

Available online on 15.07.2018 at jddtonline.info

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

© 2011-18, publisher and licensee JDDT, This is an Open Access article which permits unrestricted non-commercial use, provided the original work is properly cited

Open  Access

Review Article

ROLE OF NUTRACEUTICALS ON HEALTH PROMOTION AND DISEASE PREVENTION: A REVIEW

Sangita Dutta², Kazi Monjur Ali³, Sandeep Kumar Dash¹, Biplab Giri*^{1,2}¹Department of Physiology, University of Gour Banga, Malda 732103, India²Experimental Medicine and Stem Cell Research Laboratory, Department of Physiology, West Bengal State University, Kolkata 700126, India³Department of Nutrition, M.U.C. Women's College, Burdwan 713104, India

ABSTRACT

Nutraceuticals have received considerable zest for their expected safety, potential nutritive and therapeutic effects. These were used as alternative to modern medicines that promote quality of health, increases nutritive value of the diet and prolongs life expectancy. Major constituents of the nutraceuticals are herbals, various nutrients and dietary supplements are involved in preventing different diseases and minimizing pathophysiology of the disease too. It also acts as immune boosting, natural antioxidant, anticancer, anti-inflammatory, antidiabetic, cardioprotective, organoprotective agent in addition with different health promoting effects. Ultimately, they ensure better quality of life and the purpose of this review is to provide summary of current scientific impression in this regard which might be helpful to formulate further innovative research plan in new domain on nutraceuticals.

Keywords: Nutraceuticals; Disease prevention; Health promotion; Nutrients; Nutrition

Article Info: Received 26 March, 2018; Review Completed 13 June 2018; Accepted 16 June 2018; Available online 15 July 2018



Cite this article as:

Dutta S, Ali KM, Dash SK, Giri B, Role of nutraceuticals on health promotion and disease prevention: a review, Journal of Drug Delivery and Therapeutics. 2018; 8(4):42-47 DOI: <http://dx.doi.org/10.22270/jddt.v8i4.1759>

*Address for Correspondence:

Biplab Giri, Department of Physiology, University of Gour Banga, Malda 732103, West Bengal, India.

Email: bgiri.emscl@gmail.com

1. INTRODUCTION

Exploration of novel dietary products with medicinal properties has created a renaissance in health and nutrition research. These are the emerging natural functional products that make the line between foods and drugs. It provides physiological health benefits as well as medicinal implications¹. Nutraceuticals are taken as a part of our daily diet to accomplish lucrative effect. Now the question arises whether nutraceuticals are foods or drugs? It may be considered as food, food supplement or drug like agent since it may apply for health promotion, disease prevention and adjunct supplement with the treatment. Nutraceuticals creates a new era of research to promote quality of life. It can reduce the risk of disease onset by retaining normal health condition and improving immunity². The treatment approaches of disease in the modern medicines are seeking complementary or alternative beneficial

products, and nutraceuticals fulfilled this gap³. In this review the role of some important nutraceuticals are emphasized based on their health promoting and diseases modifying indications. Herbal nutraceuticals has been efficient to cure oxidative stress, including allergy, Alzheimer's disease, CVD, diabetes, cancer, inflammatory as well as obesity too⁴.

The motto of nutritional therapy is based on the complimentary therapy with nutraceuticals as food is not only the source of energy and nutrients but also provides medicinal benefits. Nutraceuticals are detoxifying our body, restoring our healthy digestion and dietary habits also. They can be classified based on the source of foods, mechanism of action and their chemical properties⁵. The food sources used as nutraceuticals are all natural and they are dietary fiber, probiotics, prebiotics, PUFA, antioxidant vitamins, polyphenols etc⁶.

2. NUTRACEUTICALS ON HEALTH PROMOTION

Nutraceuticals with various bioactivities towards human body are being widely examined for their ability to

provide health benefits⁷. Some of the most important bioactivities of such nutraceuticals have been discussed below (Table-1, Fig.1).

Table 1: Role of nutraceuticals in health promotion

Nutraceuticals	Health Promoting Activity	Ref
Onion, Garlic, Grapes, Rosemary, Broccoli, Spinach, Turmeric, Parsley	Antioxidant activity	8-9
Mitochondria Targeted Nutraceuticals	Mitochondrial bioenergetics	10
Flavonoids, Polyphenols, Probiotics	Gastro intestinal health	10-12
Nutraceuticals like Magnesium Citrate, Pine Bark of Pycnogenol, Pygeum, Potassium Citrate, IP6, Lutein, Lycopene, Xeaxanthin	Renal and excretory health	13-14
Ubiquinone Q10, Vitamin B6, Vitamin B12, Pycnogenol, Flax seed oil, Fish oil	Reproductive health	13-16
Blueberry, Green Tea, Catechins, Carnosine, Vit D3, PUFA, Essential Amino Acids	Stem cell growth	13-14
Nutraceuticals present in citrus fruits, Soyabean, Spermidine, Caffeic Acid and Rosmarinic Acid	Prolonging life Span	17, 12

2.1. Antioxidant activity

Several nutraceuticals reported till date having free radicals scavenging capacity. Studies shows that onion, garlic, grapes, rosemary, broccoli, spinach, turmeric, parsley possess considerable antioxidant activities¹⁸. Nutraceuticals with antioxidant properties prevents several neurodegenerative diseases including Parkinson's, Alzheimer's diseases. They act on ROS, RNS and also prevent oxidized LDL formation⁹.

2.2. Mitochondrial bioenergetics

Mitochondria have been involved in the energy utilization during exercise and nutraceuticals implicated in the prevention and treatment of heavy exercise related to mitochondrial dysfunction. Mitochondria targeted nutraceuticals (MTNs) have antioxidant effects at the molecular level and boost mitochondrial bioenergetics. It has great impact on sports medicine¹⁰.

2.3. Gastro Intestinal health

About 40 million American suffers from a various digestive disorders like gastro-esophageal reflux disease, irritable bowel syndrome, celiac disease, food allergies, diverticulitis, ulcerative colitis, crohn's disease etc.¹¹. The prebiotics which are polysaccharides in nature could be useful for both disease prevention and for healing process. Nutraceuticals have the ability to reduce antigenic and oxidative insults in the gastrointestinal tract of an individual. Flavonoids and polyphenols show antioxidant activity and have been found to be known as possible gastroprotective and cytoprotective agents. Glutamate, a neurotransmitter found in gut which improves neonatal gastrointestinal function, gastric emptying as well significant role in developing infant gastric mucosa^{10, 11}. Herbal nutraceuticals like probiotics play an unique role for healthy digestive function. It may stimulate the growth of healthy gut microflora, slow down harmful bacterium and reinforce the body's natural gut defense mechanisms. It can reduce lactose intolerance and prevent GI tract disorders¹².

2.4. Renal and excretory health

Specific nutraceuticals like magnesium citrate, pine bark of pycnogenol, pygeum, potassium citrate, IP6, lutein, lycopene, xeaxanthin plays a significant role at our excretory system that includes promotion of healthy urinary oxalate excretion, provides protective activity on kidneys, improve healthy urinary bladder health and sphincter tone, help to balance calcium accumulation, formation of calcium and oxalate crystals, maintains normal microbial flora in the bladder and urinary tract^{13, 14}.

2.5. Reproductive health

Nutraceuticals have significant role on both male and female reproductive ability. Nutraceutical food supplements control male infertility, increases sperm count by 60%, increases sperm motility by 3 fold, improves sperm quality and cures sperm dysfunction. It also prevents oxidative damage of sperms^{13, 14}.

In case of female, it reduces the risk of preterm labor in human, influences steroid output at a cellular level. Ubiquinone Q10, Vitamin B6, B12, pycnogenol, flax seed oil, pycnogenol, fish oil reduces the damage of oocytes in fallopian tubes and encourages embryonic growth and development¹⁵.

Eating healthy diets with nutraceuticals reduces the sufferings from monthly trouble of women. Most menstrual disorders caused by nutritional deficiencies which lead to improper metabolism of sex hormones. Specific nutraceutical could influence hormones, the ovarian pathological conditions and increases reproductive¹⁶.

2.6. Stem cell growth

Certain nutraceuticals produces significant effects on stem cell growth and proliferation and showed significant role in healing and tissue regeneration by stimulating and recruiting endogenous stem cell at the site of injury. Blueberries, green tea, catechins,

carosine, vitamin D3, PUFA and essential amino acids strengthen our immune system^{13,14}.

2.7. Prolonging life Span

Nutraceuticals present in citrus fruits and soybean has effects on epigenetic modifications, autophagy and necrosis^{17, 18}. Researches have shown that spermidine and its derivatives confer lifespan extension in humans by enhancing autophagy. Caffeic acid and Rosmarinic acid present in fruits, vegetables and herbs are also anti carcinogenic, antioxidant, anti-rheumatic and anti-

microbial. They can prolong the healthy life span extension¹².

3. NUTRACEUTICALS ON DISEASE PREVENTION

Nutraceuticals play an important role in preventing different disease onset and minimize complication of the disease. It provides protection against non communicable diseases, delay ageing process, increases life expectancy and improves function of the body (Table-2, Fig.1).

Table 2: Role of nutraceuticals on disease prevention

Nutraceuticals	Disease Prevention	Ref
Flavonoids, Flavones, Flavonones, Quercetin in Onion, Cruciferous Vegetables, Black Berries, Cherries, Berries, Apples and Allicin.	Cardio vascular diseases	19-23
Ginseng, Beta Carotene, Sulfur Compounds in Garlic.	Cancer	24-27
Soy Isoflavones, Omega 3 Fatty Acid, Lipoic Acid, Catechins, Spices Like Fenugreek and Cinnamon, Bitter Melon, Pomegranate	Diabetes mellitus	28
Conjugated Linoleic Acid, Capsaicin, Psyllum, Herbal Nutraceuticals like Chitosan, Caffeine, Fenugreek, Vitamin C, Green Tea, Curcumin, Black Gram, Bottle Guard.	Obesity	29-32
Diacerin, Banana, Ginger, Green Tea, Pomegranate, Boswellia, Oxaceprol, Tipi, Willow Bark, Curcumin, Avocado, Soybean, Collagen Hydrolysate, Chondroitin Sulfate and Glucosamine	Osteoarthritis	33-38
Odonto Nutraceuticals, Green Tea, Grapes, Cocoa Seed Extracts rich in Polyphenols, Flavonoids and Proanthocyanidins	Oral diseases	39-43
Curcumin, Lutein, Lycopene, Lavandula, Beta Carotene, Folic Acid and Vit B12.	Alzheimer's disease	44-45
Plant Polyphenols, Stilbenes, Soybean & Other Phytoestrogens, Vitamin C, Vitamin D, Vitamin E, Coenzyme Q 10, Unsaturated Fatty Acid, Brahmi and Inosine.	Parkinson's disease	46-48
Lutein, DHA, Green Tea, Carotenoids, Flavonoids, Vitamin E, Coenzyme Q10, Zeaxanthi, Melatonin, Spirullina, Flavonoids, Ascorbic Acid, Tocopherol, Carotenoids, Caffeine, Pyruvate.	Eye disorders	49, 39
Adaptogens (Ashwagandha, Rhodiola, L-Theanine, Ginseng)	Stress Management	50

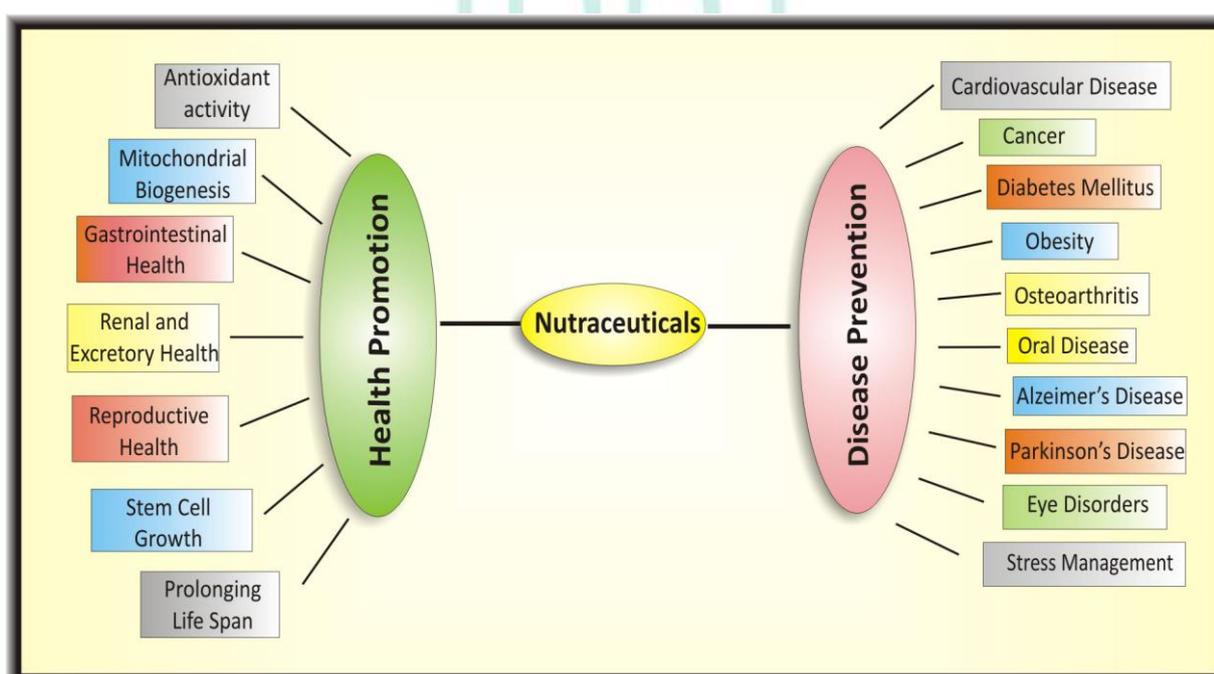


Figure 1: Role of nutraceuticals in health promotion and disease prevention

3.1. Cardio vascular diseases

Nutraceuticals like flavonoids, flavones, flavonones, quercetin in onion, cruciferous vegetables, black berries, cherries, berries, apples and other antioxidant vitamins and minerals may reduce the risk of death from CVDs. They inhibit cyclooxygenase pathway and anigiotensin converting enzyme (ACE) which is responsible for high blood pressure¹⁹. They also prevent platelet aggregation and stickiness. Flavonoid groups strengthen tiny capillaries which carry oxygen and essential nutrients to all cells. Polyphenols present in grapes alter cellular metabolism and signaling which reduces arterial diseases²⁰. A potent antioxidant ginger is an anti-inflammatory agent is recommended for the prevention of hypertension and palpitation. Allicin lowers blood pressure and cholesterol. Omega 3 series has lipid lowering property and prescribed for the treatment of arrhythmias²¹. CVD could be managed by the supplementation of different lipid lowering nutraceuticals along with maintenance of proper life style²². Poly-herbal products could affect synergistically to achieve a potential therapeutic target²³.

3.2. Cancer

Nutraceutical rich bioactive dietary components have the ability to prevent cancer²⁴. Herbal nutraceuticals possess anti-mutagenic and anti-carcinogenic properties. Antioxidant activities of carotenoids, lycopene are effective for cancer. They are oxygen quencher and decreases oxidative stress. Nutraceutical controls DNA damaging factors in cells and prevents DNA transcription in tumors²⁵. Ginseng is anti-inflammatory molecule that prevents chronic inflammation of cancer. Chemo preventive components in fruits and vegetables have potential anti-carcinogenic and anti-mutagenic activities. Beta carotene from yellow and orange fruits has anti-cancer activity. Cruciferous vegetables lowers the chances of colorectal and lung cancer. They block enzymes that promote tumor growth. Sulfur compounds in garlic boosts immune system, reduces atherosclerosis and platelet aggregation²⁶. Recent research further reported herbal nutraceuticals has the ability to alter metastatic spread of cancer²⁷.

3.3. Diabetes

Herbal dietary supplements containing nutraceuticals have proven to offer therapeutic benefit on type 2 diabetes. Soy isoflavones, omega 3 fatty acid lowers mortality and incidence of diabetes, promote insulin sensitivity, reduce glucose tolerance and bring blood sugar normal. Universal antioxidants like lipoic acid and catechins, the spices like fenugreek and cinnamon are used to treat diabetic neuropathy, nephropathy and retinopathy. Magnesium, chromium, calcium, vitamin D promotes insulin sensitivity, improve glycemic control etc. Caffeic acid reduces elevated plasma glucose in insulin resistant patients. Green tea and epicatechin 3 gallate reduces fasting and postprandial glucose and improves insulin resistance. Bitter melon, pomegranates are good for diabetes which regulates metabolism and transports glucose from the blood into cells²⁸.

3.4. Obesity

Obesity is a medical condition characterized by accumulation of excess body fat. Nutraceuticals like conjugated linoleic acid, capsaicin, psyllum have an excellent anti-obese properties. Herbal nutraceuticals like chitosan, caffeine, fenugreek, vitamin C, green tea, curcumin, black gram, bottle guard reduces body weight^{29, 30}. They secrete leptin and other cytokines like IL-1, IL-6 and help to reduce LDL and total cholesterol and regulate food intake^{31, 32}.

3.5. Osteoarthritis

Osteoarthritis is a disease with a multifactorial etiology affecting all joint tissues and involving both biochemical and mechanical factors that act in synergy to degrade cartilage³³. Joint discomfort reduces physical activities resulting energy imbalance and weight gain. Nutraceuticals like chondroitin sulfate, glucosamine, diacerin, banana, ginger, green tea, pomegranate, boswellia, oxaceprol, tipi, willow bark, curcumin, avocado, soybean, collagen hydrolysate are used to alleviate the complications³⁴. They have pharmacological properties and important role in the regulation of gene expression along with their normal function as nutrient. Nutraceutical antioxidant agents have considerable evidence for treating inflammation, pain and joint destruction³⁵. Arthritic pain and narrowing of joint space could be prevented by the combined supplementation of chondroitin sulfate and glucosamine³⁶.

Application of olive oil also reduces pain, stiffness and swelling, physical function and knee status. Functional foods like oats, bran, Psyllium, lignin, prebiotics, omega 3 milk, canola oil are very efficacious^{37, 38}.

3.6. Oral diseases

Odontonutraceuticals, a new term has been discovered³⁹. It represents pleiotropic phytotherapeutic agents in dentistry as they regulate different molecular and biochemical targets⁴⁰. These are bioactive phytochemicals that prevents oral diseases. It may play a significant role in the complex and multifactorial oral disorders. Odontonutraceuticals includes green tea, grapes, cocoa seed extracts that are rich in polyphenols, flavonoids and proanthocyanidins⁴¹. Aloe vera gel heals mucosal wound and it can alleviate pain of patient with oral lichen planus disease⁴². Probiotics are also helpful in the prevention of dental caries, gingivitis, periodontitis, halitosis, malodour etc.⁴³.

3.7. Alzheimer's disease

Alzheimer's disease is also known as senile dementia. Antioxidants appear to slow down the advancement of the disease. Nutraceuticals like beta carotene, lycopene, curcumin, lutein and lavandula exploits their antioxidant effects to combat oxidative stress induced neuronal damage. These compounds are able to delay the development of dementia⁴⁴. Several studies indicate that supplementation of vitamins like folic acid and B12 reduces homocysteine levels which also avert disease progression⁴⁵.

3.8. Parkinson's disease

In Parkinson disease the dopamine-releasing cells in the brain damaged due to neurodegeneration. It is the second most common age related disorder in the world ⁴⁶. Plant Polyphenols, stilbenes, soybean and other phytoestrogens, vit-C, vit-D, vit-E, coenzyme Q 10 and unsaturated fatty acid revealed protective roles against progression of Parkinson's disease ⁴⁷. Herbal nutraceutical (Brahmi) is a natural brain tonic that helps in mental peace and relaxation, migraine, headache, insomnia, depression, anxiety, brain cell rejuvenation, blood circulation in the brain, improved memory function and hormone secretion ³⁶. Researchers also used the dietary supplement inosine, a precursor to irate for slowing the progression of Parkinson's disease ⁴⁸.

3.9. Eye disorders

Nutraceuticals rich diet appears beneficial for age related macular degeneration. Lutein, DHA, green tea, carotenoids, flavonoids, vitamin E, coenzyme Q10 possess antioxidant activity and are effective for presbyopia, cataracts. Zeaxanthin is used for the treatment of glaucoma, visual disorders ⁴⁹. Melatonin, spirulina, coenzyme Q10 and soy isoflavones are also used for the control of macular degeneration. Flavonoids, ascorbic acid, tocopherol, carotenoids, caffeine, pyruvate are efficacious for retinitis pigmentosa ⁴⁹. Rice bran, fruits and vegetables contain both lutein and zeaxanthin which improves eye sight and reduces the chance of cataracts formation. The essential fatty acid, omega 3, 6, and 9, folic acid in rice bran also promote eye health ³⁹.

3.10. Stress Management

Stress is a vital part of our psychological make up and is a threat to our existence. The natural bioactive compounds called adaptogens helps to cope up against stress related cellular damages. They cause a non specific increase in the resistance of an organism to

noxious influences. They exert to normalize and provide balancing action both for stress and mental health. Thus they gradually increase emotional performance that promote recovery from stressful situations. Herbal nutraceuticals like ashwagandha, rhodiola, L-theanine, ginseng are effective adaptogens that activates the production of stress suppressing heat-shock protein 70 (HSP-70). They also stabilizes physiologic processes, promotes homeostasis, increases resistance to environmental stress, reduces moderate to severe anxiety, improves sleep, reduces depression and improves secondary memory ⁵⁰.

4. CONCLUSION

The scope of nutraceutical field is plenty both in terms of type and the varieties. Nutraceuticals industry in India is one of the rapid growing markets. Higher and upper middle class consumers are perceiving nutraceuticals as alternative to prescribed drugs and exclusively for their beneficial properties without any side effects. Consumers are showing sharp interest in nutraceuticals for boosting energy and improving their physical endurance and mental alertness. Nutraceutical industries are focussing to develop new product with innovative formulations and using proper advertisements for choosing the right products to the consumers.

Nutraceuticals have significant promise in the promotion of human health and prevention of disease. They are widely accepted by all age groups due to their safety, higher quality, purity, efficacy, health promoting and disease curing activities. The newest trend is moved towards nutraceuticals led to new era of medicine and health. It is still in its stage of infancy in India. But in this hype era we must say "let food be your medicine" and "proper nutraceuticals daily can keep the medicine away".

Conflict of Interest: The authors have no conflict of interest.

REFERENCES

- Raj KK. Nutraceutical and Functional Food as Future Food: A Review. *Scholars Research Library* 2010; 2(1):106-116.
- Rajasekaran A, Sivagnanam G, Xavier R. Nutraceuticals as therapeutic agents: A Review. *Research Journal of Pharmacy and Technology* 2008; 1(4):328-340.
- Das L, Bhaumik E, Raychaudhuri U, Chakraborty R. Role of nutraceuticals in human health. *Journal of Food Science and Technology* 2012; 49(2):173-183.
- Rafieian-Kopaei M, Setorki M, Douidi M, Baradaran A, Nasri H. Atherosclerosis: process, indicators, risk factors and new hopes. *International Journal of Preventive Medicine* 2014; 5(8):927-946.
- Chauhan B, Kumar G, Kalam N, Ansari SH. Current concepts and prospects of herbal nutraceutical: A review. *Journal of Advanced Pharmaceutical Technology and Research* 2013; 4(1): 4-8.
- Kalia AN. *Textbook of Industrial Pharmacology*. CBS Publisher and Distributor Pvt. Ltd; New Delhi, 2005, Pp. 204-208.
- Patil CS. Current trends and future prospective of nutraceuticals in health promotion. *BIOINFO Pharmaceutical Biotechnology* 2011; 1(1):1-7.
- Kaur S. Free radicals and antioxidant (nutraceuticals). *Book to human health. International Journal of Natural Product Science* 2012; 1:175.
- Kelsey NA, Wilkins HM, Linseman DA. Nutraceuticals antioxidant as novel neuroprotective agents. *Molecules* 2010; 15:7792-7814.
- Biddle J, Dasgupta-O'Brien S, Walch A. *Gut Health, Asheville Integrative Medicine* (undated). Available online: <http://www.docbiddle.com/moreinfo/guthealth.pdf>.
- Ostojic SM. Mitochondria-targeted nutraceuticals in sports medicine: a new perspective. *Research in Sports Medicine* 2017; 25: 91-100.
- Pietsch K, Saul N, Chakrabarti S, Stürzenbaum SR, Menzel R, Steinberg CE. Hormetins, antioxidants and prooxidants: defining quercetin, caffeic acid and rosmarinic acid-mediated life extension in *C. elegans*. *Biogerontology* 2011; 12(4):329-347.
- Sarin R, Sharma M, Singh R, Kumar S. Nutraceuticals: Review. *International Research Journal Pharmacy* 2012; 3(4):95-99.
- Dillard CJ, German JB. Phytochemicals: nutraceuticals and human health. *Journal of the Science of Food and Agriculture* 2000; 80:1744-1756.

15. Faisal N, Varma KS. Nutraceutical and its impact on health care. May 14, 2009. <http://farmacists.blogspot.in/2009/05/nutraceuticals-and-its-impact-on-health.html>
16. Biesalski HK. Nutraceuticals: the link between nutrition and medicine. In: Kramer K, Hope PP, Packer L. Editors. Nutraceuticals in health and disease prevention. New York: Marcel Dekker Inc 2001; 1-26.
17. Eisenberg T, Knauer H, Schauer A, Büttner S, Ruckstuhl C, Carmona-Gutierrez D. Induction of autophagy by spermidine promotes longevity. *Nature Cell Biology* 2009; 11:1305-1314.
18. Morselli E, Mariño G, Bennetzen MV, Eisenberg T, Megalou E, Schroeder S et al., Spermidine and resveratrol induce autophagy by distinct pathways converging on the acetylproteome. *Journal of Cell Biology* 2011; 192(4):615-629.
19. Hu FB, Willett WC. Optimal diets for prevention of coronary heart disease. *JAMA*. 2002; 288(20):2569-2578.
20. Wildman REC. Nutraceuticals and Functional foods. CRS Press, New York, 2007; Pp. 1-9.
21. Ramaa CS, Shirode AR, Mundada AS, Kadam VJ. Nutraceuticals--an emerging era in the treatment and prevention of cardiovascular diseases. *Current Pharmaceutical Biotechnology* 2006; 7(1):15-23.
22. Cicero AF, Colletti A. Combination of phytomedicines with different lipid lowering activity for dyslipidemia management: the available clinical data. *Phytomedicine* 2016; 23:1113-8.
23. Cicero AFG, Colletti A, Bajraktari G, Descamps O, Djuric DM, Ezhov M, et. al. Lipid-lowering nutraceuticals in clinical practice: position paper from an International Lipid Expert Panel. *Archives of Medical Science* 2017; 13(5):965-1005.
24. Cencic A, Chingwaru W. Antimicrobial agents deriving from indigenous plants. *RPFNA* 2010; 2:83-92.
25. Balsano C, Alisi A. Antioxidant effects of natural bioactive compounds. *Current Pharmaceutical Design* 2009; 15(26):3063-3073.
26. Sabita NS, Trygve OT. The role of nutraceuticals in chemoprevention and chemotherapy and their clinical outcomes. *Journal of Oncology* 2012; 64:1-23. doi:10.1155/2012/192464
27. Wargovich MJ, Morris J, Brown V, Ellis J, Logothetis B, Weber R. Nutraceutical use in late-stage cancer. *Cancer and Metastasis Reviews* 2010; 29(3):503-510.
28. Stephen D. A report of National Nutraceutical Centre. Nutraceuticals India 2012. Webinar 2012; 1-22.
29. Kasbia GS. Functional foods and nutraceuticals in the management of obesity. *Nutrition and Food Science* 2005; 35:344-351.
30. Dev R, Kumar S, Singh J, Chauhan B. Potential role of nutraceuticals in present scenerio: A review. *Journal of Applied Pharmaceutical Science* 2011; 1 (4):26-28.
31. Kaur G, Mukundan S, Wani V, Kumar MS. Nutraceuticals in the management and prevention of metabolic syndrome. *Austin Journal of Pharmacology and Therapeutics* 2015; 3:1-6.
32. Conroy KP, Davidson IM, Warnock M. Pathogenic obesity and nutraceuticals. *The Proceedings of the Nutrition Society* 2011; 70(4):426-438.
33. Wildman REC. Nutraceuticals and functional foods. In: Wildman Handbook of Nutraceuticals and Functional foods. New York: CRC press. 2006; Pp. 1-9.
34. Sacco SM, Horcajada MN, Offord E. Phytonutrients for bone health during ageing. *British Journal of Clinical Pharmacology* 2013; 75(3):697-707.
35. Akhtar N, Haqqi TM. Current nutraceuticals in the management of osteoarthritis: a review. *Therapeutic Advances in Musculoskeletal Disease* 2012; 4(3):181-207.
36. Agarwal S. Leading pharmaceutical consultant. Nutraceuticals and osteoarthritis. 2017; <http://www.drnsanjayagrawal.com>
37. Bohlooli S, Jastan M, Nakhoshtin-Roohi B, Mohammadi S, Baghaei Z. A pilot double-blinded, randomized, clinical trial of topical virgin olive oil versus piroxicam gel in osteoarthritis of the knee. *Journal of Clinical Rheumatology* 2012; 18(2):99-101.
38. Ruchi S, Amanjot K, Sourav T, Keerti B, Sujit B. Role of nutraceuticals in health care: A review. *International Journal of Green Pharmacy* 2017; 11(3):386-394.
39. Varani EM, Iriti M. Odonto nutraceuticals: pleioyropic photo therapeutic agents for oral health. *Pharmaceuticals* 2016; 9(1):10-13.
40. González-Vallinas M, González-Castejón M, Rodríguez-Casado A, Ramírez de Molina A. Dietary phytochemicals in cancer prevention and therapy: a complementary approach with promising perspectives. *Nutrition Review* 2013; 71(9):585-599.
41. Gaur S, Agnihotri R. Green tea: A novel functional food for the oral health of older adults. *Geriatrics and Gerontology International* 2014; 14:238-250.
42. Thongprasom K, Carozzo M, Furness S, Lodi G. Interventions for treating oral lichen planus. *Cochrane Database Systematic Review* 2011; 6(7):CD001168.
43. Janczarek M, Bachanek T, Mazur E, Chalas R. The role of probiotics in prevention of oral diseases. *Postepy Hig Med Dosw* 2016; 70(0):850-857.
44. Klätte ET, Scharre DW, Nagaraja HN, Davis RA, Beversdorf DQ. Combination therapy of donepezil and Vitamin E in Alzheimer disease. *Alzheimer Disease and Associated Disorder* 2003; 17(2):113-116.
45. Ji H, Zhang H. Multipotent natural agents to combat Alzheimer's disease. *Functional spectrum and structural features. Acta Pharmacologica Sinica* 2008; 29:143-151.
46. Mythri RB, Joshi AK, Mukunda M, Bharath S. Bioactive nutraceuticals and dietary supplements in neurological and brain disease. Academic Press 2015; Pp. 421-431.
47. Chao J, Leung Y, Wang M, Chang RC-C. Nutraceuticals and their preventive or potential therapeutic value in Parkinson's disease. *Nutrition Reviews* 2012; 70(7): 373-386. <https://doi.org/10.1111/j.1753-4887.2012.00484.x>
48. Michael J. Fox foundation nutraceuticals world. New hope for Parkinson's disease. 2008. <https://www.michaeljfox.org/understanding-parkinsons>
49. Khan RA, Elhassan GO, Qureshi KA. Nutraceuticals: In the treatment and prevention of diseases --an overview *The Pharma Innovation Journal* 2014; 3(10):47-50.
50. Kalra EK. Nutraceutical-definition and introduction. *AAPS Pharmaceutical Science* 2003; 5(3):27-28.