mention of GMO – *genetic modifying organisms* is necessary.

Genetically modified foods (GMF) or "novel foods" obtained from genetically modified organisms (GMO) attract much consumers attention especially in the past few years in Europe. Modification by the DNA (deoxy nucleic acid) recombinant technique is applied for the improvement of existing or adding new characteristics such as:

- resistance to stress factors,
- increased fertility,
- increased content of nutrient and functional ingredients,
- eliminated or decreased content of antinutrients and allergens, etc.

Genetically Modified Organisms according to the Gentechnikgesetz (GenTG) in Germany are organisms the genetical material of which was modified in a way which is not found in nature under natural conditions of crossbreed or natural recombination. A Genetically Modified Organism must be a biological unit which is able to multiply itself or to transmit genetic material.

Although GMOs have great potential for food quality improvement, consumers are suspicious and even hostile toward GMO because of ignorance of long-term consequences.

LEGISLATION OF FUNCTIONAL FOOD PRODUCTION AND MARKETS

As claimed previously the first investigations on functional food production originate from Japan where FOSHU was introduced. Nowadays there are over 150 products that are FOSHU authorized.

In the USA it has been permitted by a court decision from 1987 ("Health claim") that functional foods can be labeled. The Food and Drug Administration (FDA) allowed a number of functional food labelings such as "Food X can reduce risks of disease Y" [56]. Functional foods are viewed as one option available to Americans seeking cost-effective health care and improved health status.

There are still discussions about defining and legislating functional foods in Europe. The necessity for outlining this area has increased since 1996 when the first genetically modified crop plant, was released onto the European market. The GMO soybean (RR soy) was the first and after that GMO maize (BT-176 maize) [57]. These two varieties were released onto the European

market prior to enforcement of the European Regulation on Novel Foods and Novel Food Ingredients (258/97). This regulation stipulates how novel food products should be evaluated with respect to their safety for the consumer and also includes regulations regarding the labelling requirements of food products derived from genetically modified organisms (GMOs). Additional regulations guarantee that RR soy and Bt-176 maize are subject to the same labelling regulations (1139/98).

Last year the labelling requirements were further modified in regulation 49/2000. This change ensures that all food products containing more than 1% of GMO-derived material should be labelled as such. Within the framework of this regulation two additional products were authorised to enter the market: processed products from a tomato with delayed ripening characteristics, produced by Zeneca, UK; and a riboflavin produced by a bacterium (Hoffman La Roche). In the near future, quite a few other GMO-derived products can be expected on the European market, which is not surprising considering the number of GMOs that are already submitted for evaluation under this regulation and the number of crop plants that are currently being developed within Europe.

GM Food can be emerge on the market in many definite forms such as [58]:

- fresh products (fruit, vegetables, live bacteria in bio-yogurts) that have no modified DNA;
- processed products (canned meat, fruit and vegetables, concentrated tomato) with denatured DNA;
- products obtained by biotechnological modification accessory goods (genetically modified curdling enzyme – hymozine);
- products from genetically modified raw materials but not modified themselves, thus contain the same chemical content (sugar from GM beet);
- GM plants resistant to plant diseases or herbicide (for example soybean resistant to glyphosate).

The European Commission adopted a White Paper on Food Safety in 2000. The central goal of the European Commission is the achievement of the highest possible level of health protection for the consumers of Europe's food. The White Paper sets out a radical reform plan: a major programme of legislative reform is proposed to complete the EU's "farm to table" approach as well as the establishment of a new European Food Authority. Achieving the highest standards of food safety in the EU is a key policy priority for the European Commission and the White Paper bears testimony to this priority. The guiding principle throughout the White Paper is that the food safety policy must be based on a comprehensive, integrated approach. The Commission also decided on the allocation of food safety and industrial policy responsibilities. The new legal framework will cover animal feed, animal health and welfare, hygiene, contaminants and residues, novel food, additives, flavourings, packaging and irradiation. It will include a proposal on a General Food Law which will embody the principles of food safety such as:

- the responsibility of feed manufacturers, farmers and food operators,
- the traceability of feed, food and its ingredients,
- proper risk analysis through a) risk assessment, b) risk management, c) risk communication

Therefore, the EU intends to seriously pass a regulation about the safety and quality of food including functional food. However there is a prohibition of labeling the healing properties of food in Germany. But, there is also a clear tendency for food labeling that includes:

- Enhanced function claims – interactions of a food component and specific functions in the body are given. There are no direct references to diseases given. Some examples of enhanced function claims are:

- Strengthening the immune functions
- Antioxidants, acting against oxidative stress
- Restore or stabilize bacterial intestinal colonies such as the stimulation of *Bifidus* bacteria (*Bifidobacterium longum*)
- Bioavailability of minerals by milk oligopeptides or inulin.

- Disease risk reduction claim according to some European legislations include:

- Cardiovascular diseases
- Intestinal infections
- Diarrhea, constipation
- Osteoporosis
- Non-insulin dependent diabetes or obesity

Digestive products dominate the European Functional Foods market. The US market addresses a wide range of health conditions such as arthritis, cholesterol, blood pressure lowering, insomnia, immune boosters and vision enhancers. They are called "*Health Food*".

It is necessary to emphasize that although genetic engineering can provide significant results in the nutritive and functional value of food the GMO foods still remain prohibited in the EU and in some parts of the world because of insufficient investigations on risk consequences.

THE CONDITION AND POSSIBILITY OF FUNCTIONAL FOODS PRODUCTION IN YUGOSLAVIA

Realizing the world's trends in functional foods production, as well as conditional factors of production and marketing, the question of interest is our agroindustry is qualified to produce and our market to accept functional foods.

First of all, the possibility of raw materials for functional food must be perceived. Nowadays there are several companies that have developed production following the principle of "*organic agriculture*". The first ones are "TERRA" from Subotica, the model "*Power of nature*" – Agroekonomik from Belgrade and the model "*Natura vita*" Cooperative Association of Serbia from Belgrade. The organic agriculture of TERRA's model was developed in Vojvodina and is oriented toward grain, oil seeds, vegetables and medicinal herbs. The

other two models were developed in Serbia proper for fruit growing and cattle breeding.

These activities are undoubtedly not sufficient and even less connected or organized. It is considered that just about 0.3% farming land is included in cultivation according to ecological principles, which is miserable. At the same time the legislated EU areas for organic agriculture have increased each year. The goal is that in following five years most European countries will possess over 10–20% organic agricultural lands. Austria is surpassing that and has almost attained that goal (267000 ha of organic agricultural land). It is followed by Italy, France, Germany, England and Spain. Other countries are joining this program. The best index for that is the data that 95000 ha of organic agricultural land in 2000 has increased to 360000 ha up to date [59]. Therefore, food from organic agriculture in developed countries is recording a 20% increase per year. For example, in USA last year it reached a 6 billions US\$ profit. It is important that all governments of developed countries and transitional countries support the programs of organic agriculture.

Disregarding the unsatisfactory current conditions, our country possesses significant areas of ecological farming land that may be suitable for organic agriculture. Many crops and other plants with beneficial fitonutrients can be bred in these areas. There is no doubt that our potential for plants raw materials for functional foods production is strong. The lacks of education of manufacturer, as well as organization and processing control are some of main problems.

Scientific cooperations (scientists from medicine, nutritionists, technologists, biotechnologists etc.) for functional foods formulations is essential before production is organized on an industrial or small manufacturing scale. This is especially significant because several faculties and institutes have developed, but not commercialized some functional food products. The criteria and legislation of functional foods production is also important because of possible manipulations of producers. It requires more government activity and that of its official services which must recognize the significance of functional foods production.

Although education of the population about proper nourishment has been neglected and directed toward individual groups of people (through specialized education at schools or faculties) or reduced to newspaper articles, there is increased interest in "health food". This interest represents a chance for functional foods production that the food industry and biotechnology must not miss. Government institutions must support these efforts.

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IZVOD

ZNAČAJ I MOGUĆNOSTI PROIZVODNJE FUNKCIONALNE HRANE

(Pregledni članak)

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Obimna saznanja o značaju kvalitetne hrane za životne funkcije čoveka, rastuća svetska populacija i pojava "skrivena glad" (nedostatak mikroelemenata i vitamina u ishrani) i posledice koje iz toga nastaju u svetu i kod nas, usmeravaju proizvođače hrane na nalaženje novih postupaka proizvodnje i novih proizvoda kojima bi se zadovoljile specifične potrebe različitih kategorija potrošača, različitih s obzirom na pol, starosnu dob, etničku pripadnost, aktivnost, zdravstveno stanje, socijalni status i slično. "Organska", "prirodna", minimalno procesirana, funkcionalna (i danas sve češće nazivana "terapeutska") hrana trenutno predstavljaju ključni interes nutricionista, lekara i proizvođača hrane i reakcija su na dramatična zbivanja u svetu prouzrokovana pojavom "ludih krava" i GMH (genetski modifikovana hrana), toksika u stočnoj hrani *Listeria* sp. u mesu i mesnim prerađevinama i sl. da bi se proizvela funkcionalna hrana, koja pored ispunjenja svih nutritivnih i energetske potrebe, treba da poboljša opšti zdravstveni status ljudskog organizma delujući protektivno, profilaktički i lekovito. Za ostvarenje tog cilja potrebna je nova sveobuhvatna promena dosadašnjeg koncepta u proizvodnji hrane. Taj nov koncept mora se bazirati na dva osnovna principa, principu EU nazvanom "od farme do trpeze" ("*fam to food*") i svetski prihvaćenom principu "*održivog razvoja*". Ona zahteva punu integraciju svih činilaca proizvodnje hrane, počevši od obrade zemljišta, uzgoja stoke, preko procesiranja hrane i njene isporuke kupcu sa imperativnim ciljem da se zadovolje sve stroži zahtevi kupaca i maksimalno očuva prirodni potencijal u proizvodnji hrane tj., očuva životna sredina. Imperativni su i precizna kvantitativna i kvalitativna analitička i operativna kontrola u svim fazama proizvodnje (HACCP, ISO9000 i ISO14000) kao i stroga zakonska regulativa.

U cilju sagledavanja navedenih trendova u svetu u ovom radu izneti su podaci o uticaju hrane na ljudsko zdravlje, o problemima ishrane stanovništva u nerazvijenim i razvijenim zemljama, sadašnjem stanju u proizvodnji hrane u svetu i kod nas, zakonodavstvu i regulativama u domenu ishrane i proizvodnje hrane, nedostaci dosadašnjeg koncepta razvoja u toj proizvodnji i mogućí pravci budućeg razvoja, sa posebnim osvrtom na proizvodnju funkcionalne hrane.

Istaknuto je da u našoj zemlji postoje značajne mogućnosti u ovoj oblasti proizvodnje koje za sada nisu iskorišćene. Organizacijom u ovoj proizvodnji kroz povezivanje svih relevantnih segmenata te proizvodnje (proizvođača, prerađivača i potrošača), korišćenjem postojećeg prirodnog i ljudskog potencijala, donošenjem sveobuhvatne zakonske regulative uz podršku (finansijsku i moralnu) vlade i njenih institucija, naša zemlja bi mogla ostvariti značajan prodor na svetsko tržište, ostvariti značajan devizni priliv i uposliti veliki broj sada nezaposlenih. Mnoge zemlje Evrope to su već učinile ili se za to intenzivno i serižno pripremaju. Mi šansu imamo i moramo je iskoristiti.

Ključne reči: Funkcionalna hrana • Zdravstveni efekti • Proizvodnja • Zakonodavstvo •
Key words: Functional food • Health effects • Production • Legislation •

