

Nutraceuticals in health care

Muhammed Majeed and Appian Subramoniam

Nutrition is an essential requirement of all living organisms. Humans obtain nutrients from foods that are directly or indirectly obtained from other organisms such as plants, animals and microbes. In the long human evolutionary period, based on vast trial and error experiences and empirical knowledge at various stages of human social development and organization, different cultural groups identified many plants, animals and microbes as edibles and certain others as medicines. Materials identified as edibles are time tested for their safety for long time use within reasonable quantities. There are foods with both nutritional and medicinal values. This article focuses on such food materials, plant food in particular, for human health care and well-being.

Nutraceuticals

The term 'nutraceutical' was coined from the words 'nutrition' and 'pharmaceutical' by Dr. Stephen L. DeFelice in 1989 (Brower, 1998). He defined nutraceutical as "a food or part of food that provides medical or health benefits including the prevention or treatment of disease". Since the term was coined by Dr. DeFelice, its meaning has been modified by Health Canada as "a product isolated or purified from foods, and generally sold in medicinal forms and demonstrated to have a physiological benefit or provide protection against chronic diseases".

Sami Labs Ltd, Bangalore, India.

E-mail: subramoniam@samilabs.com

If ingredients of diet or edible items have medicinal values, they are also known as medicinal foods or bioactive foods or, even, functional foods. If a functional food aids in the prevention and / or treatment of one or more diseases and/or disorders, it is a nutraceutical (Kalra 2003). Normally, functional foods are designed to allow consumers to eat enriched foods close to their natural state (Hardy, 2000). Now, nutraceutical refers to food or any product derived from food sources with medicinal values or health benefits in addition to their basic nutritional value (Subramoniam, 2016).

Food materials (ingredients of diet) with medicinal properties are medicinal foods or nutraceuticals. However, medicinal foods are not available as an over-the-counter product to consumers in USA (Brower, 1998). The FDA considers medical foods "to be formulated, to be consumed or administered internally under the supervision of a physician, and which is intended for the specific dietary management of a disease or condition for which distinctive nutritional requirements are established by medical evaluation" (Hardy, 2000). But, these demarcations are not applicable in all countries.

A dietary supplement is a product that contains nutrients derived from food products that are generally concentrated as liquids, powders, tablets, capsules, etc. If a dietary supplement contains one or more bioactive compounds that aid in the prevention and/or treatment of diseases

or/and disorders, it is also a nutraceutical. For example, garlic extract is sold as dietary supplement to lower blood lipids.

Nutrition and nutraceuticals

In health care, first, adequate nutritious food is required to combat nutritional deficiency and malnutrition. Disorders and other medical conditions caused by nutritional deficiencies and malnutrition could be rectified with an adequate intake of balanced nutritious food, if irreversible changes have not occurred due to very severe level of nutritional deficiency early in life. This should not be confused with nutraceuticals. However, nutrients such as anti-oxidant vitamins, essential amino acids, and essential fatty acids are considered as nutraceuticals by many investigators. In health care, adequate balanced nutrition should be accompanied by appropriate amount of regular nutraceutical intake. Need-based nutraceutical consumption should be identified according to the physiological status, health status and specific medical conditions of each individual concerned.

Plant nutraceuticals

Plant foods are edible parts of plants (as such or after cooking, processing, etc.) accepted by any community through custom, habit and tradition as appropriate, desirable food or ingredient of diet. Generally, food items provide nutrients to the body without any short or long term adverse effects to health and well-being.

Plant based nutraceuticals are plant products with nutritional and medicinal values. The preference for the discovery and production of nutraceuticals over

pharmaceuticals is well seen in pharmaceutical and biotech companies. One of the reasons for the same is that diet and dietary ingredients with medicinal properties are likely to be very safe. Herbal drugs which are not edible are not nutraceuticals.

Farmaceuticals refer to medically valuable compounds, produced from modified agricultural crops or animals (usually produced through biotechnological intervention). If a non-nutraceutical drug is produced in an edible plant, it is not a nutraceutical.

Ayurvedic and other traditional medicines from plants should not be considered as nutraceuticals, if they are not from edible parts of plants. Ayurveda and traditional medicinal plants should be backed by modern scientific research and technologies. For example, the presence of hepatotoxic pyrrolizidine alkaloids in certain medicinal plants used in Ayurveda and local health traditions has been reported.

Certain pharmacy and biotech companies erroneously extended the term nutraceutical even to isolated compounds from wild plants which are not edible (Kamboj, 2000). This is a dangerous trend considering human health. However, if a bio-active compound present in a food is isolated from a non-edible (but non-toxic) plant, it can be considered as a nutraceutical. Natural health products that promote health include both nutraceuticals as well as herbals and other natural products (Shahidi, 2012). Botanicals are often used as synonyms for herbal products. There is a need for a legal

distinction of plant nutraceuticals from pharmacologically active herbals or botanicals (Koch et al. 2014).

Utilization of nutraceuticals

Many diseases can be prevented and life span can be prolonged with appropriate use of nutraceuticals and healthy lifestyles. Nutraceutical can improve health and well-being and prevent diseases to a considerable extent and support economic development. Food supplements and functional foods (other than nutraceuticals) could combat malnutrition and specific nutritional deficiencies. Examples of plants with nutraceuticals are given along with their edible parts and health benefits in **Table 1**. Examples of nutraceutical compounds include epigallocatechin gallate, piperine, quercetin, curcumin, lycopene, resveratrol, capsaicin, mangiferin, zingerone, gingerols, shogaol, ω -3 fatty acids, α -lipoic acid, genistin, rutin, hydroxycitrate, garcinol, pterostilbene, sesamin and thymoquinone.

Common people should understand the medicinal value of natural whole food nutraceuticals which can be consumed in its natural form. Many fruits, vegetables, grains, spices etc. contain compounds that deliver health benefits beyond their basic nutrition. Drug-nutraceutical interactions, interactions between different nutraceuticals as well as interactions between nutrients and nutraceuticals, and the effect of cooking and processing on the nutraceutical compounds and their efficacy should be determined by scientific studies. Besides, interaction of nutraceuticals with gut environment including microbes should be considered. For example, one study

reports that fenugreek seeds when taken with hot water showed anti-diabetic property, whereas the same when consumed with curd did not exhibit the anti-diabetic property (Kassaian et al., 2009).

Since nutraceuticals have pharmaceutical properties, like drugs, nutraceuticals should be consumed at the effective levels or optimum amounts. These amounts have to be determined by controlled clinical trials. People with specific diseases such as diabetes, cardiovascular diseases, arthritis, osteoporosis, obesity, hyperlipidemia and liver function impairment should consume specific amounts of carefully selected nutraceuticals on a regular basis. Nutritional research should focus on the examination of foods for their protective and disease preventing roles. In many cases, a medicinal food may have preventive and/or curative roles in more than one disease or health problem. Such foods (nutraceuticals) may have more than one pharmacologically active phytochemical (nutraceutical). In some cases, even one isolated nutraceutical molecule could be beneficial in more than one disease and medical condition. However, in most of the cases, rational mixtures of nutraceuticals could be more beneficial.

Antioxidant nutraceuticals

Certain anti-oxidant phytochemicals exhibit health benefits including prevention of cancer, cardiovascular diseases, etc. Such anti-oxidants present in the food are also nutraceuticals. Most of the chronic diseases such as neurodegenerative diseases, arthritis, diabetes and so on carry with them a great

deal of oxidative stress. The required levels of anti-oxidants differ between infants, children, adults, elderly people, etc. Reactive oxygen species are produced in the body as well as removed from the body. Certain food contains pro-oxidants and certain other food contains anti-oxidants. In the body, the balance between pro-oxidants and anti-oxidants in relation to the physiological state of the body determines the final effects. With age and certain disease such as arthritis, neurodegenerative diseases and diabetes, the oxidative stress increases; so, elderly people and people with certain diseases require more anti-oxidant containing foods compared to healthy young growing people. Some amount of oxidants is required for normal growth and function of the body. Examples of high levels of antioxidant containing nutraceutical include green tea (epicatechin, and epigallocatechin-3-gallate), and spinach (α -lipoic acid, leutin, etc.).

Spices as nutraceuticals

Most of the spices have varying levels of antioxidant, hypolipidemic and anti-inflammatory properties. These properties are beneficial in cardiovascular function and support in preventing and/or controlling cancer and diabetes. It should be remembered that most of the spices are used in very small amounts in food preparations. High concentrations of certain spices could be toxic. When purified nutraceutical compounds from food, spices in particular, are used, the tolerable dose should be studied based on clinical trials; too high doses may not provide desired health benefits and in rare cases toxicity may develop. Long term

clinical studies are needed to scientifically validate the role of different nutraceuticals in different diseases. Certain nutraceuticals are helpful to cope with the adverse effects of climatic conditions. For example, thermogenic spice, black pepper is more beneficial in cold climatic conditions.

Nutraceuticals for cardiovascular support

The major risk factors of cardiovascular diseases are hypertension, hyperlipidemia (particularly, high levels of low density lipoprotein cholesterol) and mental stress associated hormones. Anti-atherogenic/anti-atherosclerotic, anti-hyperlipidemic and anti-inflammatory nutraceuticals given below as well as strong antioxidants provide cardiovascular support. High intake of fruits, vegetables, vitamins and minerals are recommended for prevention and treatment of cardiovascular diseases.

Anti-atherogenic / anti-atherosclerotic nutraceuticals

Important risk factors of atherosclerosis are hyperlipidemia, oxidative stress, elevated blood pressure and, to some extent, inflammation. Edible plant parts with anti-hyperlipidemic and/or antioxidant activity include onion, garlic, peanut, cauliflower, leaf and unripe fruit of moringa (*Moringa oleifera*), bilimpi fruit, green tea, coriander, turmeric, soybean, bottle gourd, bitter melon, Indian gooseberry, red ripe tomato (tomato contains lycopene, a powerful antioxidant), spinach, rice bran, fenugreek, ginger, cinnamon, black berry, low bush blue berry and papaya fruit. Omega-3 fatty acids (which provide health benefits by modulating inflammation, lipid metabolism

and immune function) are present in salmon, flax seed, walnuts, etc.

Anti-hyperlipidemic nutraceuticals

These include garlic, bilimpi (*Averrhoa bilimbi*), rice bran, resveratrol, β -sistosterol and ω -3 polyunsaturated fatty acids (anti-arthrosclerosis). Soluble fibres such as pectins from apples and citrus fruits, β -glucan from oats and barley, fibres from flax seed, etc. are known to lower low density lipoprotein cholesterol.

Anti-inflammatory nutraceuticals

Examples of anti-inflammatory nutraceutical compounds are pheophytin-a (magnesium free chlorophyll-a), curcumin, gingerols, shogaol, quercetin and linolenic acid. Most of the nutraceuticals given under, Nutraceuticals for arthritis, possess anti-inflammatory properties.

Nutraceuticals for arthritis

Since arthritis exhibits inflammation of joints, pain, oxidative stress and hyperimmune reactions (particularly in the case of rheumatoid arthritis), nutraceuticals with high levels of one or more of these properties could ameliorate the symptoms of arthritis. Antiarthritic plant foods, when consumed regularly to the optimum level, could be extremely safe without the adverse effects of currently used NSAIDs (Non-Steroidal Antiinflammatory Drugs) and immune-suppressors. Antiarthritic foods include tea leaf (*Camellia sinensis*), cinnamon, ginger, coriander seed, turmeric, black pepper, fenugreek seed, carrot and black berry (*Syzygium cumini*). Examples of pure chemical entity nutraceuticals with antiarthritic properties include chlorophyll-

a and its degradation products, curcumin, epigallocatechin gallate, lycopene, mangiferin, quercetin and β -sitosterol.

Anti-obesity nutraceuticals

Nutraceuticals like hydroxycitrate from *Garcinia cambogia* fruit, pterostilbene from blue berries etc, anthocyanins from kokum (*Garcinia indica*), fruits of bitter melon (*Momordica charantia*), rhizome of nut grass (*Cyperus rotundus*), common bean (*Phaseolus vulgaris*), raw butter milk (contains conjugated linoleic acid), etc. possess anti-obesity activity.

Anti-diabetes nutraceuticals

These include fenugreek seed, ginger, coriander seed, cluster bean, bitter gourd, lady's finger (okra), gooseberry, ivy gourd, sweet potato, cucumber, almond, rim of water melon fruit and mango fruit peel (Subramoniam, 2016).

Anticarcinogenic nutraceuticals

Fruits and vegetables with vitamins A, C, E and trace elements like selenium may prevent cancer development to a large extent (Ranzato et al. 2014). Examples of anti-carcinogenic nutraceuticals include leaves and unripe fruits of drumstick tree (*Moringa oleifera*), thymoquinone from black cummin (*Nigella sativa*), curcumin (turmeric), genistein (soybean), quercetin (many fruits and vegetables), resveratrol (grapes, groundnut, etc.), limonene and *Lactobacillus acidophilus*.

Hepatoprotective nutraceuticals

These include bengal gram, sugarcane juice, gooseberry, carrot, wheat extract, mango peel (Ebeid et al. 2015), *Citrus paradisi* (naringenin), grapes (resveratrol),

ginger (zingerone), kokum (*Garcinia indica*) fruit (garcinol), limonene and piperine. High level of anti-oxidant containing food materials will protect from oxidative stress mediated toxic chemicals-induced liver damage.

Nutraceuticals for bone health or osteoporosis

Phyto-estrogens present in nutraceuticals such as soybean products (genistin and daidzein) and stem of *Cisus quadrangularis* provide bone health, particularly to postmenopausal woman. Examples of other nutraceuticals believed to be beneficial to bone health are spinach and other leafy vegetables, flax seed, inulin (naturally occurring polysaccharide) and conjugated linoleic acid (present in raw butter milk).

Conclusion

Health and well-being could be improved with appropriate use of nutraceuticals coupled with physically and mentally active life style and reduced mental stress. Each individual should identify with the help of experts of nutrition and medical doctors, appropriate nutraceuticals (combination of different foods with medicinal properties) along with required quantity to be consumed depending on the physiological status and medical conditions. Further research and clinical trials are required to fix appropriate doses and combinations of nutraceuticals to be consumed in specific individual cases.

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Table 1: Examples of commonly available plants with nutraceuticals

Botanical name	Common name	Edible parts	Major health benefits identified
<i>Allium sativum</i> L. (Amaryllidaceae)	Garlic	Bulbs	Anti-hyperlipidemic, anti-atherosclerotic, etc.
<i>Apium graveolens</i> L. (Apiaceae)	Celery	Leaf stalks (vegetable) and seeds	Antihypertensive (diuretic), anti-arthritis and skin support
<i>Comellia sinensis</i> (L.) Kuntze (Theaceae)	Tea	Leaves	Antioxidant, etc.
<i>Coriandrum sativum</i> L. (Apiaceae)	Coriander	Seeds and leaves	Anti-inflammatory, anti-diabetes, antimicrobial, etc.
<i>Curcuma longa</i> L. (Zingiberaceae)	Turmeric	Rhizomes	Antioxidant, cancer preventive, anti-inflammatory, etc.
<i>Garcinia indica</i> Choisy (Clusiaceae)	Kokum	Fruits	Hepatoprotection, anti-obesity, antioxidant, etc.
<i>Garcinia cambogia</i> (Gaertn) Desr. [<i>Garcinia gummi-gutta</i> (L) Roxb.] (Clusiaceae)	Kudam puli, Malabar tamarind	Fruits and fruit rinds	Anti-obesity, hypolipidaemic, anti-diabetes, anti-inflammatory, etc.
<i>Glycine max</i> (L.) Merr. (Fabaceae)	Soybean	Beans	Cancer preventive, bone health support, anti-atherogenic, etc.
<i>Momordica charantia</i> L. (Cucurbitaceae)	Bitter gourd (bitter melon)	Fruits	Anti-diabetes, etc.
<i>Moringa oleifera</i> Lam. (Moringaceae)	Drumstick tree	Leaves and fruits	Cardiovascular support, liver support and anticancer
<i>Nigella sativa</i> L. (Ranunculaceae)	Black – caraway (black cumin)	Seeds	Liver support, blood sugar support and anticancer
<i>Phyllanthus emblica</i> L. [syn: <i>Embilica officinalis</i> Gaertn](Phyllanthaceae)	Indian gooseberry	Fruits	Antioxidant, anti-diabetes and liver support
<i>Piper nigrum</i> L. (Piperaceae)	Black pepper	Fruits	Thermogenic, nutrient absorption enhancer, etc.
<i>Punica granatum</i> L. (Lythraceae)	Pomegranate	Fruits	Antioxidant, etc.
<i>Solanum lycopersicum</i> L.	Tomato	Fruits	Cardiovascular support, cancer

(Solanaceae)		(culinary vegetable)	prevention, etc.
<i>Spinacia oleracea</i> L., (Amaranthaceae)	Spinach	Leaves (vegetable)	Cardiovascular support, anti-diabetes, antioxidant, etc.
<i>Trigonella foenum-graecum</i> L. (Fabaceae)	Fenugreek	Seeds and leaves	Blood sugar support, anti-hypercholesterolemic, etc.
<i>Vitis vinifera</i> L. (Vitaceae)	Grape	Fruits and seeds	Antioxidant, hepatoprotective, etc.
<i>Zingiber officinale</i> Roscoe (Zingiberaceae)	Ginger	Rhizomes	Digestive aid, anti-inflammatory, anti-arthritis, etc.