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Superfoods: Recent Data on their Role in the Prevention of Diseases

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Abstract

By the term functional food we mean food, processed or not, which on the basis of scientific studies can contribute to the achievement of specific operational objectives within the human body and play an important role in the direction of prevention degenerative diseases and health promotion. The possible beneficial properties of functional foods are due to their content in bioactive ingredients, with specific biological properties and effects within the human body. Some examples of processed functional foods are calcium - enriched milk, enriched juices with ω-3 fatty acids, yoghurt with probiotic organisms and phytosterol-enriched margarines. At the same time, constantly new scientific findings confirm the potential beneficial properties of different conventional food, such as tea, blueberries, pomegranate, berries, hippophaes and many others, which are known by the term "superfoods". Recently, the appearance of a multitude of chronic degenerative diseases such as cardiovascular disease, diabetes, obesity, osteoporosis and cancer, has led to ways of defending human health through the adoption of appropriate dietary patterns. Hence, functional foods, provided that they fit inside hygiene and balanced nutrition, are suggested as a potential solution to reinforcing the prevention strategy, avoiding the need for therapy, with the aim of promoting the health of the population. This is the reason why there is an ever-increasing trend particularly in Europe and USA. Also, improved accessibility knowledge and information from consumers, promotes an increased search for information about their beneficial properties.

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Introduction

Conceptual Approach to Superfoods

According to literature one of the categories of functional foods, conventional functional foods, contain bioactive compounds with specific actions within the human body. In recent years many scientific studies demonstrate the importance of a non-class processed foods whose nutritional

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composition is ideal for strengthening and promoting the proper functioning of the human body.[1] These foods are known as superfoods. Conceptually superfoods are foods that are both high in nutrition value due to a high concentration of nutrients and, on the other hand, great biological value due to satisfactory bioavailability and bioactivity within the body due to a variety of bioactive ingredients they contain.[2] According to Wolfe (2009),[3] superfoods include foods that have a dozen or more unique properties and constitute a specific set of food stuffs, natural or medium processed with numerous nutrients. They are food that according to studies they are able to increase vitality of the human body and can be a good choice for improving the overall health by strengthening the immune system.[3] The most important bioactive components of superfoods which have been proven to be beneficial to human body are polyunsaturated fatty acids (ω-3, ω-6), vitamins, minerals, probiotic micro-organisms, antioxidants, essential amino acids, polysaccharides and various enzymes. Since the most important of the superfoods properties is their antioxidant activity, among the most important antioxidants of the superfoods are mostly vitamins A, C and E, flavonoids, selenium, β-carotene, zinc, lycopene, albumin, uric acid, bilirubin, coenzyme Q10 and polyphenols such as anthocyanidins.[4] The epidemic outbreak of a multitude of degenerative diseases has increased the need to find solutions from the natural environment, with more and more people now turning to food of high nutritional value in order to improve the quality of their life and the promotion of their health. This trend is reinforced from a series of recent scientific studies that have highlighted the importance of various superfoods such as hippophaes, Goji Berries, blueberry, spirulina, kefir, royal jelly and others.[5] Numerous research data suggest that superfoods are a very good option to improve overall health, boosting the immune system, increasing the production of serotonin and other hormones and promoting the smooth operation of the various organic systems of the human body, but only if they are included in a balanced diet and consumed in moderation and prudence.[6] The list of superfoods is constantly increasing year by year, while tracking valuable nutrients and understanding the mechanisms of action within the human organism have activated the scientific interest, by promoting more and more scientific research studies.[8] In particular, the most important superfoods according to the data obtained from several studies, are the following:[7]

- Fruits: pomegranate, berries, blueberries, raspberries, strawberries, goji berry, chickpeas, grape, acai berry, hippophaes.
- Dried nuts: walnuts, almonds, cereals.
- Pulses: red beans, cocoa, sweet potatoes, mastic.
- Vegetables: broccoli, spinach.
- Seaweed: spirulina, chlorella.
- Milk products: Kefir, donkey milk.
- Herbs: ginger, ginkgo biloba, tea.
- Bee products: honey, royal jelly, waxes.

Below data of the most important superfoods according to the scientific literature are presented, such as the hippophaes, maize, blueberries, tea, kefir, maca plant, acai berries, goji berries, etc., their nutritional value, and the potential beneficial actions within the human body.

Tea (*Camellia Sinensis*)

Tea is a product of the leaves of *Camellia Sinensis* plant, which belongs to the family *Theacheae.* It's the second most popular drink worldwide after water and its study is very interested due to its consumption by plenty of people around the world. Depending on the existing industrial processing, tea is categorized into three basic types: a) fermented green tea, which is produced by drying and processing with steam of the fresh leaves of the plant. In this way, the enzymes phenol oxidases are deactivated, so that the polyphenols are not oxidised. b) Oolong tea, which is produced as its leaves plants undergo a moderate fermentation prior to drying. (c) fermented black tea, which undergoes extensive fermentation prior to drying and vaporisation. This permits the action of phenol oxidases which oxidize polyphenols to various oxidized derivatives.[8,9,10] Fresh tea leaves contain an average of about 36% polyphenols, 25% carbohydrates, 15% proteins, 6.5% lignin, 5% ash, 4% amino acids, 2% lipids, 1.5% organic acids, 0.5% chlorophyll, and carotenoids and various other substances in less than 0.1%. The polyphenols account for 18-36% of the dry weight of the tea and are either in the form of glycosides or as free aglycones. The main polyphenols found in tea are flavonoids and phenolic acids. Of the

flavonoids, catechins make up 12-24% of its dry weight, flavonols 3-4% and anthocyanidins 2-3%.[9] The EGCG, that is, the ester of epigallocatechin with gallic acid is the most abundant catechin in tea (8-12%) followed by epigallocatechin (EGC) (3-6%) and the gallic ester of epicatechin (ECG) (3-6%).[10] The most important biological role of tea, which classifies it from many scientists in superfoods, is the intense antioxidant activity within the human organism. The main mechanisms of antioxidant action of tea polyphenols within the body is the free radical scavenging activity, complexation of ions that contribute to production free radicals and engaging in pro-oxidant regulation mechanisms and antioxidant enzyme systems.[11] Both green tea catechins, and black tea thioflavins bind peroxide radicals by suppressing the chain reactions and retarding lipid peroxidation.[11] Most clinical studies show an increase in plasma antioxidant status after drinking tea, suggesting as a possible mechanism the immediate increase of the concentration of catechins and attachment to red blood cell, and various blood components, in which they exert antioxidant effects.[12] Tea has been extensively studied for its possible action on preventing and controlling carcinogenicity. His role lies primarily in the following mechanisms:(i) Antioxidant activity and free radical scavenging, (ii) Binding of activated metabolites of carcinogens. (iii) Effect on carcinogenic elimination enzymes (detoxification enzymes), iv) Prevention of the mutation mechanisms and v) Suspension of the first step of the oncogenesis mechanism.[13] A ten year study of 8,500 people in Japan showed that volunteers who consumed 10 cups of tea a day had 3 years later cancer compared to those who consumed 3 cups.[14] Other patient control studies noted that the increased consumption of tea were associated with a reduced relative risk of cancer.[15] Cancer types that have been studied more extensively are cancers of the stomach, colon, skin, lung, skin, liver, prostate and breast, while most epidemiological studies have been carried out in countries of Asia where tea consumption is higher.[15] The cardioprotective effect of tea has been extensively explored and seems to be confirmed by many studies. This is related to prevention of oxidation of LDL, improvement of lipid profile, prevention of haemostasis and inflammation, inhibition of atherosclerotic procedure[16] and more generally through mechanisms which relate to the action of polyphenol-cardiovascular system. Neurological diseases and aging are associated with anxiety and increase in the concentration of various ions in the cells. Recent studies in cell cultures and animal models with neuro-illnesses have shown that antioxidant and anti-inflammatory polyphenols of tea enhance the protection of neurons of the brain and prevent cell death. The tea theanine has been shown to be able to modify serotonin and dopamine levels improving memory and learning skills while improving levels of α-waves, relaxation index and proper brain function. Studies have shown that tea consumption is associated with improvement of the symptoms of neurological diseases such as Alzheimer's and Parkinson's, mainly through action mechanisms in calcium channels, oxidant stress and AGE (Advanced Glycation Endproducts) in cerebral neurons.[17] In addition to antioxidant, anticancer, cardioprotective- neuroprotective and antidiabetic therapy, the antihistaminic-and anti-inflammatory effect of tea on various tissues has been studied. The tea seems to prevent histamine-induced inflammation process and is involved in preventing allergic reactions through inhibiting the release of histamine and its deactivation enzyme protein kinase. In addition, catechins have been shown to reduce the incidence of arthritis through an effect on the endopeptidases activity, while epidemiological studies have correlated tea with bone density increase and health improvement of

Table 1: Summary of some health benefits of tea (*Camellia Sinensis*)

Health benefits	Compound/s responsible for benefits
reduced relative risk of cancer	Polyphenols, green tea catechins, and black tea thioflavins,
cardioprotective effect	Green tea catechins, and black tea thioflavins
improving memory and learning skills	Theanine
reduce the incidence of arthritis	Catechins
Neurological diseases and aging	Tea polyphenols

bone and teeth.[10,15,17] Some health benefits related to tea consumption are presented at Table 1.

Hippophaes (*hippophae* sp.)

Hippophaes are shrubs of about 0.5 meters height that mainly thrives on land and sandy soils. The most common type is *hippophae rhamnoides* which spreads both in Europe and China. It is consumed either fresh or dried. The fresh fruit requires immediate consumption to preserve its nutrients while there is the possibility of refrigeration to increase its shelf life. The dried fruit can be maintained for long periods of time and is the most common form encountered.[18] Hippophaes is considered by the scientific community to be very important due to its high nutritional value. The fruit has high vitamin C content, ranging from 114 to 1,550 mg per 100 g with an average level of 695 mg / 100 g.19 These specific levels are up to 15 times higher than orange (45 mg / 100 g). Except for an excellent source of ascorbic acid, hippophaes is rich in other nutrients such as vitamin E, amino acids, minerals (K, Na, Mg, Ca, Fe, Zn, Se), monosaccharides, organic acids, free amino acids, volatile compounds, various flavonoids (quercetin, myricetin, kaempferol) and other phenols, fatty acids, triglycerides, waxes, glycerophospholipids, phytosterols such as β-sitosterol, esters, zeaxanthin and other carotenoids and other compounds. In total, it lists more than 190 nutrients, distinguishing vitamin C, omega-3 and omega-6 fatty acids and vitamin E.[20] The moderate consumption of hippophaes in a balanced diet it appears to be able to offer significant benefits to human health, most important of which are presented below at Table 2:[18,19,20]

Blueberries (*Vaccinium Myrtillus*)

Blueberries, (*Vaccinium Myrtillus*) come from a bush of 60-90 cm height with thick branch- foliage and translucent foliage. They can be consumed as fresh fruits or dried, the latter be the most common. The dark blue-purple color is due to the high concentration of anthocyanins, that are phytochemicals with strong antioxidant action. After numerous surveys and studies, blueberries now are classified in the category of superfoods. The plethora of nutrients contained in blueberries are presented in Table 3 which refers to 100 g of fresh fruit.21 More and more surveys highlight their valuable contribution in health promotion, mainly because of the containing polyphenols and especially anthocyanins. It has been shown that consumption of 120 ml of blueberry juice leads to higher levels of anthocyanins in the blood compared to red and white (2.42 mmol, 2.04 mmol and 0.47 mmol, respectively), indicating the high bioavailability of their anthocyanins. The contribution of blueberries in cerebral function seems to be associated with a reduction in the risk of declaring Alzheimer's disease and other neurodegenerative diseases by reducing symptoms such as loss of balance and coordination and prevention of memory loss. Studies have shown that a quantity of 150 g of blueberries per week may contribute to reduction in blood pressure levels, and a number of other studies have shown a potential effect on the prevention of various types of cancer,

Table 2: Summary of some health benefits of Hippophaes

Health benefits	Compound/s responsible for benefits
• Enhancement of the function of the nervous system	Vitamins of the B-complex as well as all necessary for the human body minerals and trace elements (calcium, magnesium, iron, phosphorus, copper, potassium, selenium, zinc, etc.)
• Protection against cardiovascular diseases and immune enhancement	phytosterols and unsaturated fatty acids (ω-3, ω-6 and ω-9)
• Antioxidant activity: free radical scavenging	Antioxidants: flavonoids, carotenoids
• Strong anti-inflammatory, antimicrobial, analgesic, anti-inflammatory and healing action	vitamin C, omega-3 and omega-6 fatty acids and vitamin E

such as colon cancer, due to the presence of phenolic compounds, tannins, flavones and generally antioxidant ingredients. Specific studies have shown a potential inhibitory effect of flavonoids kaempferol and luteolin in the development of ovarian cancer. The blueberries, can be included in a balanced diet, because of their low glycemic index which can regulate blood sugar levels especially in people

Table 3: Blueberries nutrient composition per 100g fresh fruit[21]

Carbohydrates	**Vitamins**		
Fibers	3.6 g	Vitamin A	54.0 IU
Starch	0,0 g	Thiamine (Vit B1)	0,0 mg
Sugars	14.7 g	Riboflavin (Vit B2)	0.0 mg
Sucrose	163 mg	Niacin (Vit.B3)	0.4 mg
Glucose	7,222 mg	Pantothenic acid (Vit B5)	0,1 mg
Fructose	7,355 mg	Vitamin B6	0,1 mg
Lactose	0.0 mg	Folate (Vit B9)	6.0 mg
Maltose	0,0 mg	Vitamin C	9,7 mg
Galactose	0,0 mg	Vitamin E (α-tocopherol)	0,6 mg
Proteins (amino acids)	Vitamin K	19.3 mg	
Tryptophan	3.0 mg	Choline	6.0 mg
Threonine	20.0 mg	Betaine	0.2 mg
Isoleucine	23.0 mg	**Trace elements**	
Leucine	44.0 mg	Calcium	6.0 mg
Lysine	13.0 mg	Iron	0.3 mg
Methionine	12.0 mg	Magnesium	6.0 mg
Cystine	8.0 mg	Phosphorus	12.0 mg
Phenylalanine	26.0 mg	Potassium	77.0 mg
Tyrosine	9.0 mg	Sodium	1.0 mg
Valine	31.0 mg	Zinc	0.2 mg
Arginine	37.0 mg	Copper	0.1 mg
Histidine	11.0 mg	Manganese	0.3 mg
Alanine	31.0 mg	Selenium	0.1 mg
Aspartic acid	57.0 mg	**Fat and fatty acids**	
Glutamic acid	91.0 mg	Total fat	0.3 g
Glycine	31.0 mg	Polyunsaturated	0.1 g
Proline	28.0 mg	Total ω-3 fatty acids	58.0 mg
Serine	22.0 mg	Total ω-6 fatty acids	88.0 mg

Table 4: Summary of some health benefits of Blueberries

Health benefits	**Compound/s responsible for benefits**
cerebral function and reduction of neurodegenerative diseases and blood pressure	polyphenols and especially anthocyanins
prevention of various types of cancer	phenolic compounds, tannins, flavones, flavonoids kaempferol and luteolin
constipation and diarrhea	Dietary fibers
hepatitis C virus protection and infection of the urinary tract prevention	proanthocyanidins

suffering from type II diabetes, to reduce insulin resistance and act positively on people with obesity and metabolic syndrome. The presence of fibers contributes to the constipation and diarrhea, while the antioxidants proanthocyanidins have been shown to have an effect against hepatitis C virus and can prevent a possible infection of the urinary tract.[22] A summary of some health benefits of Blueberries is presented at Table 4.

Royal Jelly: High Nutritional Value Food

Royal jelly is produced by young bees excreted by their subpharyngeal glands, it has creamy texture, an acidic pH and bitter taste.[23] It is a high nutritional food as it contains high amounts of proteins. Twenty nine amino acids have been identified, with aspartic acid glutamic acid being the most abudant.[24] Glucose and fructose are in 90% of the total sugar content, while the remaining 10% refers to various glycosides. The fatty acids of the royal jelly act as natural antimicrobial agents while royal jelly is a good source of metals such as K, Ca, Na, Zn, Fe, Cu and Mn, with potassium being the most abudant, and B complex vitamins (B1, B2, B3, B4, B6, B7, B8, B9 and B12).[25] Royal jelly contains 56% water, 17% protein, 18% sugars, 4% lipids, 3% vitamins and trace elements and 2% mineral salts. Among the important features of the royal jelly is the presence of potent peptides (jelleines) that have antibacterial action. Finally, royal jelly contains satisfactory concentration of acetylcholine.[26] The beneficial effects of royal jelly within the human body have been recognized by a multitude of scientific studies and this is why it is included into the most important superfoods. The following data for the bioactivity and health benefits of royal jelly is obtained from the literature[23-26] and presented below at Table 5.

Table 5: Summary of some health benefits of royal jelly

Health benefits	Compound/s responsible for benefits
Adjustment of blood glucose levels: Royal jelly appears to reduce blood glucose levels and improves lipid profile	Organic acids with insulin-like behavior in the body.
Contribution to connective, muscle and skeletal tissue. Evidence suggests that royal jelly acts as a means of protecting ligaments, muscles and skin	Royal jelly contains the amino acid proline necessary for the synthesis of collagen and elastin. Presence of pantothenic acid.
Improving neurological, endocrinological and metabolic disorders	high vitamin content of the B complex vitamins and acetylcholine, which acts as a neurotransmitter.
Effect on urinary and genital system	Royal jelly consumption act as an 'adrenal regulator'. During pregnancy, some cases of swelling, high blood pressure but also eclampsia were treated with royal jelly while positive effect is also observed in amenorrhea.
Elderly disorders, insomnia, increase appetite better mental and psycological functioning of the elderly.	Royal jelly has been proven to increase hemoglobin and red blood cells, resulting in the abnormal production of red blood cells (anemia) that is observed in the elderly. Responsible compounds: the vitamin B1, the phosphorus and tryptophan contained

Spirulina (*Arthrospira plantensis*)

Spirulina is an edible seaweed of fresh water with blue-green color, due to natural pigments contained therein.[27] The scientific name is *Arthrospira plantensis* and is growing mainly in alkaline lakes rich in metals and metalloids. Spirulina consists of 55-70% proteins, 15- 25% carbohydrates, 6-8% fat, 3-4% fiber, while the remaining percentage is divided into metals (iron, potassium, magnesium, etc.), trace elements and vitamines (A, B, E, K) (Table 6). Spirulina contains more than 100 nutrients and is the richest plant source of protein, it has a very

Table 6: Spirulina nutrient composition per 100g[28-30]

Basic Nutrients		**Metals / Trace Elements**	
Protein (g)	62.9	Calcium (Ca) (mg)	1.028,3
Total Fat (g)	3,8	Iron (Fe) (mg)	50,4
Polyunsaturated (g)	1.03	Phosphorus (P) (mg)	1.374,8
Monounsaturated (g)	2,4	Iodine (I) (μg)	22
Carbohydrates (g)	8,4	Magnesium (Mg) (mg)	598,8
Sugar (g)	<0,5	Zinc (Zn) (mg)	6,5
Edible Fibers (g)	6.9	Selenium (Se) (μg)	59
Aminoacids		Copper (Cu) (μg)	810
Isoleucine (g)	3.41	Manganese (Mn) (mg)	5.3
Leucine (g)	5.29	Chromium (Cr) (μg)	110
Lysine (g)	2.7	Potassium (K) (mg)	1.558
Methionine (g)	0.78	Barium (Ba) (μg)	1.190
Phenylalanine (g)	2,8	Cobalt (Co) (μg)	35
Threonine (g)	2.98	Sodium (Na) (mg)	756
Tryptophan (g)	1.16	**Fatty acids**	
Valine (g)	3.66	γ-Linolenic (C18: 3) (mg)	1.960.4
Histidine (g)	0.93	γ-Linolenic (C18: 3) (mg)	311.2
Alanine (g)	4.92	Linoleic (C18: 2) (mg)	138.7
Arginine (g)	4.07	Palmitic (C16: 0) (mg)	735.3
Asparagine Acid (g)	5.66	Oleic (C18: 1) (mg)	157.3
Cystine (g)	0.18	Myristic (C14: 0) (mg)	85.9
Glutamic Acid (g)	8.05	Capric (C10: 0) (mg)	61.2
Glycine (g)	3.08	Laureate (C12: 0) (mg)	59.3
Proline (g)	2.31	Palmitoleate (C16: 1) (mg)	48.6
Serine (g)	2.87	Stearate (C18: 0) (mg)	48.3
Tyrosine (g)	2.73	Arachidate (C20: 0) (mg)	42.2
Vitamins			
Protamine A (carotene) (mg)	60.1		
Vitamin B1 (thiamine HCl) (mg)		5.3	
Vitamin B2 (Riboflavin) (mg)	2.44		
Vitamin B3 (Niacin) (mg)	10.8		
Vitamin B5 (Pantothenic Acid) (mg)		1.07	
Biotin (μg)	44		
Folic Acid (μg)	827		
Vitamin B6 (Pyridoxine) (μg)	549		
Vitamin B12 (cyanocobalamin) (μg)		182	
Vitamin E (mg)	7.78		
Inositol (mg)	8.24		

good source of vitamin B12 and phytochemicals with strong antioxidants properties. Continuous studies confirm that spirulina contain high and wide range of different group of nutrients. Its characterization as superfood is due both to autonomous action of the numerous nutrients it contains (Table 7), but also to the harmonic natural synergy of these compounds.[28,29,30]

One of the most beneficial properties of spirulina is its effect on blood glucose level. From a range of clinical studies in patients with type II diabetes mellitus, it has been proven that 2g spirulina consumption on a daily basis for four months, led to gradual reduction of glucose levels, while a similar decrease was observed in other markers, such as glycosylated hemoglobin (HbA1c).[29,31] Another documented action of spirulina is the effect on the respiratory system. Consumption of 1 g of spirulina from patients for four months, or in combination with appropriate medication or by itself appears to contribute to substantially improve of pulmonary function and reduce of levels of immunoglobulin E (IgE). The high content of spirulina in γ-linolenic acid and antioxidants, appears to contribute to the enhancement of immune system through the stimulation of phagocytosis, the effect of production of cytokines, chemokines and other inflammation mediators, antibody production by B-lymphocytes and HIV proliferation of T-lymphocytes. This demonstrates the regulatory role of spirulina in the functioning of the immune system by enhancing the immune response and preventing over-activity of macrophages.[32,33,34] In other studies, a possible antiviral effect of spirulina has been demonstrated on human HCVV, measles, parotitis, influenza A4, HIV, and enterovirus. The mechanism of action of the spirulina against the viruses is primarily found in preventing their penetration into the host cell via the spirulina polysaccharide spirulane.[28,34] The antimicrobial action of spirulina in the presence of alpha-linolenic and linoleic acid, and its antioxidant action is recognized by the presence of antioxidant ingredients such as β-carotene, vitamin E, selenium and polyphenols.[35] All health benefits are summarized at Table 7.

Maize

Maize is an ancient cereal of high nutritional value. For thousands of years maize remained the main

Table 7: Summary of some health benefits of Spirulina

Health benefits	Compound/s responsible for benefits
effect on blood glucose level, pulmonary function	Low carbohydrate, sugars
Immune system enhancement	γ-linolenic acid and antioxidants
Antiviral effect	polysaccharide spirulane
Antimicrobial and antioxidant activity	β-carotene, vitamin E, selenium and polyphenols

Table 8: Summary of some health benefits of maize

Health benefits	Compound/s responsible for benefits
nutrients absorption and inflammation suppression	soluble proteins, fiber and monounsaturated fatty acids
immune system strengthening	lysine, a basic amino acid and rhodanine
antidepressant action	high inorganic content and especially magnesium
Vision strengthening and protection	provitamin A and vitamine E
Improvement of the lipid profile and regulation of blood sugar levels	high fiber and amino acid content

consumed cereal in Middle East and North Africa. The key attribute which distinguishes it from other cereals, such as wheat, is its very small gluten content and the different quality of it. Also, it has high levels of lysine, making products more digestible. It is probably a form of two-granule wheat (*Triticum turgidum ssp. dicoccum*), while it contains valuable nutrients with multifaceted benefits for the human organism, which characterizes it as a superfood.*36* Compared to wheat, it contains less saturated fatty acids, while at the same time it has higher amounts of soluble proteins, fiber and monounsaturated fatty acids. Maize due to the aforementioned composition and especially proteins, inorganic compounds and fibers it appears to contribute to the absorption of nutrients and suppression of inflammation. It contains lysine, a basic amino acid that strengthens the immune system and is important for brain function. It also contains highs amounts of magnesium, copper, manganese, zinc, cobalt and others metals and trace elements.[37,38] The basic feature of this type of wheat is the absence of allergens and the presence of a small amount of gluten. Studies have shown that maize's inclusion in diet can offer benefits that focus on the following points:[36-38] A summary of maize health benefits is presented at Table 8.

Table 9: Kefir nutrient composition (mg per 100g)[40]

Vitamins and minerals (mg per 100 g)	
Calcium	120
Phosphorus	100
Magnesium	12
Potassium	150
Sodium	50
Vitamin A	0.06
Carotene	0.02
Thiamine	0.02
Vitamin B2	0.17
Vitamin B6	0.05
Vitamin B12	0.005
Phosphoric acid	0.0095
Niacin	0.09
Vitamin C	1
Vitamin D	0.08
Vitamin E	0.11
Iron	0.05
Copper	0.012
Molybdenum	0.0055
Magnesium	0.005
Zinc	0.36

Kefir

Kefir is a fermented beverage milk, extremely refreshing, tasty, easy to digest and healthy. It is one viscous drink, foaming and sour with harsh taste. Kefir is produced by a lactic and alcoholic fermentation from a wide variety of microorganisms. Thus, it is considered superior to yoghurt that has been produced only by lactic fermentation. Russian scientists worked on the nutritional value of kefir and they have proven its beneficial properties. Kefir is superior to the other acidic milk products with regard to its action against microorganisms which enter the digestive tract with food and water, due to the presence of acetic acid producing bacteria and contained yeasts. It also shows intense hydrolysis of proteins and therefore high concentration of amino acids and peptides in the intestine, plus increased amounts of vitamin B complex.[39] A characteristic feature of kefir is the presence of carbon dioxide (CO_2) which contributes to the formation of a finely divided gel, therefore its components can better be in contact with digestive tracts liquids and be better absorbed. Kefir due to its special taste and its microorganisms, it promotes the secretion of enzymes from the stomach and the pancreas and thus facilitates digestion and peristaltic bowel movements and therefore the passage of food from the intestine.

The contribution of kefir to improve human health is recognized by the fact that it displays higher levels of assimilation from the human body against yoghurt, as it provides beneficial bacteria, yeasts, vitamins, minerals (Table 9) and proteins of high biological value. Kefir is a balanced superfood as it appears to boost the immune system, relieves intestinal disturbances and generally contributes to a healthy digestive system.[39] Kefirs' beneficial yeasts and bacteria consume most of the lactose of milk so it is an ideal food for sufferers from lactose intolerance. The increased presence of calcium, magnesium and phosphorus (Table 9) contributes to the proper growth of cells and the maintenance of

good body health. From the existing research data, kefir's properties for human health seem to focus on the following points:[41]

- It has an effect on the treatment of pathological conditions of the organism e.g. anemia.
- It has an effect on diseases of the digestive system e.g. chronic enteritis.
- It has increased diuretic properties.
- It does not burden the human body with calories as it has low lipid content and low calories.
- It helps to the prevention of atherosclerosis and hypertension.
- It has potential anticancer effects.
- It helps reduce high blood cholesterol.
- It has strong antioxidant and antimicrobial properties.
- It strengthens the immune system.

Maca Plant (*Lepidium meyenii*)

The Maca plant (*Lepidium meyenii*) is a turnip with several similarities to that of radish. It is a herbaceous biennial or annual plant that grows at high altitudes in South America. It has short stem and lace sheets that are renewed constantly. The seeds of the plant are the only way to reproduce and its yellow flowers are converted into fruits of the order of 4-5 millimeters. Scientific studies have highlighted the production of nutrients during the metabolism of a plurality of biologically active aromatic glycosinolates. The nutritional composition of maca plant is similar to that of cereals such as maize, rice, and wheat as it consists of 60-75% carbohydrates, 10-14% proteins, 8.5% fiber and 2.2% lipids. One hundred g dry skin contains about 250 mg of calcium, 2 g potassium and 15 mg of iron as well as significant amounts of fatty acids and 0.05-0.1% sterols. It also contains vitamins B1, B2, B12, C and E, zinc, alkaloids, tannins and saponins.[4] Plants' composition is essentially related to its contribution to sexual function and fertility, due to the high amino acid content. The high concentration in amino acids, such as phenylalanine, tyrosine and histidine, confer to the neurotransmitter constructing factor responsible for the neurotransmitter transmission of signals to the brain. The root of the plant is consumed fresh or dried or in the form of a capsule as a dietary supplement.[42] According to literature maca plant consumption seems to have a number of benefits for human health, which are summarized at Table 10:[2,42]

Cranberry (*Vaccinium oxycoccos*)

Cranberries (*Vaccinium oxycoccos*), is one type of red acidic berries which are fruits of small deciduous shrubs. Cranberries are mainly found in northern Europe and America. They are consumed fresh, dried, frozen as well as dietary supplements. They are very good source of nutrients and in particular 100 g of cranberries contain 13.30 mg of vitamin C, 4.60 g of fiber, 0.36 mg of manganese, 5.10 mg of vitamin K, and 1.20 mg of vitamin E, while having a very low calorie value. Cranberries are an excellent source of antioxidant ingredients, especially phenolic compounds and in particular they contain high concentrations of proanthocyanidins, flavonoids such as flavonols, quercetin and myricetin, ellagic

Table 10: Summary of some health benefits of maca plant

Health benefits	Compound/s responsible for benefits
improvement of sexual function and iIncreased fertility	high amino acid content
Improving the symptoms of menopause	Amino acids such as phenylalanine, tyrosine and histidine
antimicrobial and detoxifying action	vitamins B1, B2, B12, C and E, zinc, alkaloids, tannins and saponins
Antidepressant action	Amino acids such as phenylalanine, tyrosine and histidine
Supportive in endocrine system, adrenal glands and thyroid, while promoting regulation of metabolism	vitamins B1, B2, B12, C and E, zinc, alkaloids, tannins and saponins

acid and chlorogenic acid. Hence they have the potential to provide strong protection against free radicals.[43] Research data on the potential beneficial effects of cranberries within the organization are focusing on the following axes:

Cardiovascular System

Studies have shown that consumption of cranberries may retard the progression of the atherosclerotic process to arteries and lower LDL cholesterol levels, hence reducing the risk of developing cardiovascular disease[43]. Clinical and animal studies indicate that the consumption of cranberry juice decreases LDL and increases HDL cholesterol. Also, cranberry consumption improved lipidemic profile in mice fed a high fat diet.[44] Favorable effects of cranberry juice on blood lipids have been shown in the population, including obese men,[45] patients with diabetes mellitus[46] and patients with low HDL and hypertriglyceridemia.[47] Additionally, an in vitro study showed that cranberry extracts inhibit the conversion enzyme and, therefore, they reduce blood pressure.[48]

Urinary System

Research evidence has shown that this superfood may contribute to prevention and treatment of urinary tract infections due to high antioxidant content components and in particular proanthocyanidins, which have staling activity against bacteria such as *E. coli.*[43] In a meta-analysis,[49] with data from 10 studies with a total of 1,049 participants for a period of 12 months, results showed that the consumption of cranberry decreased the overall incidence of urinary tract infection by 35%, especially for women with recurrent urinary tract infections and have reduced the calvary annual percentage of new infections by 39%.[3]. Possible effect on cancer pathophysiology: Although the data is not yet clear, it seems that consumption of cranberry is likely to have little inhibitory effect on carcinogenesis and may contribute to the prevention of various forms of cancer such as breast, colon, prostate and lung cancer. This seems to be due to their ellagic acid content, antioxidant with strong action that prevents DNA alteration, but also other bioactive phytochemicals.

Other Actions

Consumption of cranberry seems to protect against the appearance of dental problems (gingivitis, plaque, periodontitis etc.). Also, data show a potential impact on acceleration metabolism, the relief of skin diseases and the improvement of mood, through the effect on hormones.[43]

Acai berries (*Euterpe oleracea*)

Acai berries are dark blue fruits and are fruits of a palm tree type with a height of 25 meters and 3-meter leaves, thriving in Amazon forest in Brazil. The acai berries are rich in ω-3 fatty acids, amino acids, proteins, electrolytes, metals, fibers, sterols, vitamins A, B1, C and E, iron, calcium, copper, magnesium, potassium and zinc. They contain in high amounts anthocyanins, which give them important antioxidant properties. The increased protein content, even higher than the egg, in combination with its important antioxidant properties make akai berry a superfood. One hundred (100) g of dried fruit purée of acai berries contain 8.1 g of protein, 52.2 g of carbohydrates, 32.5 g of fat, traces of vitamin C, 44.2 g of fiber, 260 mg of calcium, 4.4 mg of iron, 1002 IU vitamin A, glutamate and aspartic acid.50,51 Acai berries are consumed either raw or dried, while widely used as a dietary supplement in various forms. The scientific data suggests that eating acai berries within a balanced diet seems to offer significant benefits for the human organism. Consumption of this superfood seems to strengthen the human immune system, exerting intense antioxidant activity and preventing cell destruction by free radicals.[51] They also provide to the human body fatty acids such as ω-3 and ω-9, which improve the lipidemic profile and exert anti-inflammatory action. Additionally, it appears that

Table 11: Summary of some health benefits of Acai berries

Health benefits	Compound/s responsible for benefits
strengthening the human immune system	anthocyanins
anti-inflammatory action	ω-3 and ω-9 fatty acids
protection against cancer cells	vitamins A, B1, C and E and anthocyanins

help human body by excretion of harmful toxins. The high content of acai berry in antioxidants was proven along with its multiple benefits for health. With the participation of 12 healthy volunteers, improvements to metabolic levels and protection against cancer cells where proven. Also after taking blood and urine samples at 12 and 24 hours from the consumption of acai berries juice, a high concentration of antioxidants, mainly anthocyanins, was observed in the blood.[51,52] A summary of acai berries health benefits is presented at Table 11 below.

Goji berries (*Lycium barbarum*)

Goji berries are endemic fruits of Tibet. The fruits are easily oxidatized, and they are almost never fresh, except in the production areas. The degree of drying is differentiated depending on the species. They also called "berries of happiness" with the scientific name *Lycium barbarum.* Goji berries are one of the richest natural sources of nutrients, such as βcarotene, vitamins C, E, B1 and B2, minerals, antioxidants and amino acids. Also they contain a high percentage of carbohydrates, fatty acids and fibers. Goji's fruit contains 18 amino acids, 21 trace elements, such as zinc, calcium, germanium, selenium and phosphorus, vitamins of the B complex (B1, B2, B6), more beta-carotene than carrot, more iron from spinach, vitamin E, vitamin C at concentration 500 times higher than oranges, phytosterols, such as beta-sitosterol and beneficial fatty acids such as linoleic acid.[53] Goji berries are superfood with multiple benefits within the human organism. The most important action documented by many studies, is the strong antioxidant protection against the harmful free radicals present in the human body. This has the consequence of being important contributing firstly to the prevention of diseases such as cardiovascular diseases and diabetes, the pathophysiology of which is promoted in the presence of free radicals, and secondly to the strengthening of the immune system. Another action of the goji berries being studied is the possible protection against cancer, although the data is not clear. The presence of polysaccharides in the form of glycosides appears to be associated with an effect on mechanisms of carcinogenesis, while the presence of germanium and various antioxidant substances enhance the potential protection against cardiovascular action. Concerning the effect on cardiovascular prevention goji berries contribute to the reduction of LDL and lowering of blood pressure. Additionally, consumption of goji berries has been associated with the enhancement of the endogenous antioxidant system, through increased production of enzymes such as superoxide dismutase, resulting in reduction of LDL oxidation. The contribution of goji berries to the proper regulation of blood sugar concentration and prevention of insulin resistance is scientifically recognized, since these are the key factors for the prevention of type II diabetes. Research data demonstrate the beneficial effects of goji berries and the enhancement of sexual function, by increasing testosterone levels.[53,54] Goji berries can reduce inflammation, reduce blocking of the blood vessels, while they can contribute through the antioxidants contained in the prevention of various types of cancer. Goji contribute to improved vision due to its high content of antioxidants, including compounds such as zeaxanthin, lutein, polysaccharides and polyphenolic compounds. Beta-sitosterol of Goji berries seem to significantly inhibit stomach cancer, suppressing the reproduction of cells and toxicity production of cancer cells.[54] But there are not sufficient scientific data, but only indications hence further research for safer conclusions are needed. A summary of acai berries health benefits is presented at Table 12 below.

Table 12: Summary of some health benefits of Goji berries

Health benefits	Compound/s responsible for benefits
Prevention of cardiovascular diseases and diabetes	Polysaccharides in the form of glycosides, germanium and various antioxidant substances
Reduce of inflammation and blocking of the blood vessels	Antioxidants like phenolic compounds
Stomach Cancer prevention	Beta-sitosterol
Improve vision	Zeaxanthin, lutein, polysaccharides and polyphenolic compounds

Ginger Root (*Zingiber officinale*)

Ginger comes from South Asia with its cultivation now spreading to almost all tropical countries. It comes from a herbaceous plant of the family of *Zingiberaceae*, while it consists of a fleshy rhizome with dense branches. Mainly it consists of water (80%), while it contains satisfactory quantities of potassium, zinc and polyphenols. The nutritional value of ginger per 100 g is: 0.4 g fat, 18 g carbohydrate, 2 g fiber, 2 g protein, 43 mg magnesium, 2 mg copper, 415 mg potassium, 34 mg phosphorus, 16 mg calcium, sodium 13 mg, vitamin C 5 mg, folate 11 μg.55 The main bioactivity and health benefits following ginger root consumption, as documented by various research studies, is presented below at Table 13.[56,57]

Pomegranate (*Punica granatum* L.)

Pomegranates are the fruit of the plant *Punica Granatum* L., which is a deciduous shrub 2-4 meters high or small tree of 5 to 7 m high. It is cultivated all over the world and thrives in light and cool soils, and multiplied during spring. The fruit of the pomegranate in most varieties consists of 24% bark, 14% of the spores and 62% of the juice. Pomegranate is considered a popular edible fruit, while in recent years a lot of scientific studies show potential beneficial effects of the pomegranate on health promotion and advocacy from various pathologies situations, hence scientists consider it as superfood. The important properties of the pomegranate are directly related to its high content of bioactive substances, including phenolic compounds, polyphenols, ellagitannins and vitamins. Many of these phytochemicals have been shown to have significant antioxidant and anti-inflammatory properties which promote human health. The most important pomegranate polyphenol is punicalagin which is responsible for over 50% of the strong antioxidant activity of the juice. The high content of pomegranate in polyphenols seems to be associated with the prevention of hypertension and endothelial function improvement.[58,59] Studies have shown that consumption of pomegranate juice can lead to improved arterial blood pressure, reduced triglyceride levels and increased HDL cholesterol. Therefore, and in combination with other data, there is evidence of a significant contribution of pomegranate to slowing the atherosclerotic procedure and reducing the risk of cardiovascular disease. Also, the punicic acid, which is found in the seeds of pomegranate, has been shown to inhibit the formation of prostaglandins. Generally, several studies have concluded that pomegranate juice consumption can be beneficial to high-risk populations of atherosclerotic and cardiovascular diseases, as well as people with high risk factor for diabetes. The high content of polyphenolic components, such as anthocyanins, ellagitannins, etc., can lead to improvement of cardiovascular biomarkers, provided that pomegranate is part of a balanced diet.[60] A summary of pomegranate health benefits is presented at Table 14.

Donkey Milk

Donkey milk seems to be the best substitute for human milk due to its content of lactose, proteins,

Table 13: Summary of some health benefits of Ginger root

Health benefits	Compound/s responsible for benefits
Cardiovascular disease prevention	polyphenols
Digestion	Inorganic compounds
Antimicrobial and anti-inflammatory activity	Vitamin C, potassium, zinc and polyphenols

Table 14: Summary of some health benefits of pomegranate

Health benefits	Compound/s responsible for benefits
Antioxidant activity	phenolic compounds especially punicalagin, polyphenols, ellagitannins and vitamins
Hypertension prevention and endothelial function improvement	Punicalagin
Reducing the risk of cardiovascular disease	punicic acid, anthocyanins, ellagitannins

minerals and ω-3 fatty acids. In recent years, studies have highlighted its attributes and is considered as a superfood. The effect from colostrum and donkey milk (of the Martina Franca breed) in general has been evaluated on the functioning of the nerve cells of human peripheral blood (PBMC) to different intervals from lactation. The results showed that colostrum caused higher IgG responses, whereas donkey milk has triggered higher immunoglobulin G (IgG) responses, substances which are related to the strengthening of the immune system. Both the milk and colostrum had an effect on CD25 and CD69 of mononuclear cells that are related to the immune system via their involvement in T-cells. The ability of donkey milk to induce interleukins (IL) (IL-12, IL-1 beta and IL-10) release and tumor necrosis factor alpha (TNFa) was restricted to milk only, while colostrum lacks this ability. Finally, both colostrum as well as milk caused the release of nitric oxide (NO) with milk showing greater NO release activity, which promotes vasodilatation of the arterial endothelium. Taken together, these immunological effects are caused both from colostrum and donkey milk, can be useful in the prevention and / or treatment of human diseases associated with the immune system. Also, NO production from donkey milk can be very useful in preventing atherosclerosis, being a powerful vasodilator and an effective antimicrobial agent, as pathogens and / or their products play a strong proatherogenic role. Finally, donkey milk has been shown to have antimicrobial activity primarily against pathogenic microorganisms, hence protects against possible infections within the human body. However, more research is needed to strengthen data about the vigorous effects of donkey milk.[61,62,63]

Summary of Superfood Properties

The Antioxidant Properties of Superfoods

Superfoods include a number of beneficial ingredients which the human organism is making use of, for the overall health improvement and the treatment of certain diseases. Superfoods when consumed even in small quantities are beneficial for the human body due to the number of beneficial substances contained. Some of the most important superfoods, such as kefir, maca plant, acai berries, goji berries, hippophaes, maize, blueberries, royal jelly, spirulina, ginger, donkey milk and pomegranate have become particularly important for the human health. Other superfoods that are reported in the literature are the aronia plant, quinoa, blackberry, and others. The most important benefit of superfoods has been shown to come from their high antioxidant content, such as carotenoids, vitamins A and E, and polyphenols. The creation of free radicals in the body is a result of normal biological processes, but the overproduction has a deleterious effect, destroying healthy cells speeding up the aging process and significantly increasing the likelihood of various diseases. At this point antioxidant components interfere and inhibit this process, scavenging the free radicals and inhibiting the resulting pathophysiological conditions associated with a variety of degeneration diseases. In a study conducted at the Department of chemistry at the National and kapodistrian University of Athens (Proestos' unpublished work), the total antioxidant capacity (measured by the Ferric Reducing Antioxidant Power, FRAP assay) and total phenolic components (measured by Folin Ciocalteau method), after extraction with 50% aqueous methanol of various dried superfoods

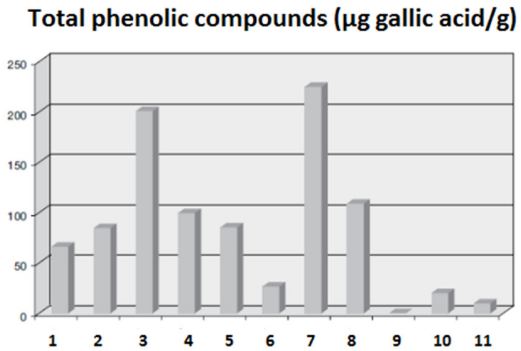

Fig. 1: Total phenolic compounds content (in μg gallic acid/g) of some superfoods, where: 1-cranberries, 2-aronia plant, 3-goji berries, 4-hppophaes, 5-blueberries, 6-quinoa, 7-raspberry, 8-acai berries, 9-ginger root fresh, 10-ginger root dried and 11-maca plant

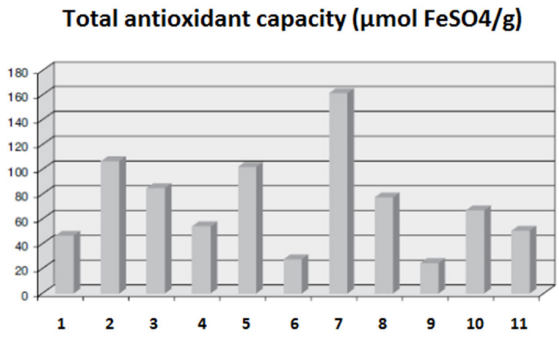

Fig. 2: Total antioxidant capacity (in µmol FeSO4/g) of some superfoods, where: 1-cranberries, 2-aronia plant, 3-goji berries, 4-hppophaes, 5-blueberries, 6-quinoa, 7-raspberry, 8-acai berries, 9-ginger root fresh, 10-ginger root dried and 11-maca plant.

was determined. The results showed high content of total phenolic compounds in goji berries, aronia plant, hippophaes, blueberries, acai berries and raspberries, with goji berries and raspberry displaying the highest prices, which is explained by the high concentration of anthocyanins (Fig 1).

All of the above superfoods are rich in polyphenols, and in particular flavonoids, which have a high antioxidant activity. This also explains the high antioxidant activity observed in the same study for most of the superfoods with raspberries, aronia plant, blueberries and goji berries having the highest values (Figure 2).

The high antioxidant activity of superfoods is due to the high concentration of polyphenols on the one hand, and on the other the synergistic action of polyphenols with other antioxidants, such as carotenoids and vitamins A and E.

Superfoods within the Daily Diet

A review of the scientific data shows that superfood consumption can offer the human body a plethora of antimicrobial and antioxidant substances, fiber, plenty of vitamins (A, B, C, K, etc.), inorganic compounds but also beneficial fatty acids such as ω-3, ω-6 and other ingredients in quantities that often exceed the typical daily intake of other foods. The inclusion of superfoods in the daily diet can contribute to reduce the risk of various degenerative diseases, such as cardiovascular diseases, diabetes, metabolic syndrome, obesity, neurological conditions and cancer. So it seems that superfoods serve the basic role of conventional functional foods in prevention, offering a high amount of bioactive compounds. At the same time, it is important that they provide a plethora of nutrients typically having low caloric content. Regardless of any recognized and scientifically documented health benefits of superfoods, it should be noted that a nutritional program should not be exclusively based in the presence of superfoods but these must be part of a healthy and balanced diet. However, continuous and fast rhythms of everyday life have led to the formation of a diet model in which certain foods which offer value nutrients are missing. This very "nutritional gap" can be covered by superfoods, by offering balanced nutrition on the one hand and significant health benefits on the other. That's the point where particular importance should be given to include superfoods in more and more nutritional standards, but not to replace the consumption of other foods that provide the human body with valuable nutrients. It is important, on the one hand, that consumers are informed by qualified scientific sources for those 'superfoods ' for which there are sufficient evidence of their beneficial effects on human health to avoid the possibility of misleading, and on the other hand to understand that superfoods, which are more likely to be consumed as supplements, may have an adverse effect on their health (e.g. hypotension, pro-oxidative stress, removal from a balanced food, etc.). The continuous spread of superfoods is a fact due to the tendency to find new ways of shielding health, due to intense rhythms life of modern reality. In this context, superfoods when consumed stably and meticulously, preferably in the form of fresh or dried foodstuffs and only in special cases as supplements, always in the context of a balanced diet, can play an

important role in the direction of health promotion and the prevention of chronic diseases.

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Conflict of interest

The author declares no conflict of interest

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