

Aspects of Nutraceuticals as Medicine for Humans

Imran Husain, Rishabh Charan Choudhary*

*Corresponding Author

Assistant Professor

School of Applied Sciences and Agriculture

Suresh Gyan Vihar University, Jaipur, Rajasthan

Email id- emraanhusain@rediffmail.com, c.rishabh84@gmail.com

Abstract

“Nutraceutical” is the combination of two different words, ‘nutrition’ and ‘pharmaceutical’. When considering nutrition in broader sense they are the food that play eminent role in maintaining and reshaping the essential physiology that is involved in the maintenance of human health where as pharmaceutical meaning having medicinal properties. Thus, Nutraceuticals are the substances, which carries both nutritional as well as medicinal properties. The major argumentation for the development of nutraceutical market globally is the recent trend for the human population suffering from various diseases. Basically the food items that are being used as nutraceuticals are classified as antioxidants, probiotics, dietary fibers and polyunsaturated fatty acids and prebiotics also including many other herbal foods. Such nutraceutical products claim to encounter some of the biggest health problems of the modern era people such as cardiovascular diseases, osteoporosis, arthritis and cancer etc. In perfect sense ‘nutraceutical’ shall be preeminent in the modern era of medicine in which food industry inculcates much more as a research-oriented area.

Key words: Nutraceuticals, Probiotics, Dietary fiber, Antioxidants

Introduction

The advanced contemporary life style of people these days has completely changed the primary food habits of common people. Expenditure and consumption of the junk food is enhancing day by day and is readily increasing the cases of inappropriate nutrition. Moreover obesity has now been identified as a global controversy. Although the cardiac problems are the major cause of deaths when it comes to the developing countries, further arthritis, osteoporosis and many others included. Problems have been arisen due to consumption of the processed food as it has been far away from the natural state. Processed food lacks most of the nutrients that are lost during food processing. It has been said by Hippocrates, some 2500 years ago “Let food be your medicine and medicine be your food”. His framework is quite corresponding to the concept of nutraceuticals. Initially the nutraceuticals are making up their presence noticed as a cadre of products of natural origin those are on the verge of reducing the gap in between food and drugs substantially (Adelaja and Schilling 1999). Despite the fact application of nutraceuticals has been used up by the people all over the history, only modern scientifically supported provided the base to the nutraceuticals to appear as being highly effective and useful (Pathak 2011, Dillard and German 2000). Comprising the both types of nutraceuticals that are found to have emerged from the plant and animal sources holds up an intriguing chances when it comes to food industries in order to make a innovative future food product that is widely acceptable. Basically more and more nutritional studies are now concerned more on potential of food to exhibit properties that based on their ingredients are disease preventive and protective in nature (Nicoli et al.1990). In the

recent year perception about nutraceuticals is increased which has increased the market affinity towards using such nutraceutical products (Kennedy et al., 2012, Mark B et al., 2011) and has lead to develop multibillion-dollar industry world wide (Nicoletti 2012). Based on the increasing demand of nutraceuticals it is predicted that countries like Mexico, Russia China, India, and Brazil may become the largest producers of nutraceuticals (Freedonia Group 2011). In Indian medicine such as Ayurveda medicine nutraceuticals are defined as the extracts of food having beneficial effect on human health (Choudhary and Singh 2012). Current review is focused on the general perception and health advocating influential effects of nutraceuticals that comprises the probable chance of being incorporated as a food product.

Nutraceutical

The perception of “nutraceutical” first arose in the scrutiny from Germany, U.K and France, where the diet was given higher regards rather the exercises and genetic factors in order to achieve a better health condition (Pandey et al 2010). Eventually the term “nutraceutical” was conceived from “nutrition” and “pharmaceutical” by Stephen De Felice, the very founder and chairman of the Foundation for Innovation in Medicine (FIM), Cranford, NJ in 1989 (Maddi et al. 2007; Brower 1998). When we refer to the concept of De Felice, nutraceutical can be simply elaborated as,” a food that provides both the health and medical advantages, also concluding the prevention and cure for the particular disease”. Vice versa, Health Canada defines the term nutraceutical as “ a product that is made from foods, but sold in a finalized version of pills, or powder or in other useful forms, but is not normally associated with foods” (Wildman 2001; Bull 2000). Generally nutraceuticals are commonly

found as the cocktail of different products arising from the food industry and also as a herbal dietary supplements available in the market used widely in pharmaceuticals and which gave rise to the modern amalgamation of pharmaceuticals, agribusiness and nutrition conglomerates. Considered in a wide variety of range starting from specially isolated nutrients, dietary supplements, herbal products and also including the genetically engineered designer foods and processed food products that includes soups, beverages and cereals (Malik 2008; Dureja et al. 2003). Nutraceuticals wrap up most of the common therapeutic areas such as cold, cough and depression (Pandey et al.2010). The market of nutraceuticals is exhibiting very consistent and fast growth it achieved a rapid increment from \$46 billion to \$75 billion in comparison with the year 2002 to 2007 (BCC Research). The market of nutraceuticals is mainly present in the developed nations like UK and USA (BCC Research). Converging and focusing towards the rapid development finally has resulted in an emerging peak in the field of nutraceuticals, but the recent fast development has also arises the natural need for the checking of nutritional standards and quality control of such items that are widely available in market linked to different nutraceutical companies.

Classification of Nutraceuticals

Most ordinarily accepted ways, which qualifies for the classification, have their basic foundation on their mode of action, food sources and origin. The food antecedent used as nutraceuticals is all natural and distributed in the following manner (Kalia 2005; Kokate et al.2002).

- 1. Spices**
- 2. Antioxidant vitamins**
- 3. Probiotics**
- 4. Dietary Fiber**

5. Prebiotics

1. Spices: They are always considered as an abstruse for food wide used as an additional ingredient, basically is in practice since many centuries in order to enhance the taste and aroma of the food. There is a wide variation in the quantity and quality of spices and their products that generally belongs to the tropical countries. As the differential and typical climatic conditions effects the characteristic aroma and flavor of food, eventually effecting the texture and also modifying the appetite. Contemporary research exhibits that specialized dietary spices though are used in minute quantities but they do have their profound effect on human health as they impart the chemopreventive, antioxidative and immune modulator effects on cellular level. They provide advantage for the human health by their mechanism of action in reproductive, neural and cardiovascular systems (Kochhar 2008; Lampe 2003; Kretchmer 1994; Kohlmeier et al.1995; Hendrich et al.1994; Rao 2003; John 2001). Most basic utilitarian facet of the spices are described in many research papers. The most peripheral ingredient of species are terpenes in combination with the essential oil. Their medicinal and therapeutic properties had been discovered in different forms. For example, about 6 cloves of garlic and 51g of onion in their perfect raw form are most sufficient in order to reduce the cholesterol level of humans Kochhar 2008; Lampe 2003; Kretchmer 1994). The current studies and analysis on lipid profile including the blood pressure of moderately hypercholesterolemic subject exhibited better and beneficial effects when the dietary supplement was used with aged garlic extract in comparison to the fresh ones (Steiner et al. 1996). Further, a combination of fish oil and garlic was reported to had a better influence on serum lipoproteins

and lipids concentration as they help by providing a associated activity for reducing the LDL cholesterol level and triglyceride concentration. Considering plenty of cases when spices are used in food they are always harmless but just like the medicine higher dose can be toxic in nature if their dosage to be admisintered is turned high up and also due to with the cocktail formation with the other pharmaceutical products (Ernst 2003; Argento et al.2000). As plenty of reports have stated that overdose of garlic may result in the adverse influence on health resulting in kidney toxicity, liver damage etc (Bannerjee at al.2003) and other skin related issues (Sahu 2002). On the other hand over eating of onion also caused the lung and several other tissue damage in rats (Ali et al. 2000). Eventually the regular consumption of curcuminoid effectively reduces blood lipid peroxide level by about 33% because of their antioxidant activity (Sreejayan and Rao 1994).

2. Antioxidant vitamins: Vitamins C, E and carotenoids are mutually considered as the vitamins with antioxidant nature. Such vitamins can work singularly and also in collaboration for the avoidance of oxidative reaction those may result into many of degenerative disorders and diseases that may include cardiovascular diseases and cancer etc (Elliot 1999). Basically such are plentiful among many vegetables and fruits and commonly strive their protective action by the free radical scavenging activity. Moreover vitamin E consist of tocoperol altogether with the tocoterienols transfer their hydrogen atom and savenge the remaining single oxygen and other profounf reactive species hence, it protects the peroxidation of PUFA included in the biological membrane and LDL through the mechanism of free radical scavenging acivity (Meydani 2000). Basically the tocoperol are found to be of

more mobile inside the biological membrane than to the tocoperols as the presence of unsaturated side chain and eventually it penetrates tissues with saturated fatty layers (Watkins et al.1999). On the other hand selenium and vitamin E had a combined role when it comes to the role against the case of liquid peroxidation. Also the vitamin C is renound as ascorbic acid and it signify the hydrogen atom to the lipid radicals, that satisfies oxygen radical and removes the oxygen of molecular nature. The process of scavenging of radicals that are of aqueous nature is due to the combined nature and effect of vitamin C and E supplementation is well renounced all over for their antioxidant mechanism (Lee et al.2004).

3. Probiotics: The antiquity related to the probiotics literally dates back to the first intake of fermented milk by the humans, some time over 2000 years ago. Initially the area of scientific research is boosted and supplemented by the work of Metchinkoff (1907) which eventually transformed the toxic flora of the large intestine into a host friendly colony named as *Bacillus bulgaricus* (Hord 2008). Generally in other words a probiotic could be easily defined as supplements having the live microbial feed, which is when taken in a very adequate amount has pronounced positive influence on the host animal by fixing and remodeling the balance of intestinal microbes (Food and Agricultural Org. 2001; Fuller 1992).

When probiotics are taken into consideration they consist of the following divisions of bacteria:

- a) Gram-positive cocci such as the *Enterococcus faecium*.
- b) Bifidobacteria such as *B.longum*.

Probiotics are normally accessible in various types such as powder form, gel or paste etc. (Suvarna and Boby 2005). Some particular probiotics are used for curing the gastro intestinal disorders that also include the lactose intolerance and antibiotic side effects (Doron et al 2005). Many probiotic agents already have got the qualities of non toxic, resistance to the gastric acid and attachment to the epithelial tissues of the gut and secreting the antibacterial substances (Suvarna and Boby 2005). There are confirmatory proof that treatment via probiotics eventually reduces the danger of systemic conditions like cancer, asthma and many other ear infections (Lenoir- Wijnkoop et al 2007).

4. Dietary Fiber: Elaborating the dietary fiber in more accurate manner it is more of a plant material that is not all easily hydrolyzed by the enzymes secreted by the digestive system, but by the micro flora of the gastrointestinal tract. They normally consists of hemicellulose and pectins and lignins. Foods that are having the high amount of soluble fiber that include the beans and oats. When considering in chemical manner dietary fiber means the carbohydrate polymer having a degree of polymerization that is not lower in amount, which aren't yet digested nor absorbed into the small intestine.

Also depending upon their solubility the dietary fibers are subjected into following classes:

- a) Soluble Dietary Fiber (SDF): They incorporate gums, mulicage and hemicellulase that are readily fermented in the colon.
- b) Insoluble Dietary Fibers (IDF): They comprises the liginins and hemicelluloses which are fermented to a very narrow region of the colon.

On the other hand the combination of mixture of SDF and IDF are altogether termed as non-starch polysaccharides (NSP).

Soluble ingredients of dietary fiber are valued because of their enlarging and viscous nature and abilities that finally slows down the gastric emptying of stomach (Leclere et al 1994). But they also known to upgrade the insulin receptor binding and improving the delayed glycemic response. Inside the colon the dietary fiber are known to enhance the fecal bulking due the their property of water retention and water holding capacity, elevating the transit time and heightening the fecal bacterial mass that is a result of the soluble fiber fermentation. These fibers help in the advanced growth of the Bifidobacteria in the gut. Individuals engrossing the large amount of dietary fibers, are low on risk of CHR (Liu et al. 1999) in comparison with those who are not having it and have a very minimal fiber intake. They also risk the stroke (Steffen et al.2003), hypertension (Whelton et al.2005), diabetes (Montonen et al.2003), obesity (Lairo et al.2005) and slected gastro intestinal disorders (Petruzzello et al.2006). Most importantly the serum lipoprotein is amount is enhanced by the increased intake of high fiber food (Brown et al.1999), readily lower the blood pressure (Keenan et al.2002), makes the conditions better for the blood glucose control for diabetes (Anderson et al.2004), also supports the weight loss (Birketvedt et al. 2005) and enhances the regularity (Cummings 2001). Extreme research and analysis has reveled that some fibers of soluble nature also effects the immunity in a very positive manner for the humans (Watzl et al. 2005). Some possible hidden negative influences of the dietary fibers involve reduction in vitamin absorptions, proteins and minerals. Basically the suggested dietary fiber intake for the adults and children are predicted to be 14g/1,000 kCals (Andersan et al. 2009).

Many of the cases in recent history reported that too much consumption of enormous amounts of dietary fiber results in diarrhea (Saibil 1989).

5. Prebiotics: They are the dietary components that positively effects the consumer by precisely altering the metabolism of gut flora (Macfarlane et al. 2006; Gibson and Roberfroid 1995). As, they are the short chain polysaccharide but have an exclusive chemical structure that is found to be non digestible to the humans, specifically the fructose based oligosaccharides that exists naturally in food. The exact amount of prebiotic intake affirms the Lactobacillus and Bifidobacterial growth in the gut, hence proving highly beneficial for the metabolism (Hord 2008; Gibson 1999). Some vegetables like tomatoes and chicory roots are found to be high in fructo-oligosaccharides. But other example may also include the stachyose and raffinose commonly found in beans and peas. Eventually the health benefits are enormous when it comes to prebiotics as they enhance the the anti tumor properties, lowering the blood cholesterol levels and lactose tolerance (Fuller 1992; Isolauri et al. 1991; Lin et al.1989; Sanders 1994). The every day intake 20g insulin and oligosaccharides does highly enhance the growth of Bifidobacteria (Schrezenmir and De Verse 2001). Again, consumption and utilization in large amounts of oligosaccharides do causes diarrhea and other simultaneously related gastric disorders (Gibson and Wang 1994; Guarner 2005; Nadeau 1999).

Conclusion: Following the modern life style these days, oxidative stress is overloading the antioxidant defense system. The working efficiency of different stages of antioxidant defense system and its functionality of mechanism decreases with the increasing age factor as well as different feeding behavior

simultaneously. The research and analysis since the past decade is focusing on the different nutraceuticals some of the antioxidant products intrinsically work in order to scavenge the free radical, specifically to stimulate the human bodies defense system. This through scrutiny emulates the possible pros and cons subjected to nutraceuticals among the healthy individuals. The personal perceptivity towards any particular disease most importantly depends on the genetic make up and lifestyle of that particular individual that might include smoking and drinking. Hence the acknowledgement of the nutraceuticals towards the specified individual may vary. Further, nutraceuticals have already confirmed their health benefits and their consumption with in their recommend amounts, effectively keep the disease away and supports the good health unanimously.

Acknowledgement

The authors (R.C. Choudhary & I. Husain are grateful to SGVU, Jaipur for facilitating technical facilities and peaceful environment for performing this job.

References

1. Adelaja AO, Schilling BJ (1999) Nutraceutical: blurring the line between food and drugs in the twenty-first century. *Mag Food Farm Resour Issues* 14:35–40.
2. Argento A, Tiraferri E, Marzaloni M (2000) Oral anticoagulants and medicinal plants: an emerging interaction. *Ann Ital Med Interna* 15:139–143.
3. Bannerjee SK, Mukherjee PK, Maulik SK (2003) Garlic as an antioxidant: the good, the bad and the ugly. *Phytother Res* 17:97–106.

4. Brower V (1998) Nutraceuticals: poised for a healthy slice of the healthcare market? *Nat Biotechnol* 16:728–731.
5. Brown L, Rosner B, Willett WW, Sacks FM (1999) Cholesterol lowering effects of dietary fiber: a meta analysis. *Am J Clin Nutr* 69:30–42.
6. Bull E (2000) What is nutraceutical? *Pharm J* 265:57–58.
7. Choudhary A, Singh N (2012) Intellectual property rights and patents in perspective of Ayurveda. *Ayurveda* 33(1): 20-26.
8. Dillard CJ, German JB (2000) Phytochemicals: nutraceuticals and human health. *J Sci Food Agric* 80:1744–1756.
9. Doron S, Snyderman DR, Gorbach SL (2005) *Lactobacillus GG*: bacteriology and clinical applications. *Gastroenterol Clin North Am* 34:483–498.
10. Dureja H, Kaushik D, Kumar V (2003) Developments in nutraceuticals. *Indian J Pharmacol* 35:363.
11. Ernst E (2003) Complementary medicine: where is the evidence? *J Fam Pract* 52:630–634.
12. Food and Agricultural Org World Health Org 2001. Health and nutritional properties of probiotics in food including powder milk with live lactic acid bacteria. <http://www.who.int/foodsafety/publications/fsmanagement/probiotics/en/index.html>.
13. Freedonia Group (2011) World Nutraceutical Ingredients: Forecasts for 2015&2020 in 40 countries. Report, FED00497, Cleveland, OH, pp568.
14. Fuller R (ed) (1992) Probiotics: the scientific basis. Chapman and Hall, London.
15. Gibson GR, Wang X (1994) Regulatory effects of bifidobacteria on other colonic bacteria. *J Appl Bacteriol* 77:412–420.
16. Guarner F (2005) Inulin and oligofructose: impact on intestinal diseases and disorders. *Br J Nutr* 93(Suppl):S61–S65.
17. Hendrich S, Lee K-W, Xu X, Wang HJ, Murphy PA (1994) Defining food components as new nutrients. *J Nutr* 124:1789s–1792s.
18. Hord NG (2008) Eukaryotic microbiotic crosstalk: potential mechanisms for health benefits of prebiotics and probiotics. *Annu Rev Nutr* 28:215–231.
19. John B (2001) Natural compounds in cancer therapy. Oregon Medical Press, Princeton.
20. Kalia AN (2005) Textbook of Industrial Pharmacognocny, CBS publisher and distributor, New Delhi, pp 204 –208.
21. Keenan JM, Pins JJ, Frazel C, Moran A, Turnquist L (2002) Oat ingestion reduces systolic and diastolic blood pressure in patients with mild or borderline hypertension: a pilot trial. *J Fam Pract* 51:369–375
22. Kennedy ET, Luo H, Ausman LMJ (2012). Cost implications of alternative sources of (n-3) fatty acid consumption in the United States. *Nutrition* 142(3):605S-609S.
23. Kochhar KP (2008) Dietary spices in health and diseases: I. *Indian JPhysiol Pharmacol* 52:106–122.
24. Kohlmeier L, Simonsen N, Mottus K (1995) Dietary modifiers of Carcinogenesis. *Environ Health Perspect* 103:177–184.
25. Kokate CK, Purohit AP, Gokhale SB (2002) Nutraceutical and Cosmaceutical. *Pharmacognosy*, 21st edition, Pune, India: Nirali Prakashan, pp 542–549.
26. Kretchmer N (1994) Nutrition is the keystone of prevention (editorial). *Am J Clin Nutr* 60:1.
27. Lampe JW (2003) Spicing up a vegetarian diet: chemopreventive effects of phytochemicals. *Am J Clin Nutr* 78:579S–583S.
28. Lairon D, Arnault N, Bertrais S, Planells R, Clero E, Hercberg S, Boutron-Ruault M-C (2005) Dietary fiber intake and risk factors

- for cardiovascular disease in French adults. *Am J Clin Nutr* 82:1185–1194.
29. Leclere CL, Champ M, Boillot J, Guille G, Lecannu G, Molis C, Bornet F, Krempff M, Delort-Laval J (1994) Role of viscous guar gum in lowering the glycemic response after a solid meal. *Am J Nutr* 59:914–921.
 30. Lee J, Koo N, Min DB (2004) Reactive oxygen species, aging and antioxidative nutraceuticals. *CRFSFS* 3:21–33.
 31. Lenoir-Wijnkoop I, Sanders ME, Cabana MD, Caglar E, Corthier G, Rayes N, Sherman PM, Timmerman HM (2007) Probiotic and prebiotic influence beyond the intestinal tract. *Nutr Rev* 65:469–89.
 32. Liu S, Stampfer MJ, Hu FB et al (1999) Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health study. *Am J Clin Nutr* 70:412–419.
 33. Maddi VS, Aragade PD, Digge VG, Nitaliker MN (2007) Importance of nutraceuticals in health management. *Phcog Rev* 1:377–379.
 34. Malik A (2008) The potentials of Nutraceuticals. *Pharmainfo.net* 6
 - Metchinkoff E (1907) The prolongation of life. Putmans Sons, New York, pp 151–183.
 35. Mark B, Ashley L, Carla O and Mary EL (2012) Herb supplement sales increase 4.5% in 2011. *HerbalGram* 95:60-64.
 36. Meydani M (2000) Effect of functional food ingredients: vitamin E modulation of cardiovascular diseases and immune status in the elderly. *Am J Clin Nutr* 71:1665S–1668S.
 37. Montonen J, Knekt P, Jarvinen R, Aromaa A, Reunanen A (2003) Whole-grain and fiber intake and the incidence of type 2 diabetes. *Am J Clin Nutr* 77:622–629.
 38. Nadeau DA (1999) Oligosaccharides play important health role. *The Soy Connection Interactive* 7(3) Nemets B, Stahl Z, Bemaker RH (2002) Addition of omega-3 fatty acid to maintenance medication treatment for recurrent unipolar depressive disorder. *Am J Psychiatr* 159:477–479.
 39. Nicoletti M (2012). Nutraceuticals and botanicals: Overview and perspectives. *Int J Food Sci Nutr* 63(1):2-6.
 40. Nicoli MC, Anese M, Parpinel M (1999) Influence of processing on the antioxidant properties of fruits and vegetables. *Trends Food Sci Technol* 10:94–100.
 41. Pandey M, Verma RK, Saraf SA (2010) Nutraceuticals: new era of medicine and health. *Asian J Pharm Clin Res* 3:11–15.
 42. Pandey M, Verma RK, Saraf SA (2010) Nutraceuticals: new era of medicine and health. *Asian J Pharm Clin Res* 3:11–15.
 43. Pathak Y (2011) Handbook of Nutraceuticals. Vol II, Scale-Up, Processing Automation, CRC Press, Boca raton, FL, pp 1-14.
 44. Petruzzello L, Iacopini F, Bulajic M, Shah S, Costamagna G (2006) Review article: uncomplicated diverticular disease of the colon. *Aliment Pharmacol Ther* 23:1379–1391.
 45. Rao BN (2003) Bioactive Phytochemicals in Indian foods and their potential in health promotion and disease prevention. *Asia Pac J Clin Nutr* 12:9–22.
 46. Sahu SC (2002) Dual role of organosulfur compounds in foods: a review. *J Environ Sci Health C Environ Carcinog Ecotoxicol Rev* 20:61–76.
 47. Sanders ME (1994) Lactic acid bacteria as promoters of human health. In: Goldberg I (ed) *Functional foods: designer foods, pharma- foods and nutraceuticals*. Chapman & Hall, London, pp 294–322.
 48. Schrezenmeir J, de Vrese M (2001) Probiotics, prebiotics, and synbiotics—approaching a definition. *Am J Clin Nutr* 73:316S–364S.
 49. Sreejayan R, Rao MNA (1994) Curcuminoids as potent inhibitors of lipid

- peroxidation. *J Pharm Pharmacol* 46:1013–1016.
50. Steffen LM, Jacobs DR Jr, Stevens J, Shahar E, Carithers T, Folsom AR (2003) Associations of whole-grain, refined grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: the Atherosclerosis Risk in Communities (ARIC) Study. *Am J Clin Nutr* 78:383–390
51. Steiner M, Khan AH, Holbert D, Lin RIS (1996) A double-blinded crossover study in moderately hypercholesterolemic men that compared the effect of aged garlic extracts and placebo administration on blood lipids. *Am J Clin Nutr* 64:866–870.
52. Suvarna VC, Bobby VU (2005) Probiotics in human health: a current assessment. *Curr Sci* 88:1744–1748.
53. Watkins TR, Bierenbaurn MI, Giampalala A (1999) Tocotrienols: biological and health effects. In: Papas AM (ed) *Antioxidant status, diet, nutrition and health*. CRC Press, Boca Raton, pp 479–496.
54. Whelton SP, Hyre AD, Pedersen B, Yi Y, Whelton PK, He J (2005) Effect of dietary fiber intake on blood pressure: a metaanalysis of randomized, controlled clinical trials. *J Hypertens* 23:475–481
55. Wildman REC (ed) (2001) *Handbook of nutraceuticals and functional foods*. CRC Press, Boca Raton, pp 13–30