Chapter 1

# Introductory Chapter: Phytochemicals and Disease Prevention

Md Asaduzzaman and Toshiki Asao

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.81877

## 1. Introduction

Phytochemicals, the nonnutritive chemical compounds derived from plants, play a significant role in human disease prevention. Phytochemicals such as secondary metabolites and antioxidants have important medicinal properties. This chapter will briefly outline the source of phytochemicals, their role in disease prevention, phytochemicals produced due to stress conditions, and accumulation of bioactive compounds in fruits and vegetables. It will also discuss the role of allelochemicals as phytochemicals that produced under stressed environment in the plant rhizosphere and neighboring plants leaving significant ecological role. The purpose of this chapter is to provide a general description of phytochemicals and their roles in major diseases prevention.

## 2. Role of phytochemicals in disease prevention in human

Phytochemicals present in medicinal plants, such as alkaloids, tannins, saponins, flavonoids, phenols, steroids, carotenoids, etc., have several disease prevention activity [1]. These plant-derived chemical compounds play important preventive activities mainly anti-inflammatory, antidiabetic, antiaging, antimicrobial, antiparasitic, antidepressant, anticancer, antioxidant, and wound healing [2]. They also have great role in stress tolerance of plants and accumulation of many important bioactive compounds in fruits and vegetables.

Flavonoids are the most common bioactive compounds found in medicinal plants [3]. They have several preventive activities in human disease such as antimicrobial, antioxidant, anticancer, anti-inflammatory, and wound-healing capacity [4–6]. Anticarcinogenic flavonoids

have been reported to be found in a number of fruits and vegetables [7, 8]. Apple and berries found to have cardioprotective properties and showed positive impact on blood pressure [9].

Anthocyanins are the flavonoid constituents abundant in cell vacuole responsible for pigmentation in flowers, fruits, and vegetables and produced generally during plant under environmental stress [10, 11]. *In vitro* studies showed antioxidative activities of anthocyanins in cell culture systems such as colon, liver, breast, leukemic cell, and keratinocytes [12–15].

Carotenoids are considered as the potential natural antioxidant found in fruits and vegetables. They include xanthophyll and carotenes having scavenging of peroxyl radical [16]. Lycopene is common in tomato and berries, while β-carotenes are orange-colored carotenoids abundant in yellow-orange and dark-green leafy vegetables [17].

## 3. Allelochemicals as phytochemicals in the plant rhizosphere and its ecological role

Plant releases a numerous phytochemicals in order to protect it from environmental stresses such as drought, submergence, chemical pollution, UV exposure, pest and disease infection, and several other unfavorable conditions [18, 19]. Through this process, plant produces secondary metabolites and bioactive compounds having potential antioxidative roles [20]. In general, under natural ecosystem, plant releases numerous chemical compounds to the environment from its body and maintains its normal growth and development. However, plant produces several other chemicals/allelochemicals under environmental stress conditions [21–23]. The released allelochemicals create both heterotoxic and autotoxic conditions for the plant and its neighboring species [24]. Under replanting conditions and recycled hydroponics, plant found to produce a number of allelochemicals that inhibit its own growth and development, and this phenomenon has been reported in beans, taro, strawberry, lettuce, several other leafy vegetables, and ornamentals [25–29]. On the other hand, these allelochemicals may play a significant ecological role in controlling weeds, pests, and plant diseases [30, 31].

## 4. Conclusion

Fruits and vegetables are the great source of phytochemicals that play protective role in many age-related diseases. Phytochemical supplementation can benefit human health through supplying specific antioxidative/bioactive compounds which have preventive role in several diseases. Flavonoids are the most common phytochemicals that provide antimicrobial, antioxidant, anticancer, anti-inflammatory, and wound-healing activities. Plant under stress also produces allelochemicals that can inhibit either its own growth or neighboring plant species. Under stress condition, plant-produced allelochemicals may also play significant ecological roles through controlling weeds, plant disease, and insect pests.

## Author details

Md Asaduzzaman[1,2]* and Toshiki Asao[1]

*Address all correspondence to: asadcbt@bari.gov.bd

1 Department of Agriculture, Faculty of Life and Environmental Science, Shimane University, Matsue, Shimane, Japan

2 Olericulture Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh

## References

[1] Barbosa A, Silveira GD, de Menezes I, Neto J, Bitencurt J, Estavam CD, et al. Antidiabetic effect of the *Chrysobalanus icaco* L. aqueous extract in rats. Journal of Medicinal Food. 2013;**16**:538-543. DOI: 10.1089/jmf.2012.0084

[2] Bahramsoltani R, Farzaei MH, Rahimi R. Medicinal plants and their natural components as future drugs for the treatment of burn wounds: An integrative review. Archives of Dermatological Research. 2014;**306**:601-617. DOI: 10.1007/s00403-014-1474-6

[3] Pietta PG. Flavonoids as antioxidants. Journal of Natural Products. 2000;**63**:1035-1042. DOI: 10.1021/np9904509

[4] Cushnie TPT, Lamb AJ. Antimicrobial activity of flavonoids. International Journal of Antimicrobial Agents. 2005;**26**:343-356. DOI: 10.1016/j.ijantimicag.2005.09.002

[5] Procházková D, Boušová I, Wilhelmová N. Antioxidant and prooxidant properties of flavonoids. Fitoterapia. 2011;**82**:513-523. DOI: 10.1016/j.fitote.2011.01.018

[6] Chirumbolo S. Flavonoids in propolis acting on mast cell-mediated wound healing. Inflammopharmacology. 2012;**20**:99-102. DOI: 10.1007/s10787-012-0125-9

[7] Barrientos S, Brem H, Stojadinovic O, Tomic-Canic M. Clinical application of growth factors and cytokines in wound healing. Wound Repair and Regeneration. 2014;**22**:569-578. DOI: 10.1111/wrr.12205

[8] Ahmed SA, Nazim S, Siraj S, Siddik PM, Wahid CA. *Euphorbia neriifolia* Linn: A phytopharmacological review. International Research Journal of Pharmacy. 2011;**2**:41-48

[9] Toh JY, Tan VMH, Lim PCY, Lim ST, Chong MFF. Flavonoids from fruit and vegetables: A focus on cardiovascular risk factors. Current Atherosclerosis Reports. 2013;**15**:368. DOI: 10.1007/s11883-013-0368-y

[10] Chalker-Scott L. Environmental significance of anthocyanins in plant stress responses. Photochemistry and Photobiology. 1999;**70**:1-9. DOI: 10.1111/j.1751-1097.1999.tb01944.x

[11] Heerboth S, Housman G, Leary M, Longacre M, Byler S, Lapinska K, et al. EMT and tumor metastasis. Clinical and Translational Medicine. 2015;**4**:6. DOI: 10.1186/s40169-015-0048-3

[12] Parry J, Su L, Moore J, Cheng Z, Luther M, Rao JN, et al. Chemical compositions, antioxidant capacities, and antiproliferative activities of selected fruit seed flours. Journal of Agricultural and Food Chemistry. 2006;**54**:3773-3778. DOI: 10.1021/jf060325k

[13] Shin DY, Lee WS, Kim SH, Kim MJ, Yun JW, Lu JN, et al. Anti-invasive activity of anthocyanins isolated from *Vitis coignetiae* in human hepatocarcinoma cells. Journal of Medicinal Food. 2009;**12**:967-972. DOI: 10.1089/jmf.2008.1338

[14] Takikawa M, Inoue S, Horio F, Tsuda T. Dietary anthocyanin-rich bilberry extract ameliorates hyperglycemia and insulin sensitivity via activation of amp-activated protein kinase in diabetic mice. The Journal of Nutrition. 2010;**140**:527-533. DOI: 10.3945/jn.109.118216

[15] Olsson ME, Gustavsson KE, Andersson S, Nilsson A, Duan RD. Inhibition of cancer cell proliferation *in vitro* by fruit and berry extracts and correlations with antioxidant levels. Journal of Agricultural and Food Chemistry. 2004;**52**:7264-7271. DOI: 10.1021/jf030479p

[16] Stahl W, Sies H. Antioxidant activity of carotenoids. Molecular Aspects of Medicine. 2003;**24**:345-351. DOI: 10.1016/S0098-2997(03)00030-X

[17] Rao AV, Rao LG. Carotenoids and human health. Pharmacological Research. 2007;**55**:207-216. DOI: 10.1016/j.phrs.2007.01.012

[18] Gibson EL, Wardel J, Watts CJ. Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. Appetite. 1998;**31**:205-228. DOI: 10.1006/appe.1998.0180

[19] Mathai K. Nutrition in the adult years. In: Mahan LK, Escott-Stump S, editors. Krause's Food, Nutrition, and Diet Therapy. 10th ed. Philadelphia, Pa: W.B. Saunders; 2000. pp. 274-275. https://trove.nla.gov.au/version/44576287

[20] Rao N. Bioactive phytochemicals in Indian foods and their potential in health promotion and disease prevention. Asia Pacific Journal of Clinical Nutrition. 2003;**12**:9-22

[21] Putnam AR. Allelopathic research in agriculture: Past highlights and potential. In: Thompson AC, editor. The Chemistry of Allelopathy: Biochemical Interactions among Plants. Washington DC: American Chemical Society; 1985. pp. 1-8. DOI: 10.1021/bk-1985-0268.ch001

[22] Miller DA. Allelopathy in forage crop systems. Agronomy Journal. 1996;**88**:854-859. DOI: 10.2134/agronj1996.00021962003600060003x

[23] Singh HP, Batish DR, Kohli RK. Autotoxicity: Concept, organisms and ecological significance. Critical Reviews in Plant Sciences. 1999;**18**:757-772. DOI: 10.1080/07352689991309478

[24] Asaduzzaman M, Fuad Mondal M, Ban T, Asao T. Selection of ideal succeeding crops after asparagus, taro and beans replanting field in seedling growth bioassay. Allelopathy Journal. 2013;**32**:1-22

[25] Asaduzzaman M, Asao T. Autotoxicity in beans and their allelochemicals. Scientia Horticulturae. 2012;**134**:26-31. DOI: 10.1016/j.scienta.2011.11.035

[26] Asao T, Hasegawa K, Sueda Y, Tomita K, Taniguchi K, Hosoki T, et al. Autotoxicity of root exudates from taro. Scientia Horticulturae. 2003;**97**:389-396. DOI: 10.1016/S0304-4238(02)00197-8

[27] Kitazawa H, Asao T, Ban T, Pramanik MHR, Hosoki T. Autotoxicity of root exudates from strawberry. The Journal of Horticultural Science and Biotechnology. 2005;**80**:677-680. DOI: 10.1080/14620316.2005.11511997

[28] Lee JG, Lee BY, Lee HJ. Accumulation of phytotoxic organic acids in reused nutrient solution during hydroponic cultivation of lettuce (*Lactuca sativa* L.). Scientia Horticulturae. 2006;**110**:119-128. DOI: 10.1016/j.scienta.2006.06.013

[29] Asao T, Kitazawa H, Ushio K, Sueda Y, Ban T, Pramanik MHR. Autotoxicity in some ornamentals with the means to overcome it. Hortscience. 2007;**42**:1346-1350

[30] Rizvi SJH, Rizvi V. Exploitation of allelochemicals in improving crop productivity. In: Rizvi SJH, Rizvi V, editors. Allelopathy: Basic and Applied Aspects. London: Chapman and Hall; 1992. pp. 443-472. DOI: 10.1007/978-94-011-2376-1

[31] Kohli RK, Batish D, Singh HP. Allelopathy and its implications in agroecosystems. Journal of Crop Production. 1998;**1**:169-202. DOI: 10.1300/J144v01n01_08

IntechOpen