Int. j. adv. multidisc. res. stud. 2022; 2(6):286-291

Received: 20-09-2022
Accepted: 30-10-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Sweet Potato Leaves: A Review

[1] Yashwant Kumar Patel, [2] Krishna Kumar Patel, [3] Jitendra Kumar, [4] Vinod Kumar

[1] Assistant Professor, Department of FPT, Atal Bihari Vajpayee Vishwavidyalaya, Bilaspur, Chhattisgarh, India
[2] Assistant Professor, Department of Agricultural Engineering, PG College, Ghazipur (VBSPU), Uttar Pradesh, India
[3] Assistant Professor, Department of Agricultural Engineering, SDJPG College Chandeshwar, Azamgarh, Uttar Pradesh, India
[4] Research Scholar, Department of Agricultural Engineering, PG College, Ghazipur (VBSPU), Uttar Pradesh, India

Corresponding Author: **Yashwant Kumar Patel**

Abstract

The sixth-most important food crop in the world is the edible tuber native to America called the sweet potato (*Ipomoea batatas*). In a 45 trillion USD market, China dominates production. Domesticated sweet potato varieties vary phenotypic and genetic characteristics, but they are all high in sugars, resistant/slow-digesting starch, vitamins, minerals, bioactive proteins and lipids, carotenoids, polyphenols, ascorbic acid, alkaloids, coumarins, and saponins, depending on the genotype. The phytochemicals in sweet potato, either singly or in combination, protect against a wide range of diseases, including several forms of cancer and heart disease. Vitamins, minerals, antioxidants, dietary fibre, and vital fatty acids can be found in sweet potato leaves. This vegetable's bioactive ingredients contribute to health promotion by enhancing immunological function, lowering oxidative stress and free radical damage, decreasing the risk of cardiovascular disease, and inhibiting the formation of cancer cells. Consuming sweet potato leaves has been shown to have a few hemo-preventive benefits, and is now most popular in Asian and African nations as well as on Pacific Ocean islands. As a result, higher consumption of this vegetable should be encouraged. Since lowering the prevalence of chronic illnesses is important for public health. When compared to the main commercial vegetables, sweet potato leaves have a higher concentration of polyphenolics, specifically anthocyanins and phenolic acids. At least 15 biologically active anthocyanins, found in sweet potato leaves, have significant medical significance for a number of human ailments and can also be used as natural food colouring. The acylated cyanidin and peonidin types of anthocyanins were present. This review article examines the nutritional value and therapeutic importance of green sweet potato leaves, soil and climate, and health-promoting and disease-preventing bioactive chemicals.

Keywords: Antioxidants; Sweet potato; *Ipomoea batatas*; Phenolic Compounds and Antioxidant Activity

Introduction

According to the FAO (2018) [11], China produces the most vegetables and has the largest population of consumers worldwide. China is the world's top producer of sweet potatoes within this production, with yearly output in 2017 total 72 million tonnes (or 63.6 percent of global production) (FAOSTAT, 2019) [12] Sweet potato leaves (SPL), the primary by-product of sweet potato manufacturing, are a nutrient-dense source of polyphenols, proteins, vitamins, and minerals (Ishida *et al.*, 2000) [20]. *Ipomoea batatas L. (Lam.)* is the scientific name for the sweet potato, a dicotyledonous plant in the morning glory family (Convolvulaceae). It originated in Central America and was domesticated more than 5000 years ago. The crop was brought to China in the late 16th century, and during the 17th and 18th centuries, it expanded quickly throughout Asia and Africa. A significant crop in many parts of the world, sweet potatoes are now grown in over 100 nations and are among the top five food crops in tropical regions, where many of the world's poorest people reside (Woolfe, 1992) [51]. Only 15% of the sweet potatoes farmed worldwide are grown in Africa, while the remaining 6 percent are grown in the rest of the globe (Horton, 1988) [16]. The sweet potato has been developed as an alternative crop to produce food for human and animal demands in both fresh and processed form due to the benefits of sweet potato production and its high nutritional content. The sweet potato serves a variety of key functions in the world food system, all of which have significant effects on satisfying food needs, alleviating poverty, and boosting food security (El-Sheikha and Ray, 2017) [9]. Ascorbic acid (vitamin C), one of the important vitamins for human health, and a few B vitamins are both found in sweet potatoes in high concentrations. A few sweet potato tissues, in addition to the plant's typically eaten root, are edible and rich in nutrients. Even though studies have shown that sweet potatoes contain water-soluble vitamins, a study from the University Agricultural Centre found that both young and mature sweet potato leaves may supply considerable levels of vitamin B_6 and other necessary vitamins.

Ipomoea batatas, a perennial herbaceous vine that grows on marginal areas and produces edible leaves and storing roots, is known as the sweet potato. Since being domesticated in the New Planet, sweet potato plants have been widely disseminated by people all over the world. After rice, wheat, potatoes, maize, and cassava, sweet potatoes are currently the sixth most significant food crop. Worldwide, 105 million tonnes of sweet potatoes were produced in 2015, with developing nations accounting for 95% of that total with China as the top producer. The seventh-most significant food crop in the world is the sweet potato (FAO, 1997), and is among the crops selected by the U. S. National Aeronauts-tics and Space Administration to be grown in a controlled ecological life support system as a primary food source (Hoff *et al.*, 1982) [15].

In nations where there are persistent food shortages, using the sweet potato leaves as a vegetable in addition to the storage roots might greatly boost food supply. Sweet potato greens are currently only sometimes eaten as a fresh vegetable in select regions of the world (Villarreal *et al.*, 1982). Each sweet potato leaf demonstrated a high level of radical scavenging activity, which extended the *in vitro* lag time for the onset of low-density lipoprotein oxidation. We discovered that the total amount of polyphenols in sweet potato leaves was substantially linked with the radical scavenging activity and rate of lag time prolonging. The lag time prolongation rate showed strong correlations with total polyphenol content. When treated with sweet potato leaves, the formation of thiobarbituric acid reactive compounds, which are caused by endothelial cell-mediated low-density lipoprotein oxidation, was reduced. Following their consumption of 18 g of "Suioh," or raw sweet potato leaves, 13 healthy volunteers had their low-density lipoprotein oxidizability levels tested. "Suioh" lowered low-density lipoprotein mobility and delayed the time it took for low-density lipoprotein oxidation to begin. These findings imply that antioxidant activity in sweet potato leaves prevents low-density lipoprotein oxidation (Low *et al*., 2007; Hotz *et al*., 2012; Van Jaarsveld *et al*., 2005) [36, 17, 36].

Soil and Climate

Sweet potatoes are farmed from 40°N to 32°S; especially in the tropics from sea level to 3,000 m. Growth is minimal below 10°C and optimal above 24°C. Frost will kill the plants, and freezing temperatures will damage store roots, but the harm may not be visible for several months. Cultivation is thus restricted to temperate locations with a minimum frost-free time of four months. With enough rainfall, tropical climates may grow many crops each year. During the growth season, the ideal rainfall is around 50 cm. The crop can withstand severe dryness and continue growth once established, although drought during establishment can result in low stands and poor root set. Sandy loams with permeable subsoils are the best soils. Sweet potatoes do not handle wet soils well, especially towards harvest, when roots may rot in the field or during storage. Soils with higher bulk densities or inadequate aeration produce irregular forms and have a lower root set. Cultural management, such as the use of mounds or ridges, can enable for productive use of these soils. Sweet potatoes may grow on a variety of soils, with pH levels ranging from 5.0 to 7.5 considered ideal as long as there are no mineral deficits (Bouwkamp, 1985) [2, 3].

Table 1: Health-promoting and disease-preventing bioactive compounds in green sweet potato leaves

S. No	Green sweet potato leaves	Functions	References
1.	Polyphenols	Antioxidative; free radical scavenging; improved immune response; decreased lipid peroxidation; decreased DNA oxidation; inhibition of LDL oxidation	Huang *et al*. (2007) [18]; Chen *et al.* (2005) [6]; Chen *et al*. (2008) [7]; Salleh *et al.* (2002) [45]
2.	Caffeic acid derivatives	Antioxidative; antimutagenic; chemo preventive; antidiabetic	Yoshimoto *et al*. (2002) [57]; Kurata *et al.* (2007) [31]; Islam *et al*. (2009) [25]; Jung *et al*. (2006) [29]
3.	Quercetin	Antihypertensive; chemo preventive	Edwards *et al*. (2007) [8]; Caltagirone *et al.* (2000) [4]
4.	Kaempferol	Antioxidative; chemo preventive	Park *et al.* (2006) [42]; Luo *et al*. (2009) [38]
5.	Fisetin	Anti-inflammatory; chemo preventive	Lu *et al*. (2005) [37]; Geraets *et al*. (2009) [14]; Lim and Park (2009) [34]
6.	Morin	Chemo preventive; anti-inflammatory	Kawabata *et al*. (1999) [30]; Galvez *et al.* (2001) [13]
7.	Luteolin	Anti-inflammatory; chemo preventive	Ju *et al*. (2007) [28]; Lim *et al*. (2007) [33]; Jang *et al*. (2008) [27]
8.	Apigenin	Chemo preventive	Liu *et al*. (2005) [35]; Van Dross *et al.* (2003) [48]; Caltagirone (2000) [4]
9.	Mono-and di galactosyl, diacylglycerol	Anti-inflammatory	Lenti *et al*. (2009) [32]
10.	Dietary fiber	Chemopreventive; antidiabetic; cardioprotective; increased faecal excretion of bile acids	Innami *et al*. (1998) [19]; *Pereira et al.* (2004) [43]; Weickert and Pfeiffer (2008) [49]
11.	Phytochemicals	Antioxidative, Antimutagenic; Vasorelaxation	Islam *et al*. (2009) [25]; Runnie*et al*. (2004)
12.	Omega-3 fatty acids	Cardioprotective; anti-inflammatory	Massaro *et al*. (2009)

Nutritional Values

Many different chemical components that are important to human health may be found in sweet potato leaves. Sweet potato leaves have nutritional levels that are equivalent to spinach depending on genotypes and growth circumstances (Woolfe, 1992; Yoshimoto *et al*., 2002; Ishiguro *et al*., 2002) [51, 57, 21]. The average mineral and vitamin content per 100 grammes of fresh weight of leaves in the recently created cultivars "Suioh" was 117 mg calcium, 1.8 mg iron, 3.5 mg carotene, 7.2 mg vitamin C, 1.6 mg vitamin E, and 0.56 mg vitamin K. When compared to other important vegetables, the concentrations of iron, calcium, and beta-carotene are among the highest (Ishiguro *et al*., 2004) [23].As a crop, sweet potato leaf is more resistant to diseases, pests, and excessive wetness than many other green vegetables cultivated in the tropics. It is also rich in vitamin B, carotene, iron, calcium, zinc, and protein (AVRDC 1985; Woolfe, 1992; Yoshimoto *et al*., 2003) [1, 51, 52]. In comparison to other commercial vegetables, sweet potato leaves were a superior source of antioxidative polyphenolics, including anthocyanins and phenolic acids like caffeic, mono-cafeoylquinic (chlorogenic), dicaffeoylquinic, and tricaffeoylquinic acids (Islam *et al*., 2002b; Yoshimoto *et al*., 2001 [56]; Ishiguro *et al*., 2002 [21]).

Concerns about oxalate levels in food crops have existed for a long time. High oxalate intake is associated with a number of health problems, including acute poisoning that result in hypo calcemia and chronic poisoning that damages the kidneys by depositing calcium oxalate crystals there. Furthermore, oxalic acid and soluble oxalates can bind calcium, reducing its bioavailability and calcium oxalate itself is poorly utilised by humans. The average content of oxalic acid of sweet potato variety ‘Suioh’ leaves was 280 mg/ 100 g fresh weight. Compared to spinach, which contains 930 mg/100 g of fresh weight, this content was not excessive. Oxalic acid contents of other sweet potato varieties tested were also several times less than that of spinach (Yoshimoto *et al*., 2002b) [58].

Several reports have indicated that sweet potato leaves inhibited HIV replication, mutagenicity, diabetes, and the proliferation of cancer cells, although the effect of these leaves in inhibiting LDL oxidation has not been sufficiently demonstrated. The aim of this study was to compare the antioxidant effect on LDL oxidation of several cultivars of sweet potato leaves. Additionally, the findings revealed that the riboflavin content varied depending on the sweet potato tissue type, but was always higher in the leaves. Compared to young leaves, mature leaves had higher levels of riboflavin.

Ethnic/Cultural Details

In Asian and African nations as well as in Pacific Ocean islands, sweet potato leaves are primarily consumed as a vegetable. Sweet potato leaves may be crushed and used to ointments to cure skin diseases including rashes, as well as mouth and throat irritations, according to folk treatments. A hot water infusion of sweet potato leaves was traditionally used in Brazil to help relieve hunger and the signs of metabolic problems.

Nutritive worth

Low in saturated fat and cholesterol, high in carbohydrates, protein, and fibre, and rich in omega-3 fatty acids, which are essential for the health of the body's tissues, including the heart, lungs, blood vessels, immune system, and hormone production.

Many different chemical compounds that are important to human health can be found in sweet potato leaves. Sweet potato leaves have nutritional levels that are equivalent to spinach depending on genotypes and growth circumstances. The average mineral and vitamin content per 100 grammes of fresh weight of leaves in the recently developed cultivars "Suioh" was 117 mg calcium, 1.8 mg iron, 3.5 mg carotene, 7.2 mg vitamin C, 1.6 mg vitamin E, and 0.56 mg vitamin K. When compared to other main vegetables, carrots have some of the highest concentrations of iron, calcium, and carotene (Ishiguro *et al*., 2004) [23].

Sweet potato leaf nutrition: Micronutrients (Vitamins and Minerals)

a) **Vitamins:** A, C, K, B_1, B_2, B_3, B_9
b) **Minerals:** calcium, iron, magnesium, phosphorus, potassium.
c) Also contains zinc, manganese, copper.
d) Low in sodium.
e) The slides include bar graphs to compare nutrient levels of other common leafy greens including cabbage, kale, lettuce, spinach and Swiss chard.
f) The crude protein content of sweet potato leaves (2.99 g/100 g FW) was similar to that of milk.
g) The K/Na ratios in 19 cultivars of sweet potato leaves were higher than that of spinach.
h) The INQ of protein, fiber, and most minerals in sweet potato leaves were >2.
i) Polyphones were the most important antioxidants in sweet potato leaves.

Sweet potato leaves can be consumed to combat malnutrition.

Fruits and vegetables include bioactive substances that are essential for shielding cellular components from oxidative damage that contributes to disease aetiology. Sweet potato leaves have the ability to increase dietary protein and amino acid intake, as well as growth performance, when added to the diets of animals. A significant amount of nitrogen was added to the protein value in the New Guinean diet each day by eating sweet potato leaves, according to earlier studies. Also expected to supply close to one-third of the total antioxidant activity in vegetables taken as part of the average Taiwanese diet are sweet potato leaves (unpublished data). The traditional Hawaiian diet, which includes sweet potato leaves along with other dietary fiber-rich, complex-carbohydrate, and low-fat foods, decreased the risks of cardiovascular disease. Consuming sweet potato leaves has been shown to alter serum lipid profiles in both humans and animals, according to Tuskegee University researchers, suggesting potential for lowering the risks of developing cardiovascular diseases (Johson and Pace, 2010) [40].

Plant parts that contain naturally occurring polyphenolic compounds have the ability to defend against some dangerous diseases. When compared to the major commercial vegetables like spinach, broccoli, cabbage, lettuce, and so on, sweet potato leaf has high polyphenolic concentrations. Sweet potato leaf is a physiologically functional food that offers protection from diseases linked to oxidation, such as cancer, hepatotoxicity, allergies, aging, human immunodeficiency virus, and cardiovascular problems. Therefore, sweet potato leaves utilised as a vegetable, a tea, in noodles, breads, confectioneries, and as a nutritional supplement can become a good dietary source for beneficial polyphenolic components. To the best of our knowledge, no published information is available on the particular dosage of sweet potato leaves for human consumption.

Leaves of the sweet potato and the immune system

Chen *et al*. evaluated the effects of eating purple sweet potato leaves on the modulation and manifestation of immune response in basketball players. For two weeks; 200 g of purple sweet potato leaves per day led to an increase in plasma polyphenol levels. Additionally, taking purple sweet potato leaves increased both the cytotoxic activity of natural killer cells and the proliferation responses in peripheral blood mononuclear cells. Consuming sweet potato leaves improved immune response in a positive way. Consuming sweet potato leaves specifically increased the proliferation of lymphocytes.

Medicinal Importance

1. Sweet potato helps to reduce the chances of liver disease and stomach cancer.
2. It lowers depression and helps to lose weight.
3. The fresh leaf helps to treat neoplasia.
4. The leaves are considered to possess an antioxidant, ant mutagen, anti-cancer, anti-hypertension, anti-microbial and anti-inflammatory properties.
5. It is used to provide relief from constipation.
6. It helps to enhance the immunity power and prevents the disease and infections.
7. The drink made from the leaves helps to eradicate diarrhea, nausea and stomach aches.
8. It is also effective for colds, flues, burns, bug bites and scrapes.
9. It also lowers anxiety, stress and blood pressure.

Recommendations

There are lot of scope for the new product development from the leaves of sweet potato in fresh forms or in dried form (powder). For enhancement of nutritional quality in or daily diet, we must incorporate the same in our meal in any forms. Encapsulation of dried powder of sweet potato leaves can also be done in future.

Acknowledgement

I would like to express my special thanks to Professor Arun Diwakar Nath Bajpai, Honourable Vice-Chancellor, Atal Bihari Vajpayee Vishwavidyalaya, Bilaspur Chhattisgarh and Dr Nirmala S Maurya, Honourable Vice-Chancellor, Veer Bahadur Singh Purvanchal University, Jaupur, Uttar Pradesh for their support and kind gesture to complete this manuscript.

References

1. Asian Vegetable Research and Development Center [AVRDC]. 1985. Composition of edible fiber in sweet potato tips. AVRDC Prog Rep, 1985, 310-313.
2. Bouwkamp J. Production requirements. In: Sweet potato Products: A Natural Resource for the Tropics (Bouwkamp JC, editor). Boca Raton, FL: CRC Press. 1985a, 9:34.
3. Bouwkamp JC. Processing of sweet potatoes—canning, freezing, dehydrating. In: Sweet potato Products: A Natural Resource for the Tropics (Bouwkamp JC, editor). Boca Raton, FL: CRC Press, 1985b,185-203.
4. Caltagirone S, Rossi C, Poggi A, *et al*. Flavonoids apigenin and quercetin inhibit melanoma growth and metastatic potential. Int J Cancer. 2000; 87:595-600.
5. Chang WH, Chen CM, Hu SP, Kan NW, Chiu CC, Liu JF. Effect of purple sweet potato leaf consumption on the modulation of the antioxidative status in basketball players during training. Asia Pac J Clin Nutr. 2007; 16:455-461.
6. Chen CM, Li SC, Lin YL, Hsu CY, Shieh MJ, Liu JF. Consumption of purple sweet potato leaves modulates human immune response: T-lymphocyte functions, lytic activity of natural killer cell and antibody production. World J Gastroenterol. 2005; 11:5777-5781.
7. Chen CM, Lin YL, Chen CY, Hsu CY, Shieh MJ, Liu JF. Consumption of purple sweet potato leaves decreases lipid peroxidation and DNA damage in humans. Asia Pac J Clin Nutr. 2008; 17:408-414.
8. Edwards RL, Lyon T, Litwin SE, Rabovsky A, Symons JD, Jalili T. Quercetin reduces blood pressure in hypertensive subjects. J Nutr. 2007; 137:2405-2411.
9. El-Sheikha AF, Ray RC. Potential impacts of bio processing of sweet potato: Review. Crit Rev Food Sci & Nutr. 2017; 57:455-471.
10. Evenson SK, Standal BR. Use of tropical vegetables to improve diets in the Pacific region. HITAHR res. ser. 028. HITAHR, Univ. of Hawaii. Hawaii, USA, 1984.
11. FAO, 2018. Available at: www.fao.org/faostat/en/#data/QC/visualize
12. FAOSTAT, 2019. Available at: http://www.fao.org/faostat/en/#data/QC/visualize.
13. Galvez J, Coelho G, Crespo ME, *et al*. Intestinal anti-inflammatory activity of morin on chronic experimental colitis in the rat. Aliment Pharmacol Ther. 2001; 15:2027-2039.
14. Geraets L, Haegens A, Brauers K, *et al*. Inhibition of LPS induced pulmonary inflammation by specific flavonoids. Biochem Biophys Res Commun. 2009; 382:598-603.
15. Hoff JE, Howe JM, Mitchell CA. Nutritional and cultural aspects of plant species selection for a controlled ecological life support system. NASA Contractor Rpt. 166324, Moffett Field, Calif, 1982.
16. Horton DE. World patterns and trends in sweet potato production. Tropical agriculture. 1988; 65(3):268-270.
17. Hotz C, Loechl C, de Brauw A, Eozenou P, Gilligan D, Moursi M, *et al*. A large-scale intervention to introduce orange sweetpotato in rural Mozambique increases vitamin A intakes among children and women. Brit J Nutr. 2012; 108:163-176.
18. Huang Z, Wang B, Eaves DH, Shikany JM, Pace RD. Total phenolics and antioxidant capacity of indigenous vegetables in the southeast United States: Alabama Collaboration for Cardiovascular Equality Project. Int J Food Sci Nutr, 2007, 1-9.
19. Innami S, Tabata K, Shimizu J, *et al*. Dried green leaf powders of Jew's mellow (Corchorus), persimmon (*Diosphyros kaki*) and sweet potato (*Ipomoea batatas* poir) lower hepatic cholesterol concentration and increase fecal bile acid excretion in rats fed a cholesterol-free diet. Plant Foods Hum Nutr. 1998; 52:55-65.
20. Ishida H, Suzuno H, Sugiyama N, Innami S, Tadokoro

T, Maekawa A. Nutritive Evaluation on Chemical Components of Leaves, Stalks and Stems of Sweet Potatoes (*Ipomoea Batatas* Poir). Food Chem. 2000; 68(3):359-367. Doi: 10.1016/S0308-8146(99)00206-X.
21. Ishiguro K, Kumagai T, Kai Y, Nakazawa Y, Yamakawa O. Genetic resources and breeding of sweet potato in Japan. In: Rmanatha R, Campilan D, editors. Exploring the complementarities of *in situ* and *ex situ* conservation strategies for Asian sweet potato genetic resources, Proceeding of the 3rd international workshop of the Asian Network for sweet potato genetic resources; Bali, Indonesia; 2002 Oct 2–4. Indonesia: Asian Network for sweet potato genetic resources, 2002, 57-61.
22. Ishiguro K, Toyama J, Islam MS, Yoshimoto M, Kumagai T, Kai Y, Yamakawa O. Suioh, a new sweet potato cultivar for utilization in vegetable greens. Acta Hortic. 2004; 637:339-345.
23. Ishiguro K, Toyama J, Islam MS, Yoshimoto M, Kumagai T, Kai Y, Yamakawa O. Suioh, a new sweet potato cultivar for utilization in vegetable greens. Acta Hortic. 2004; 637:339-345.
24. IShiguro K, Toyama J, Islam S, Yoshimoto M, Kumagai T, Kai Y, Yamakawa O. Suioh, a new Sweet potato Cultivar for Utilization in Vegetable Greens, Act Hortic. 2004; 637:339345.
25. Islam I, Shaikh AU, Shahidul IM. Antioxidative and antimutagenic potentials of phytochemicals from *Ipomoea batatas* (L.). Intl J Cancer Res. 2009; 5:1-12.
26. Islam I, Shaikh AU, Shahidul IM. Antioxidative and antimutagenic potentials of phytochemicals from *Ipomoea batatas* (L.). Intl J Cancer Res. 2009; 5:1-12.
27. Jang S, Kelley KW, Johnson RW. Luteolin reduces IL-6 production in microglia by inhibiting JNK phosphorylation and activation of AP-1. PNAS. 2008; 105:7534-7539.
28. Ju W, Wang X, Shi H, Chen W, Belinsky SA, Lin Y. A critical role of luteolin-induced reactive oxygen species in blockage of tumor necrosis factor-activated nuclear factor-kappa B pathway and sensitization of apoptosis in lung cancer cells. Mol Pharmacol. 2007; 71:1381-1388.
29. Jung UJ, Lee MK, Park YB, Jeon SM, Choi MS. Antihyperglycemic and antioxidant properties of caffeic acid in db/db mice. J Pharmacol Exp Ther. 2006; 318:476-483.
30. Kawabata K, Tanaka T, Honjo S. Chemopreventive effect of dietary flavonoid morin on chemically induced rat tongue carcinogenesis. Int J Cancer. 1999; 83:381-386.
31. Kurata R, Adachi M, Yamakawa O, Yoshimoto M. Growth suppression of human cancer cells by polyphenolics from sweet potato (*Ipomoea batatas L.*) leaves. J Agric Food Chem. 2007; 55:185-190.
32. Lenti M, Gentili C, Pianezzi A,. Monogalactosyldiacylglycerol anti-inflammatory activity on adult articular cartilage. Nat Prod Res. 2009; 23:754-762.
33. Lim DY, Jeong Y, Tyner AL, Park JHY. Induction of cell cycle arrest and apoptosis in HT-29 human colon cancer cells by the dietary compound luteolin. Am J Physio Gastrointestinal Liver Physiol. 2007; 292: G66-G75.
34. Lim DY, Park JHY. Induction of p53 contributes to apoptosis of HCT-116 human colon cancer cells induced by the dietary compound fisetin. Am J Physiol Gastrointest Liver Physiol. 2009; 296:G1060-G1068.
35. Liu LZ, Fang J, Zhou Q, Hu X, Shi X, Jiang BH. Apigenin inhibits expression of vascular endothelial growth factor and angiogenesis in human lung cancer cells: Implication of chemoprevention of lung cancer. Mol Pharmacol. 2005; 68:635-643.
36. Low JW, Arimond M, Osman N, Cunguara B, Zano F, Tschirley D. A food-based approach introducing orange-fleshed sweetpotatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. J Nutr. 2007; 137:1320-1327.
37. Lu X, Jung J, Cho HJ, *et al*. Fisetin inhibits the activities of cyclin-dependent kinases leading to cell cycle arrest in HT-29 human colon cancer cells. J Nutr. 2005; 135:2884-2890.
38. Luo H, Rankin GO, Liu L, Daddysman MK, Jiang BH, Chen YC. Kaempferol inhibits angiogenesis and VEGF expression through both HIF dependent and independent pathways in human ovarian cancer cells. Nutr Cancer. 2009; 61:554-563.
39. Massaro M, Scoditti E, Carluccio MA, De Caterina R. Basic mechanisms behind the effects of n-3 fatty acids on cardiovascular disease. Prostag Leukot Essent Fatty Acids. 2008; 79:109-115.
40. Melissa johson & Ralphenia d pace. 2010; 68(10):604-615.
41. Nwinyi SCO. Effect of age at shoot removal on tuber and shoot yields at harvest of five sweet potato (*Ipomoea batatas* L.) cultivars; Nat Prod Res. 1992; 12:221-225.
42. Park JS, Rho HS, Kim DH, Chang IS. Enzymatic preparation of kaempferol from green tea seed and its antioxidant activity. J Agric Food Chem. 2006; 54:2951-2956.
43. Pereira MA, O'Reilly E, Augustsson K, *et al*. Dietary fiber and risk of coronary heart disease: A pooled analysis of cohort studies. Arch Intern Med. 2004; 164:370-376.
44. Runnie I, Salleh MN, Mohamed S, Head RJ, Abeywardena MY. Vasorelaxation induced by common edible tropical plant extracts in isolated rat aorta and mesenteric vascular bed. J Ethno pharmacol. 2004; 92:311-316.
45. Salleh MN, Runnie I, Roach PD, Mohamed S, Abeywardena MY. Inhibition of low-density lipoprotein oxidation and up-regulation of low-density lipoprotein receptor in HepG2 cells by tropical plant extracts. J Agric Food Chem. 2002; 50:3693-3697.
46. Shahidul Islam S. Sweet potato (*Ipomea batatas L.*) leaf: Its potential effect on human health and nutrition. J. Food Sci. 2006; 71:R13-R121.
47. Shiguro K, Toyama J, Islam S, Yoshimoto M, Kumagai T, Kai Y, Yamakawa O. Suioh, a new Sweet potato Cultivar for Utilization in Vegetable Greens," Act Hortic. 2004; 637:339345.
48. Van Dross R, Xue Y, Knudson A, Pelling JC. The chemo preventive bioflavonoid apigenin modulates signal transduction pathways in keratinocyte and colon carcinoma cell lines. J Nutr. 2003; 133(S):S3800-S3804.
49. Weickert MO, Pfeiffer AF. Metabolic effects of dietary

fiber consumption and prevention of diabetes. J Nutr. 2008; 138:439-442.
50. Woolfe JA. Sweet potato. An untapped food resource. Cambridge, U.K.: Cambridge Univ. Press, 1992, 118-187.
51. Woolfe JA. Sweet potato: An untapped food resource. Cambridge University Press, Cambridge, 1992, p643.
52. Yoshimoto M, Okuno S, Islam MS., Kurata R, Yamakawa O. Polyphenol content and antimutagenicity of sweet potato leaves in relation to commercial vegetables. Acta Hortic. 2003; 628:677-685.
53. Yoshimoto M, Okuno S, Kumagai T, Yoshinaga M, Yamakawa O, Yamaguchi M, *et al*. Antimutagenicity of sweetpotato (*Ipomoea batatas*) roots. Bio sci Biotechnol Bio-chem. 1999b; 63:537-541.
54. Yoshimoto M, Okuno S, Kumagai T, Yoshinaga M, Yamakawa O. Distribution of antimutagenic components in colored sweet potatoes. Jpn Agric Res Q. 1999a; 33:143-148.
55. Yoshimoto M, Okuno S, Suwa K, Sugawara T, Yamakawa O. Effect of harvest time on nutrient content of sweet potato leaves. Proc. 12th Symp. of the Intl. Society for Tropical Root Crops; 2000 Sept 11-14; Tsukuba, Japan. Japan: International Institute for Tropical Root Crops, and National Agricultural Research Center, 2002a, 319-323.
56. Yoshimoto M, Okuno S, Yamaguchi M, Yamakawa O. Antimutagenicity of deacylated anthocyanins in purple-fleshed sweet potato. Bio sci Biotechnol Biochem. 2001; 65:1652-1655.
57. Yoshimoto M, Yahara S, Okuno S, Islam S, Ishiguro K, Yamakawa O. Antimutagenicity of mono-, di- and tricaffeoylquinic acid derivatives isolated from sweet potato (*Ipomoea batatas* L.) leaf. Biosci Biotechnol Biochem. 2002; 66:2336-2341.
58. Yoshimoto M, Yahara, Islam MS, Ishiguro K, Yamakawa O. Anti-mutagenicity of mono-, di-, and tricaffeoylquinic acid derivatives isolated from sweetpotato (*Ipomoea batatas* L.) leaf. Biosci Biotechnol Biochem. 2002b; 66:2332-2338.
59. Yoshimoto M. New trends of processing and use of sweet potato in Japan. Farming Jpn. 2001; 35:22-28.