

PHYTOCHEMICALS AS CANDIDATE THERAPEUTICS: AN OVERVIEW

Satyand Tyagi^{1*}, Gunjan Singh², Anamika Sharma³, Gulshan Aggarwal⁴

¹Department of Pharmaceutical Chemistry, K.N.G.D Modi Institute of Pharmaceutical Education & Research, Modinagar, Ghaziabad (dt), U.P, India-201204.

²Associate Labeling, Ranbaxy Laboratories Ltd, Gurgaon (dt), Haryana, India-122001.

³Department of Pharmacy practice, Jamia Hamdard University, Hamdard Nagar, New Delhi, India-110062.

⁴Department of Biotechnology, Deakin University, Geelong campus, Waurn Ponds, Victoria, Australia- 3210.

*Email: sntyagi9@yahoo.com

ABSTRACT

Phytochemicals are chemical compounds such as beta-carotene that occur naturally in plants. The term is generally used to refer to those chemicals that may affect health, but are not yet established as essential nutrients. While there is abundant scientific and government support for recommending diets rich in fruits and vegetables, there is only limited evidence that health benefits are due to specific phytochemicals. Phytochemicals have been used as drugs for millennia. Most phytochemicals have antioxidant activity and protect our cells against oxidative damage and reduce the risk of developing certain types of cancer. They help to reduce menopausal symptoms and osteoporosis. The phytochemical allicin from garlic has anti-bacterial properties. Some phytochemicals bind physically to cell walls thereby preventing the adhesion of pathogens to human cell walls. Proanthocyanidins are responsible for the anti-adhesion properties of cranberry. Consumption of cranberries will reduce the risk of urinary tract infections and will improve dental health. Phytochemicals are naturally present in many foods but it is expected that through bioengineering new plants will be developed, which will contain higher levels. This would make it easier to incorporate enough phytochemicals with our food. In the present article, we have concentrated on therapeutic utility of Phytochemicals. The aim of present article is to provide in depth knowledge about clinical utility of Phytochemicals in current clinical scenario.

Keywords: phytochemicals, beta-carotene, carotenoids, polyphenols, phytosterols, saponins.

INTRODUCTION

Phytochemical are a large group of plant-derived compounds hypothesized for much of the disease protection provided by diets high in fruits and vegetables, beans, cereals, and plant based beverages such as tea and wine¹. Phytochemicals are naturally occurring, non-nutritive chemicals. They appear to work alone and in combination, and perhaps in conjunction, with vitamins and other nutrients in food to prevent, halt, or lessen disease. This makes it important to eat whole foods in place of supplements. A phytochemical is often found in the coloring agent of fruits and vegetables, so eating brighter colored varieties may have benefits. However, there are also several beneficial phytochemicals in colorless or less colorful fruits and vegetables for example, onions^{2,3} and corn are rich in phytochemicals. Based on their chemical structure, phytochemicals are classified into the ten categories¹ basically they are subdivided into three main categories i.e. phenolic acids, flavonoids and stilbenes or ligans; these flavonoids are further subdivided into anthocyanins, flavones, flavanones, isoflavones as well as flavanols and flavanols. The flavanols are further divided into catechins and epicatechins as well as proanthocyanidins and proanthocyanidins are further subdivided into procyanidins as well as prodelphinidins.

Description about Flavonoids

Flavonoids are the most diverse group of phytochemicals. Research suggests that flavonoids, in particular, may be an important phytochemical group that contributes to the reduced mortality rates observed in people consuming high levels of plant-based foods. In the Zutphen Elderly

Study, findings revealed a significant inverse association between flavonoid and myocardial infarction⁴. Similarly, findings from the Seven Countries Study (Comparing the diets of men living in Finland, Italy, Greece, Japan, Serbia, the Netherlands, and the United States) suggested that consumption of flavonoids was responsible for 25 percent of the observed difference in the mortality rates in the various countries studied⁵. Indeed, once consumed and absorbed flavonoids act favorably in the body through actions such as xanthine oxidase and arachidonic acid metabolism⁶. Some common examples of flavonoids and their food sources are summarize in Table.1

Table 1: Common examples of flavonoids and their food sources

Class	Example	Common Food Source
proanthocyanidins	cyanidin	berries
flavonol	quercetin	apples, onions
flavanol	catechin	Tea, coffee, chocolate
flavonone	hesperitin	grapefruit
Isoflavone	genistein	soy

Epidemiological studies parameters related to Phytochemicals

Epidemiological studies suggest that consumption of a diet high in fruits and vegetables is associated with reduced risk of chronic disease⁷. Unfortunately, there is not yet enough evidence to support the concept that

phytochemicals are responsible for these effects. Fruits and vegetables are important sources of a variety of beneficial agents including vitamins, minerals, fiber, and phytochemicals. More research is needed to fully explain the actions of phytochemical compounds in the human body⁸. Hundreds of phytochemical compounds, with several different biological functions, have been identified in plant-based foods. Therefore, consuming a variety of

plant-based foods helps ensure that individuals receive the optimum benefits from the fruits and vegetables they eat⁹.

Potential health benefits from some phytochemical compounds^{10, 11}

The Potential health benefits from some phytochemical compounds are summarize in Table. 2

Table 2: Potential health benefits from some phytochemical compounds

Food	Phytochemical	Potential benefit
Soy beans, soy milk, and tofu	Isoflavones (genistein and daidzein)	Reduction in blood pressure and increased vessel dilation
Strawberries, red wine, blueberries	anthocyanins	Improvement of vision, inhibition of nitric oxide production, induction of apoptosis, decreased platelet aggregation, and neuroprotective effects
Red wine, grape juice, grape extracts, cocoa	Proanthocyanidins and flavan-3-ols	Inhibition of LDL oxidation, inhibition of cellular oxygenases, and inhibition of proinflammatory responses in the arterial wall
Garlic, onions, leeks, olives, carrots, tomatoes, and tomato products, and various types of fruits and vegetables	Sulfides, thiols Carotenoids such as lycopene, beta carotenes	Decrease in LDL cholesterol Neutralization of free radicals that cause cell damage
Broccoli and other cruciferous vegetables such as kale, horseradish	Isothiocyanates (Sulphoraphane)	Neutralization of free radicals that cause cell damage and protection against some cancers

Phytochemicals as candidate therapeutics

Phytochemicals have been used as drugs for millennia. For example, Hippocrates may have prescribed willow tree leaves to abate fever. Salicin, having anti-inflammatory and pain-relieving properties, was originally extracted from the bark of the white willow tree and later synthetically produced became the staple over-the-counter drug called Aspirin. There is evidence from laboratory studies that phytochemicals in fruits and vegetables may reduce the risk of cancer, possibly due to dietary fibers, polyphenol antioxidants and anti-inflammatory effects. Specific phytochemicals, such as fermentable dietary fibers, are allowed limited health claims by the US Food and Drug Administration (FDA). An important cancer drug, Taxol (paclitaxel), is a phytochemical initially extracted and purified from the Pacific yew tree.

Among phytochemicals from edible plants with promise for deterring disease, diindolylmethane, from Brassica vegetables (broccoli, cauliflower, cabbage, kale, Brussels sprouts) is being tested against recurring respiratory papillomatosis tumors (caused by the human papilloma virus), is in Phase III clinical trials for cervical dysplasia (a precancerous condition caused by the human papilloma virus) and is in several clinical trials for prostate cancer.

Some phytochemicals with physiological properties may be elements rather than complex organic molecules. Abundant in many fruits and vegetables, selenium, for example, is involved with major metabolic pathways, including thyroid hormone metabolism and immune function¹². Particularly, it is an essential nutrient and

cofactor for the enzymatic synthesis of glutathione, an endogenous antioxidant¹³.

Food processing and phytochemicals

Phytochemicals in freshly harvested plant foods may be destroyed or removed by modern processing techniques, possibly including cooking. For this reason, industrially processed foods likely contain fewer phytochemicals and may thus be less beneficial than unprocessed foods. Absence or deficiency of phytochemicals in processed foods may contribute to increased risk of preventable diseases^{14, 15}.

Interestingly, a converse example may exist in which lycopene, a phytochemical present in tomatoes, is either unchanged in content¹⁶ or made more concentrated¹⁷ by processing to juice or paste, maintaining good levels for bioavailability

ACKNOWLEDGEMENT

The authors are thankful to the Management of K.N.G.D Modi Institute of Pharmaceutical Education & Research for providing facilities to utilize the library and internet in the college.

REFERENCES

1. Arts I.C, P.C.Hollman, Polyphenols and disease risk in epidemiologic studies, *Am J Clin Nutr*, 81, 2005, 317-325.
2. Bordia T, Mohammed N, Thompson M, An evaluation of garlic and onion as antithrombotic

- agents, Prostaglandins, Leukotrienes and Essential Fatty Acids, 54(3), 1996, 183-186.
3. Briggs W.H, Folts J.D, Osman H.E, Goldman I.L, Administration of raw onion inhibits platelet-mediated thrombosis in dogs, *J. Nutr*, 131, 2001, 2619-2622.
 4. Hertog M.G, E.J. Feskens, P.C.Hollman, M.B. Katan, D.Kromhout, Dietary antioxidants flavonoids and risk of coronary heart disease: The Zutphen Elderly Study, *Lancet*, 342(8878), 1993, 1007-1011.
 5. Hertog M.G, D.Kromhout, C Aravanbis, H Blackburn, R.Buzina, F.Fidanza, S.Giampoli, A. Jensen, A. Menotti, S.Nedeljkovic, Flavonoid intake and long-term risk of coronary heart disease and cancer in the seven countries study, *Arch Intern Med*, 155, 1995, 381-386.
 6. Nijveldt R.J, E.van Nood, D.van Hoorn, P Boelens, K.van Norren, and P.van Leeuwen, Flavonoids: A review of probable mechanisms of action and potential applications, *Am J Clin Nutr*, 74(4), 2001, 418-425.
 7. Hung H.C, K.J. Joshipura, R.Jiang, F.B.Hu, D.Hunter, S.A.Smith-Warner, Fruit and vegetable intake and risk of major chronic disease, *J Natl Cancer Inst*, 96(21), 2004,1577-1584.
 8. Halliwell B, Dietary polyphenols: Good, bad, or indifferent for your health? *Cardiovasc Res*, 73(2), 2007, 341-347.
 9. Manach C, A.Scalbert, C.Mornand, C.Remesy, L.Jimenez, Polyphenols: Good, bad, or indifferent for your health? *Cardiovasc Res*, 73(2), 2004, 341-347.
 10. Erdman J.W, Jr D.Balentine, L Arab, G Beecher, et al, Flavonoids and heart health: Proceedings of the ILSI North America Flavonoids Workshop, May 31-June 1, Washington, DC, *J Nutr*, 137(3), 2005, 718-737.
 11. Juge N, R. F Mithen, M.Traka, Molecular basis for chemoprevention by sulforaphane: A comprehensive review, *Cell Mol Life Sci*, 64(9), 2007, 1105-1127.
 12. Brown KM, Arthur, "Selenium, selenoproteins and human health: a review", *Public health nutrition*, 4 (2), 2001, 593-599.
 13. Papp LV, Lu Holmgren, Khanna, "From selenium to selenoproteins: synthesis, identity, and their role in human health", *Antioxidants & redox signaling*, 9 (7), 2007, 775-806.
 14. Liu RH, "Potential synergy of phytochemicals in cancer prevention: mechanism of action", *The Journal of nutrition*, 134 (12 Suppl), 2004, 3479S-3485S.
 15. Rao AV, Rao, "Carotenoids and human health", *Pharmacological research*, 55 (3), 2007, 207-216.
 16. Agarwal A, Shen Agarwal, Rao, "Lycopene Content of Tomato Products: Its Stability, Bioavailability and in Vivo Antioxidant Properties", *Journal of medicinal food*, 4 (1), 2001, 9-15.
 17. Dewanto V, Wu Adom, Liu, "Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity", *Journal of agricultural and food chemistry*, 50 (10), 2002, 3010-4.
