Hungarian fruits and vegetables of high anti-oxidant activity as functional foods *(Review article)*

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Summary: Recently, projects aiming to enhance the consumption of fruits and vegetables are intensified. Experts agree in the principle of fresh vegetable foods being a valid panacea in averting risks of ailments as well as curing immune-insufficiency, inflammations, moreover, certain cancerous processes. It is generally accepted that among substances of biological activity the anti-oxidant compounds such as vitamins C, E and carotenoids, etc. have the major role in this process. Hungarian agriculture has outstanding chances in utilising its natural as well as cultivated plant resources and favourable climatic conditions. It would be, however, necessary to build up a databank of anti-oxidant substances found in fruits and vegetables and including the modifying effects of technology, growing site, variety, etc. The concept of promoting the trade of Hungarian food-specialities as "Hungaricum" needs, urgently, the aid of a databank of that kind. Some of those excellent products are for instance the sour cherry, pepper and onion. They enjoy high priority as "Hungaricum" in the EU and it should be enhanced by intense and consequent research work, which may prove their role as functional foods. The USA is the leading country in research on the anti-oxidant substances of sour cherries, and up to now more than 17 compounds have been found in Hungarian varieties among others. In pepper fruits used as vegetable and source of vitamin C, the analyses are still lacking because research of the past concentrated on the products of milled spice pepper. Onion and garlic are entirely unexplored in this respect. It should be noted that availability of these fresh products in the moderate climate is restricted to a relatively short season. For that reason, some processing and preservation methods are needed in order to use those fruits and vegetables as functional foods all around the year. The scientifically founded endeavour as a solution of the questions mentioned is stimulated by vigorous commercial interests as well as by the urgent needs of the consumers to improve their health.

Key words: anti-oxidants, horticultural crops, fruit, vegetables, functional foods, Hungaricum

Introduction

Basic foods of the prehistorical man came from the wild growing seeds and fruits (berries), shoots and roots, completed with some animal resources, the latter being maintained up to the present, however, with progressing conglomeration and urbanisation of civilisation the share of foods of vegetable origin decreased dramatically. It went so far that in the 16th and 17th century some distinguished experts doomed fruit consumption to be noxious (*Kőrösi, 1939*). Nutrition as a science has been revolutionised in the 20th century, modern biochemistry has formed, essential vitamins and mineral substances have been detected. After the 1930's, medical science revised the former thesis about fruit consumption and revealed the indispensable role of "useful substances" of fruits and vegetables in the prevention and curing of certain diseases. Oriental cultures has known it already for several millennia and the vegetarian diet has represented a system of mastering the challenges of urbanised life, the scarcity of natural resources included.

A theses allegedly of Hippocrates stated on the same empirical basis: "We are depending on our diet". "*Your food should be your medicine, and your medicine should be your food.*" A decisive pioneer of this idea in the western world has been Edmond Bordeaux Székely of Hungarian descent, who founded the International Biogenic Society in 1928 together with Romain Roland, the Nobel prize winner (*Székely, 2002*).

In spite of the huge body of accumulated scientific facts, industrial food production prevailed in the last decades which disregarded the inner content of the product. Ancient customs of fruit and vegetable consumption seem to be

justified, however, with arguments of biochemistry and even molecular biology. The popularity of projects promoting healthy nutrition gained worldwide acceptance. In Hungary, this tendency aims to improve public health as well as agricultural economy (*Bíró* et al., *1997; Lugasi & Hóvári, 2000*). The former purpose is supported by scientific research on nutritional factors related to oncological processes, immunological insufficiencies and senescence, the main field of this research is the study of anti-oxidant compounds (*Anonymous, 1996*).

The present study is assigned to explore this field of interest, the role of anti-oxidants present in fruits and vegetables, in preserving health and the introduction of these products as "functional foods" to the market of commodities are discussed.

General biological importance of anti-oxidants

Relevant literature stated (*Passwater, 1999*) that in 1954, Denham Harman revealed the noxious effect of free radicles emerging as a result of enzymatic processes and environmental impacts (e.g. smoking), which contributes, lastly, to the senescence of the human body. In addition to senescence, the un-paired electrons of the free radicles may cause diseases too. They are responsible for cancer, arthrytic complaints, cataract, immunological disorders, cardio-vascular diseases, etc. The anti-oxidant compounds are considered to be hopeful remedies, which are designed to catch the free radicles, thus they are valid supporters of the biological defence mechanism (*Fodor* et al., *1997*). Their beneficial effect is derived from the fact that the lacking electron of the emerging free radicles will be paired with an electron of the compound in question. Most common anti-oxidants are the carotenoids, vitamins E and C, the flavonoids, some mineral substances, which occur mainly as constituents of enzymes involved mainly in anti-oxidant defence, etc. Some of the compounds are products of the body itself – those are the endogenous anti-oxidants – others are coming from foods, which are the exogenous anti-oxidants (*Passwater, 1999*). As far as the relevant compounds are lacking in the substrate the free radicles, – which may occur in the human body as peroxyl (ROO), hydroxyl (HO), hydrogen peroxid (H_2O_2), superoxid-ion (O_2^-), „singlet" oxygen ($^1O_2$) and peroxy-nitrit ($OONO^-$) (*Halliwell, 1991*), – will catch an electron from the living substance of the respective cells thus damaging the health of the body. The anti-oxidant molecule itself having neutralised the free radical may become a weakened radical, which in turn needs to be regenerated by another synergent anti-oxidant molecule. For instance, alfa-lipid-acid and pycnogenol are anti-oxidants, which regenerate the used up vitamin C, which may prolongate the anti-oxidant capacity of vitamin E (*Passwater, 1999*).

About the endogenous anti-oxidants

As explained earlier, endogenous anti-oxidants are compounds – mainly enzymes and sulphurous substances – which are produced by the human body. Such compunds are the superoxid-dismutase, the glutation peroxidase and the catalase enzymes, which need to be complemented by mineral substances.

The superoxid-dismutase enzyme (SOD) produces noxious hydrogen-peroxide out of the noxious superoxid ion (O_2^-), which in turn may be neutralised by the glutation peroxidase and the catalase enzyme. The superoxid anion damages the human body by attacking the membranes of nerve endings together with other free radicals, or alternatively, damages important proteins and amino acids, e.g. of L-arginin, which is transformed to a deleterious peroxy-nitrite ion. The accumulation of free radicles may result in the deterioration of nerve terminals causing Parkinson-disease (*Vizi, 2003*). Important role is assigned in the prevention of the disease to the SOD enzyme, which needs a completion with Zn, Cu and Mn. Manganese is defending against free radicals within the mitochondria, whereas the health of cytoplasm is dependent on copper and zinc. Copper found mainly in pulses, liver and soya-meal, would be beneficial, however, combined with iron it becomes noxious because of catalising the peroxidation of lipids and transforms Fe^{2+} into Fe^{3+}. This process induces the development of superoxid anion, as a deleterious free radicle (*Fehér, 2000; Gárdián* et al., *1999*).

The enzyme glutation-peroxidase (GP) dissociates the hydrogen-peroxide, which was raised by superoxid-dismutase, so the end product will be water. To the action of this enzyme (GP) selenium (Se) is indispensable, though being considered earlier harmful as it is toxic if consumed at higher doses. The lack of glutation-peroxidase or selenium may allow peroxidase processes in the organism, which cause the death of myocardial muscles with fatal consequences. That disease has been coined with the name Keshan syndrom because in that region of China where the soil and its vegetable products contain very low quantities of selenium people are frequently exposed to it (*Pais, 1997*). Besides the prevention of myocardial disorders selenium is active in inhibiting plug formation in the vascular system, moreover, it increases the ratio of HDL ("beneficial") cholesterol by lowering the rate of LDL ("harmful") cholesterol, thus serving the health of the heart. Investigations of the last five years at the Cornell University and the University of Arizona proved that the daily intake of 200 µg selenium lowered the mortality caused by cancer of the prostata by 65%, of the colon and the anal region by 58%, of the lung by 46%, and of other cancerous processes by 39% (*Anonymous, 2003c*). According to a joint professional committee of the WHO, the FAO and the International Agency of Atomic Energy (IAEA), a daily dose of 20–70 µg selenium is needed by an adult man in order to preserve his health, whereas higher doses than 400 µg/day become harmful (*Anonymous, 1996*). Convincing proofs are though lacking, the presumption seems highly probable that in the etiology of AIDS peroxidative mechanisms of free radicals are involved, which are likely to

be counteracted by anti-oxidants, as glutation-peroxidase combined with selenium (*Pais, 1997*).

The enzyme catalase (CAT), like GP, dissociates the hydrogen-peroxide created by the enzyme superoxid-dismutase, producing - conditioned by the presence of iron - water and oxygen (*Fehér, 2000*).

The most important exogenous anti-oxidants and their effects

Vitamin E, a lipotropic compound has been discovered by Herbert M. Evans in 1922 at the laboratory of the University of California (*Jones, 2002*). The naturally occurring compound is identified by d-alpha-tokoferol marking, whereas the artificial variant contains the dl-alpha group. Both variants are found in the vascular sytem of muscles, and it should be kept in mind that. *Leong* (*2002*) proved the 40–60-fold higher efficiency of α-tokotrienol in neutralising free radicles compared to α-tokoferol, so it has also a nerve-protecting effect. Tokoferol counteracts the radicles of superoxid and lipid-peroxid in a fat substrate of cells by releasing hydrogen atoms from the phenolic hydroxyl groups to meet the harmful radicles. As vitamin E is effective against the lipid-peroxid radicles, it is important as a means to inhibit peroxidase of multiply unsaturated fatty acids (*Novák & Nyitrai, 2001*). Vitamin E is protecting the erythrocytes, inhibiting blood clotting and the sedimentation of LDL cholesterine in the arterial vessels leading to arteriosclerosis. Anti-oxidant effect of vitamin E has been the subject of several authors, one of those, *Harman* (1968) explored the life expectancy of mice after having been fed by a diet containing 0.5% vitamin E. He stated that the low dosis increased the life span of the animals by 5% (*Passwater, 1999*).

Anti-oxidant effect of vitamin C is highly dependent on pH and the presence of oxygen, metals as well of certain enzymes (*Bauernfeind & Pinkert, 1970*) - it passes down one hydrogen to the free radical, and so ascorbinic acid changes to dehydro-ascorbinic acid. Dutch students tested the effects of various anti-oxidants against the Alzheimer disease during the 1990's. It turned out that more than 133 mg/day of vitamin C lowered the risk of the disease by 34% compared to those persons, who consumed less than 95 mg/day (*Engelhart, 2002*). *Herbert* (*1996*) claims that substantial difference has been observed between the efficacy of vitamin C taken in through the diet – where the compound is present in reduced as well as oxidised form at the same time – and the preparates, which contain the reduced form only, because in the latter case the reduced vitamin C of the tablets meets with the iron (III)-ions of the organism and reduces them to iron (II)-ions, which are liable – under those conditions – to form harmful radicles. The free radicles of iron(II)-ions and the reduced vitamin C together are rather pro-oxidative instead of being anti-oxidative, thus more harmful than beneficial for health (*Herbert, 1996*).

Vitamin A is represented by its pro-vitamins, the carotenoids ,which are absorbed with weak efficacy, one of their well known representants is the ß-carotene, which is built up with double bonds being able to neutralise the free radicles in the fatty substrate of cells. It is important to note that more than 600 carotenoids have been identified up to now. There is a distinct group of carotenoids, the xantophylls which contain in addition to carbon and hydrogen also oxygen, (*Passwater, 1999*). Their anti-oxidant activity eliminating the free radicles is connected with corroborating the immune system of the human body. The lycopene of the tomato is one of the most important anti-oxydant neutralising the "singlet" oxygen. *Moorhead* (*2002*) states that the astaxanthin occurring in marine organisms is 10 times more efficient than β-carotene, and 550 times more than vitamin E because it is able to neutralise radicles in watery as well as in lipotrop substrates.

Compounds of the flavonoid type with a skeleton of diphenyl-propane, are known in cca. 4000 forms and are considered to be secondary metabolites of plants. They are anti-oxidants, anti-phlogistics, anti-cancerogenes, and protect the LDL cholesterol from oxidation, moreover, enhance the effect of vitamin C. An experiment in Finland proved the reduced risk of heart attack and apoplexy due to flavonoids (*Knekt* et al., *1996*). *Winston* (*2002*) reports that useful compounds of soya, as saponins, iso-flavonoids, phytosterols are beneficial in fighting against cancerous processes in breast, lung, prostate, stomach and bowels. The ratio of flavonoid-type compounds in the diet is of great importance in evaluating their biological effects. Estimates claim that the American population takes 1 g/day flavonoids, including cca. 100 mg flavonols and flavones. In the Netherlands the daily intake is 23 mg, 48% of it is derived from black tea, 29% from onion, 7% from apple. The Danish consumers take 28 mg flavones, flavonols and flavonones (*Lugasi & Hóvári, 2000*).

Chlorogenic acid, which is not a flavonoid, and other polyphenols lower the cholesterol level of blood, prevent cancerous processes and lipid-peroxidation, moreover, block those enzymes, which activate the pre-carcinogenic substances (*Stevens* et al., *1995; Lazarov & Werman, 1996*). *Lugasi* et al. (*1999*) maintain that the anti-oxidant capacity of chlorogenic acid is superior to ß-carotene and the synthetic BHA (butyl-hydroxy-anisol), but inferior to vitamin E. *Corder* et al. (*2001*) see the beneficial effect of polyphenols in the inhibition of the peptide, endothelin-1, which is seemingly a key factor responsible for diseases of the vascular system.

Anti-oxidant compounds of some fruit and vegetable species

As indicated in earlier, research aimed to reveal the beneficial effects of bio-active compounds in fruits and vegetables was by no means a novel endeavour. Medical science has only concentrated on the "useful substances" of horticultural products are indispensable for controlling some diseases since the formation modern biochemistry. As a

remarkable fact, in 1980 József Kiss, the author of the book "Catechism of dealing with health", wrote about the role of "fruits" in preserving health. At the moment, many workshops, all over the world, are studying the anti-oxydants. In the USA, research focuses on sour cherry, garlic, cabbage, soya, etc., in Hungary, spice (milling) pepper, garden beets and a couple of fruit and vegetable species are examined, whereas in Finland the high quercetin content of apple and onion is at stake.

Research on the anti-oxidant content of sour cherry in the USA

The subject of the American attempts is an established sour cherry variety, *Montmorency* and a Hungarian variety named *Balaton*, acclimatised in 1984; there it has been grown as *Újfehértói fürtös* since long. According to the results, 17 different anti-oxidant compounds have been identified in sour cherry. They are useful in controlling cancer and heart diseases, arthritic complaints and also headache (*Muraleedharan, 2002*).

Anthocyanines of sour cherries, that have been studied at the Michigan Sate University, are inhibitors of the COX enzymes and of colon cancer, moreover, they have a role in the defence of arterial vascular system against different injuries. *Muraleedharan (2002)* being a researcher of the sour cherry project was the first to identify the anthocyanines of sour cherries in1999. As a historical fact, we shall mention that *Gasztonyi & Lásztity (1992)* described some of the anthocyanines already: cyanidine-3-rutinoside, cyanidine-3-glycoside, cyanidine-3-sophoroside and cyanidine-3-glykosilrutinose. The quantity of anthocyanines of sour cherry is highly dependent on the variety or type of variety. The "morello" type *(Balaton)* contains more of antocyanines than the "amarello" type *(Montmorency)*, the latter produces it in the peel of the fruit, only.

Reiter (2002) claims – as a renown American hormon expert – that melatonine, which is identical to the hormon produced by the pieal gland of the brain, is an important anti-oxidant of sour cherry since it is active in neutralising the harmful effects of free radicles in lipotropic as well as hydrotropic substrates of the body. In the Health Centre of the Texas University it was stated that *Montmorency* fruits contain more melatonine than human blood under natural conditions, i.e. 13.5 nanogram/g (*Reiter, 2002*).

Raymond Hohl found at the University of Iowa that sour cherry produces also perillyl alcohol (POH), which is claimed to be a remedy of all kind of cancerous diseases. POH deprives the cancerous cells of all those proteins which are indispensable for their growth. In animal experiments the effect of POH has been tested with carcinogenes of breast and prostate gland, and it turned out that the risk of breast cancer has been lowered by 81%, and it cured the advanced stage at a rate of 75% (*Hohl, 2002*).

Due to the work of the Cherry Marketing Institute, American consumers are familiar with the beneficial effects of sour cherry, thus nowadays most of the adult and elderly consumers prefer to eat sour cherry or to drink 100% cherry juice instead of taking various pharmaceutical products (*Anonymous, 2002a*). In 2000, the Amway Corporation of the USA spent two million USD for exploring the chemistry and the technology of the variety *Balaton* as well as for clinical experiments, preparing extracts of the active ingredients, commercial preparation, marketing and advertisement (*Holczer, 2001*), and according to our information, 6 patents have been registered.

Anti-oxidant substances of the pepper fruit

Research related to this subject started a century ago and the number of papers on it amounts to several hundreds. Abroad, the *capsaicinoid compounds* – which are causing the pungent (hot) taste – have been first explored for their anti-oxidant properties, intensely. As many as 7 capsaicinoids have been identified. The most frequently met compounds are the capsaicin (8-methyl-*N*-vanillyl-6-nonenamid) and the dihidrocapsaicin, which are responsible for 90% of pungency. *Yahia & Padilla* (1998) followed up the question, how quantitative changes in capsicinoids are related to the activity of peroxidases. As a result, they stated that the diminution of capsaicinoids increased the harmful effect of perxidases in the tissues of the pepper fruit. *Slickman* et al. (1999) compared the anti-oxidant ability of capsaicine with those of the artificial BHT and of melatonin. The claimed that capsaicin has been much more potent against the harmful radicles of the human body than melatonin but not better than BHT.

In Hungary, several researchers investigated the anti-oxidant vitamins of spice pepper grown at Kalocsa and at Szeged, the centres of pepper growing (*Biacs* et al.,*1992*, *Daood* et al., *1996*). They measured concentrations of the most efficient vitamins C and E as well as carotenoids, as changing during maturation, processing and storing. The results revealed a growing tendency of anti-oxidant vitamins except for ascorbinic acid, which increased up to a certain stage of reddening, then declined. Artificial drying – of cut pieces by ventillation in an exsiccation box – increased the content of most vitamins of anti-oxidant effect because relative content of ß-carotene and of vitamin E was higher after drying than before, however, vitamin C content decreased. The milled spice pepper – with 0.5 µm particle size – lost its anti-oxidant activity after 90 days in storage. Vitamin E was affected the most. For the sake of historical fidelity we have to note that Albert Szent-Györgyi developed the technology to produce a concentrate of red pepper with high vitamin C content in 1935, which got the designation of „Vitapric" (*Farnadi, 2000*). The preservation of the high vitamin content in spice pepper powder needs, however, special measures by protective gas atmosphere during milling and storing according to the Hungarian patent of Károly Ereky and Béla Dörner in 1943 (*Ereky & Dörner, 1943*).

Anti-oxidant substances of the vegetable (large, succulent) pepper varieties have not been charted yet. In Germany 100% juices are offered as "cocktails" *(Anonymous, 2003b)*.

Anti-oxidant compounds of other vegetable crops

Several countries participated in the campaign of searching beneficial effects of flavonoids found in vegetables. In Finland e.g. flavonoids were tested, between 1967 and 1992, as remedies of heart diseases. It has been stated that the high quercetin content of apple and onion proved to be efficient as a dietary complement. In the University of Hawaii flavonoids have been useful in the treatment of lung cancer. Convincing arguments witness the positive results achieved with patients by administering fruits and vegetables. Beneficial effects are attributed to quercetin in apple and in onion as well as to naringenin in grapefruit (*Engelhart, 2002*). *Lugasi* et al. (1999) determined the content of chlorogenic acid and of total polyphenols in fruits of tomato varieties. They attempted to answer the question, whether different levels of nitrogen fertiliser will change the concentration of polyphenols in tomato fruits. The answer was definitely negative, however, the level of polyphenols depends rather on the tomato variety, and varies between 13.6 and 15.4 mg / 100g of the fresh mass of the fruit. Industrial processing diminished the polyphenol content. *Lugasi & Hóvári (2000)* analysed the content of the most important flavonoids (quercetin, kaempferol, myricetin, apigenin, luteolin) in vegetables collected on thirty-one different markets of Hungary. In 2002, the same tests have been performed on 45 fruit samples (*Lugasi & Takács, 2002*). As a result, the highest flavonoid concentration in vegetable crops has been shown in spinach (338.6 mg/kg, including 272.2 mg/kg of quercetin), whereas among fruits walnut was the winner, in which the myricetin content alone attained 4.565 mg/kg. None of the flavonoids listed above has been found in grape, peach, banana, orange, grapefruit, mandarin, almond, pistach, raisin, date and fig. The data obtained may serve as a basis for assessing the supply of flavonoids for the Hungarian population necessary for preserving health. *Takácsné* et al. *(2003)* dealt with the bio-active substances and the ability of garden beet varieties to catch free radicles in order to prove scientifically their role in medicine. Studies have been performed in the Laboratory for Molecular Biology and Free Radicles at Szeged. The total anti-oxidant activity of several varieties has been assessed (*Takácsné* et al., *2003*). *Daood* et al. focused on anti-oxidant vitamins (vitamin C, E and carotenoids) of different horticultural products, e.g. the mentioned spice pepper, tomato varieties, persimmon (*Diospyros kaki*), etc. The state of maturity, different kinds of processing as well as effects of storing have been considered too (*Daood* et al., *1992; Daood* et al., *2000*).

Recently, the National Institute for Fighting against Cancer of the USA spent 20 million USD to reveal the anti-tumor effects of vegetable matters and foods, and rated garlic, soya, cabbage, ginger, fennel and other umbelliferous vegetables as being the most efficient (*Winston, 2002*).

The era of functional foods: special value of fruits and vegetables

The concept of functional foods appeared first in Japan in 1991. Since then, legislation has not dealt with the new concept neither in the European Union, nor in the USA (*Rechkemmer, 2003*).

The meaning of functional foods involves in Japan that the food in question is acting not only as a nutrient but also as a compound strenghtening the defense mechanism of the body, a contribution to the prevention of diseases – e.g. diabetes, hypertension – and improves the physical state of the body, etc. (*Bíró* et al., *199; Rechkemmer, 2003*). In Japan, functional foods are grouped into two categories (*Anonymous, 2002b*). The FOSHU (Foods for Specified Health Uses) or as the Japanese say „tokutei ho kenyo shokuhin" interpreted by the Health Food & Nutrition Food Association (JHNFA) as "Foods for Specified Health Uses (FOSHU)" means that the foods contain components, which act on the function and the structure of the organism. These foods are utilised for the maintenance of health in the digestive tract, pressure and colesterin level of blood". The distinction (logo) of FOSHU is given by the Ministry of Health, Labour, and Welfare (MHLW). In 1993, ten FOSHU products have been offered in the Japanese market. This number grew to three hundred until 2002, 80% of which represented preparates containing *Lactobacillus* (*Bailey, 2002*). In 1994, the Japanese Ministry of Health classified the components promoting health into twelve categories. The components are: vegetable fibers, sugar alcohol, protein constituents, glucosides, alcohols, vitamins, colin, lacto-bacteria, mineral substances, unsaturated fatty acids, and other substances, e.g. anti-oxidants (*Goldberg, 1994*). An other catergory of foods has existed in Japan since April 2002: "Food with Nutrient Function Claims (eiyo kino shokuhin)", which means that a unit of the respective food contains as much vitamins and mineral substances – twelve vitamins and two minerals – as the daily requirement of the consumer. This category of food – which has not been accepted by the MHLW – is sold not only as a food, but also as a complement (capsule, tablet). More than a hundred Japanese enterprises endeavoured to develop the technology and marketing of functional foods (*Anonymous, 2003a*).

In Canada, tablets and powders derived from foods though not considered as "foods" are coined as "Nutraceuticals". Those preparates are intended to prevent chronical diseases and to strengthen the physiological status. Food industry of the USA calls the functional foods as "health-promoting foods". According to a survey, 44% of the citizens are convinced that the use of drugs may be decreased by adequate diet, and 64% believes also that food consumption is tightly related to health. In North-America, selected foods are distinguished by the attribute "health claims", and admitted by the US Food and Drug Administration (FDA). Their success is demonstrated by the data of 1999, when 17.6 billion USD of the total 67.6 billion USD food sales was from functional foods (*Mazza & Oomah, 2002*).

Functional foods started to be accepted in Europe with the foundation of the organisation „Functional Food Science in Europe (FUFOSE)" of the EU, which is coordinated by the „International Life Science Institute Europe (ILSI Europe)". Between 1996 and 1999, the European team developed scientific criteria for the definition of functional foods: „Any food may be considered as functional if, in addition to its nutritional value, one or more of its effects are positive on the physiological mechanism of the body resulting in improved health, feeling better and/or signs of recovery." *Functional foods are to be sold as foods only, not as tablets or capsules.* It should be an integral part of eating habits and *be efficient at accustomed quantities of the respective type of food* (*Diplock* et al., *1999; Katan, 1999; Rechkemmer, 2003*). Those foods are characterised either by an "enhanced function", or „lowering the risk of a disease". The Codex Alimentarius qualifies a food to be of enhanced function, if its consumption is coined with some determined benefit meeting a physiological, psychical or other biological claim. The functional foods contribute to the preservation or impovement of health. Foods, which „diminish the risk of disease" are pointed to particular (common) diseases, which are threatening our health (*Roberfroid, 2002*).

In Germany, the most known functional foods have been offered for the last three years, and are probiotic preparates, like in Japan. An increasing tendency of „probiotic" carbohydrate preparates is witnessed, which represents mainly inulin and β-glycane. That type of commodity is the „Wellness -Brot" (*Rechkemmer, 2003*).

In Hungary, research and development related to functional foods enjoyed the distinguished subvention of the Ministry of Education among others. In April 2003, the Hungarian Association of Food Science orgaised a conference connected with an exhibition of products with the title: „Functional foods and probiotics", dealing with the development of technologies and the possibilities of subvention coming from the EU. Some groups of products have been dealt individually, e.g. Hungarian functional meat preparates and probiotic milk products.

Products similar to functional foods are the „Novel Food", meaning a new type of food, the „Nutraceutical", meaning a remedy, which is available as a tablet, capsule or powder and different food complements, which contains vitamins or trace elements *(Rechkemmer, 2003)*. Similar products are also the „Medifoods", the „Designer foods", and the „Vitafoods".

Rechkemmer (2003) states that most scientific arguments are in favour of the functional "effects" of fruits and vegetables *(Himelrick, 2002; Bíró, 2003)* because those products are considered to be natural foods with a high level of bio-activity. The designation "functional" supposes the knowledge of the composition of the product. *Table 1* shows the bioactive compounds of plants, which constitute the basis of being highly recommended for consumption.

It is not sufficient to know which are the bio-active substances of foods, we have to be informed about the dose, which ought to be consumed in order to reach the necessary level of the respective substance. Studies aimed to determine the "quantity of anti-oxydants" sufficient to counteract the harmful effects of free radicles. Recommendations of the WHO claim a daily dose of 400 g fruits and vegetables and at least 30 g of pulses and oily seeds (*Winston, 2002*). Epidemiological studies in Europe see 60-100 mg vitamin C, 25–37 mg vitamin E and 6-10 mg caroten to be necessary for preserving health and prevent ailments (*Lanchance, 1988; Germann, 1990*). The unit of the Oxygen Radical Absorption Capacity (ORAC) has been developed in the USA in order to rate horticultural products from that point of view. The highest ORAC values were found in stone fruits (*Prunus* sp.), which contain 5.700 units per 100 g (*Dixon, 2002*). For being able to apply the parameters in the practice, we have to know the quantity of ORAC units needed by the organism. Researchers set the daily dose at 5000 ORAC units. According to the prevailing eating habits, the mean consumption is about 1.250 ORAC units, only. People living according to a special, e.g. F-diet, which means "living food" eat raw vegetable foods exclusively, that means germinating seeds, vegetables, fuits, berries, nuts, cereals. Nothing shall be cooked, but some of the foods is fermented in order to utilise the beneficial substances of fermentation by *Lactobacteria*. No coffe, tea, alcohol, moreover, salt should be consumed. This way less cholesterol is involved, and the risk of cardiovascular complaints is reduced. The vegetable fibers prevent the risks of constipation, inflammations of the colon, bilestone and appendicitis. All those are explained by the fact that the intestinal bacteria transform the fibers to benefitial phyto-estrogenes (lignans and isoflavonoids). One of the risks of that diet is the insufficiency in vitamin B_{12} and in calcium (*Manek, 2002*).

Preserved functional foods as Hungaricum, fruits and vegetables: urgent need for further research

As considerable masses of functional foods are to be produced derived from fruits and vegetables grown in Hungary and sold as specialities, i.e. Hungaricum, the effect of processing technologies have to be tested as for their alleged "harmfulness" affecting the respective bio-active compounds. Those technologies have to be selected, which may less affect the original vitamin and mineral content of the products. As an example 60-80% of the vitamin content of fruits will be lost when making jam, other canned products lose 35–45% of it at least, whereas deep freezing – performed at appropriate circumstances – causes some 20–25% loss of vitamins at most (*Bencsik, 1992*).

Regarding the initial experiences, biotechnological projects should be planned in the future to explore the

Table 1 The main anti-oxidant components of horticultural products
(Bíró, 2003; Lugasi et al.., 1999; Lugasi & Takács, 2002; International Food Information Council Foundation, 2000, a condensed summary)

Some anti-oxidant compounds	Fruits and vegetables as sources of anti-oxidants	Quantities occurring in horticultural plants	Effects of antioxidants on the organism	Daily dose recommended for consumers
Carotenoids: β-carotene, lutein, zeaxanthin, astaxanthin, lycopene	*β-carotene:* musk melon, carrot, broccoli, squash, pumpkin, spinach, sweet potato, papaya, mango, kiwi *Lutein:* spinach, kiwi, broccoli *Zeaxanthin:* maize, spinach, pumpkin, citrus fruits *Astaxanthin:* marine organisms, green alga *(Haematococcus pluvialis) Lycopene:* tomato, watermelon	green alga: 10–40 mg/kg	Anti-cancerous effect, strengthening the immune system	Infant (7–12 months): 400 µg 11–60 year and more: 800–1000 µg
Flavons and flavonols: kaempferol, guercetin, luteolin, myricetin, rutin, sibelin, apigenin, crysin	apple, blueberry, broccoli, celery, lettuce, olives, onion, parsley, spinach	*Kaempferol:* 66.4 mg/kg in parsnip *Quercetin:* 272,2 mg/kg in spinach, 67–121,5 mg/kg in onion *Myricetin:* 4565 mg/kg in walnut	Antiphlogistic and tumour-inhibiting effect, strengthen the effect of vitamin C, defences the LDL-cholesterin against oxidation, regulates the sugar level of blood	
Flavanols, flavanons: hesperetin, naringenin, taxifolin	citrus species, cranberry, cocoa			
Anthocianins: cyanidin, delphinidin, malvidin, pelargonidin, peonidin, petunidin	small fruits (raspberry, blackberry, blueberry, black currant), sweet and sour cherry, red wine			
Non-flavonoid phenols: cffee-acid, chlorogenic acid	tomato	*Chlorogenic acid:* 6–22,3 mg/kg in tomato		
Ascorbic acid:	citrus species, pepper, tomato, camu-camu, acerola, cabbage-like vegetables	2780–4000 g/100 g in camu-camu	Strengthening the effect of vitamin-E	60–65 mg and 100 mg for smokers
Tokoferol: α-, β-, γ-, δ-tokoferol, α-, β-, γ-, δ-tokotrienol	*α-, β-, γ-, δ-tokoferol:* wheat germs, tomato *α-, β-, γ-, δ-tokotrienol:* vegetable oils (e.g.: seed of cranberry)	17–30 mg/kg in seeds of cranberry		12 mg

possibilities of breeding new varieties of the respective fruit and vegetable species, which may serve as functional foods and to develop and/or adapt the most reliable technologies of growing, harvesting, post harvest treatments and storing, to introduce alternative processing and/or storing methods which preserve the higher value of those functional foods and also to improve the eating habits of the domestic consumers. For that purpose an intense cooperative attempt would be favourable among horticulturists, physicians, dietetical experts and biologists on an interdisciplinary level. The widening of the markets of horticultural products is of national interest, and a distinction of special products distinguished by the mark of Hungaricum would be a suitable means to fulfil the task. The multiple benefits of the project help the growers in finding realisations of income and improve the nutritional status as well as health of the population, especially the elimination of deleterious consequences of free radicals.

Summary

The contemporary man is steadily tempted to neglect the care for his health though being exposed to increased stress. The tempestuously changing conditions are difficult to be met by adequate changes in eating habits and in lifestyle. Thus, additional harmful effects accumulate the risk of different diseases induced by his inadequate responses to unexpected challenges of modern life. The pathological syndroms, diseases and processes related to senescence are very probably due to the harmful effects of free radicles and are expressed in different cardiovascular complaints, cancer, arthrytis, inflammations, etc. Free radicles are noxious by attacking the structural constituents of the cells by catching electrons in order to get neutralised.

We are convinced that the best antidotes of senescence and of the diseases mentioned are the so-called anti-oxidant compounds, which are ready to help the organism and contribute to its self- defence mechanism in neutralising the

incriminated free radicals. Anti-oxidants are known also as produced by our body, but there are others, which are available only as constituents of our food. The latter group comprises the vitamins C and E and the provitamins of vitamin A, the carotenoids, all of them are mainly present in horticultural products.

During the last 10-year period several scientific studies dealt with the importance of anti-oxidant compounds available in foods, mainly horticultural products, and their effects on the consumer in the prevention of certain diseases. Some startling results have been revealed, which are related to Hungarian horticulture. In the USA 17 anti-oxidant compounds have been identified in the sour cherry variety *Újfehértói fürtös*. Examining the effects of flavonoids, Finish researcherss claimed that the consumption of apple and onion containing a high level of quercetin is beneficial to patients with heart complaints. At the University of Hawaii flavonoids have been tested as antidotes of lung cancer. Recently, the National Institute for Fighting against Cancer of the USA spent 20 million USD to reveal the anti-tumor effects of vegetable matters and foods, and rated garlic, soya, cabbage, ginger, fennel and other umbelliferous vegetables as being the most efficient. At many parts of the world – also preferably in Hungary – the vitamin C, E, carotenoid and capsaicinoid content of spice pepper varieties was the object of scientific research. Flavonoids were traced in fruits and vegetables in Hungary with the purpose to assess their role in health care whereas free radicles catching ability of garden beet varieties has been explored. All those represent only a small sample of the worldwide attempts, which are aimed to support the arguments in favour of the beneficial role of anti-oxidant compounds in the prevention of maladies threatening the contemporary man.

As a novelty, the recognition of fruits and vegeables as potential functional foods opens a fruitful field of research and development for the food industry. Functional foods were first introduced in Japan during the 1990's. Foods of special hygenic value may be coined with the attribute of "functional" and recommended for their positive effect in health care.

With due interest, experts as well as consumers ask the question, how much should they eat from the respective foods in order to keep their health and being protected against diseases known as threatening contemporary people, i.e. saved from the harmful free radicles. For that purpose, researchers developed methods to assess the daily "quantity of anti-oxidants" needed for enjoy of their effect. There are still open questions before a safe protocol could be recommended for the average consumer, therefore, further multidisciplinary cooperation is necessary.

In our laboratory, research has been initiated recently, in order to check the anti-oxidant capacity of pepper and onion varieties as potential "Hungaricum" and other less explored horticultural commodities as local varieties of sour cherries. Moreover, processing and preservation technologies of the food industry will be revised from the aspect of maintaining the original high content of bio-active substances.

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