

Vitamin C content of naturally produced fresh vegetables in Kalasin Province, Thailand

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ABSTRACT

The purpose of this study was to ascertain the vitamin C content of locally cultivated vegetables in Thailand. As the study's sample veggies, local, conveniently accessible product is regularly consumed by Thais. Vegetables include eggplant, *Solanum melongena* L., kajon flowers, *Telosma minor* Craib, lettuce, *Lactuca sativa* L., butterfly pea flowers, *Clitoria ternatea* Linn, acacia. *Acacia farnesiana* (L.) Willd, spinach. *Spinacia oleracea* L., and zucchini, *Cucurbita* L. var. *cylindrica* Pans. Fresh vegetable vitamin C levels range from $130 \pm 1.00 \text{ mg kg}^{-1}$, $340 \pm 0.58 \text{ mg kg}^{-1}$, $350 \pm 1.00 \text{ mg kg}^{-1}$, $340 \pm 0.58 \text{ mg kg}^{-1}$, $440 \pm 0.58 \text{ mg kg}^{-1}$, $490 \pm 0.58 \text{ mg kg}^{-1}$ and $140 \pm 0.58 \text{ mg kg}^{-1}$, respectively. Spinach contained the most vitamin C, with a concentration of 490 mg kg^{-1} followed by Acacia, lettuce, kajon flowers, butterfly pea flowers and zucchini respectively. However, vitamin C is still necessary for healthy skin and a strong immune system. The body can also get the appropriate daily quantity of vitamin C by eating the right kinds and amounts of fruits and vegetables.

Key Words: Antioxidant, Vitamin C, Vegetables, Water-soluble, Nutrient.

Article type: Short Communication.

INTRODUCTION

The immune system is reliant on ascorbic acid, also known as vitamin C, which the body cannot produce on its own capable of combating free radicals and other toxins, including those caused by metabolic processes in the body, which result in cellular degradation (Bradshaw *et al.* 2011). Vitamin C reduces aging and wrinkles to improve skin health and benefits. Furthermore, it helps prevent colds, since it has properties that improve the performance of the body's immune system and helps avoid other ailments such as allergies and scurvy. They are easily accessible and available in Thailand (Balan *et al.* 2005). Vitamin C is one of the few supplements that is both useful and safe. While vitamin C is not a treatment for the common cold, it may guard against immune system deficits, cardiovascular infection, prenatal health issues, eye sickness, and even skin aging (Padayatty *et al.* 2003). The acceptable upper intake level for humans is 2000 mg per day, which is regarded to be the most that will not be dangerous. Keep in mind that many people do not always consume the recommended dose of vitamin C. In addition, vitamin C deficiency is more common in malnourished individuals. Scurvy is a disease that causes anemia, bruising, bleeding, and loose teeth in severe cases (Moser *et al.* 2016). Free radicals, toxic chemicals, and pollutants such as cigarette smoke can all harm the body and cause cancer. Vitamin C is one of these compounds. Free radicals can collect and play a role in the development of diseases such as cancer, heart disease, and arthritis. An overdose of vitamin C is not dangerous, since the body does not store it. To avoid diarrhea and stomach pain, the 2,000 mg daily safe maximum limit must still be followed (du Toit *et al.* 2001). Vitamin C is easily absorbed in the form of food and pills and, when combined with iron, can improve iron absorption (Frei *et al.* 2012). A single vitamin cannot solve serious health problems. They frequently cooperate, as well as make other lifestyle choices such as obtaining adequate sleep (Pacier *et al.* 2015). Regular exercise and stopping smoking are essential. Nonetheless, research indicates that vitamin C may benefit your health in the following ways (Levine *et al.* 1999): Topical vitamin

C therapies have been shown in several studies to reduce wrinkles. It can also be used to treat macular degeneration, reduce inflammation, and lower the risk of cancer and cardiovascular disease, according to previous studies (Pullar *et al.* 2017). Moreover, these therapies include hydrating and moisturizing the skin for all skin types, improving skin evenness, and reducing redness, minimizing hyperpigmentation, reducing dark circles and fine wrinkles, promoting collagen production, avoiding sagging skin, protecting against UV damage, healing sunburns, and elevating skin radiance (Fukushima *et al.* 2010). Vitamin C is a natural antioxidant that is required for the elimination of free radicals from the body, reduction of oxidative and inflammatory damage, and prevention of infections, as well as a variety of pathological illnesses. In the case of collagen production and wound healing, vitamin C is absolutely essential. Vitamin C and its supplements dramatically reduce the risk of cancer, heart disease, and respiratory disease. Another significant effect of vitamin-rich meals is the synthesis of collagen, a protein found in bones, tissues, and blood vessels (Liu 2003). Because of its high amounts of biosynthesis and antioxidants, it helps to maintain a healthy immune system, which improves overall brain health (Rickman *et al.* 2007). To suit the demands of the skin, it should be used topically as an oil or serum. To our delight, the market is currently swamped with skincare foundations containing this fantastic beauty factor (Levine *et al.* 2001). The presence of vitamin C helps collagen production by restoring damaged tissue to its natural state and assisting in skin nourishing, as well as the rehabilitation of burnt dry skin. To rebuild skin that is supple and healthy, according to Bradshaw *et al.* (2011), water-soluble vitamins, including vitamin C, use the proteins in cells to strengthen their interactions and extend cell life, and improve iron absorption. It has an organic laxative effect. It enhances the effectiveness of drugs used to treat urinary tract infections and reduces the symptoms caused by irritants, helps to speed up wound healing after surgery by defending against bacterial contamination and viral infection, accelerates the healing of fresh wounds and burns (Pisoschi *et al.* 2011). "Local vegetables" are frequently used in cuisines by Thai people. Vegetables are widely consumed in many areas, because of containing dietary fiber, which promotes stool excretion, prevents constipation, and lowers the risk of colon cancer and hinders the bloodstream's ability to absorb sugar. Insulin levels are consequently decreased. Some dietary fibers also aid in lowering cholesterol levels, which poses a danger of developing heart disease and stroke. Vitamin C, a substance with antioxidant characteristics, is present in local vegetables together with other vitamins and minerals. It lowers inflammation, boosts the body's defenses against infection, and aids in the prevention of cancer and heart disease. The aim of this study was to estimate the amount of vitamin C present in fresh vegetables sold at the agricultural market in the Mueang District of the Kalasin Province. The following vegetables were chosen for this study, since are widely available, easy to grow, and popular among consumers in the Kalasin Province: Eggplant, kaffir flower, lettuce, butterfly pea blossom, acacia, spinach, and zucchini were the vegetables selected.

MATERIALS AND METHODS

Vegetable samples

In Mueang District, Kalasin Province, farmers sell a variety of fresh vegetables in the agricultural market. In this province, the following vegetables that were commonly available, simple to grow, and well-liked by customers were selected for this study: eggplant, *Solanum melongena* L., kajan flowers, *Telosma minor* Craib, lettuce, *Lactuca sativa* L., butterfly pea blossoms, *Clitoria ternatea* Linn, acacia, *Acacia farnesiana* (L.) Willd, spinach, *Spinacia oleracea* L., and zucchini, *Cucurbita* L. var. *cylindrica* Pans. respectively. Vegetables of every variety were brought in from the production section. All vegetables were sourced from the same growers in Kalasin Province.

Analyzing vitamin C in vegetable samples

Vegetables of all varieties were transported from the countryside for research purposes. The process for examining vitamin C in vegetables is broken down into the next five steps.

1. The samples were thoroughly grinded and carefully weighed (2 g) with accuracy, then documented the findings.
2. An aliquote of 10 mL potassium was added. A reddish-brown solution was produced by mixing 10 mL potassium iodide solution with 10 mL sulfuric acid solution.
3. Sodium thiosulfate solution was used to do titration.
4. An aliquote of 2 mL starch water was added to the blue solution while keeping track of the yellow solution.

5. Titration was continued the mixture until it got colorless, then the volume was measured to determine how much vitamin C is present. (Mussa & El Sharaa 2014).

RESULTS AND DISCUSSION

The findings revealed that in the plants including *Solanum melongena* L., kajon flowers, *Telosma minor* Craib, lettuce, *Lactuca sativa* L., butterfly pea flowers, *Clitoria ternatea* Linn), acacia, *Acacia farnesiana* (L.) Willd, spinach, *Spinacia oleracea* L., and zucchini, *Cucurbita* L. var. *cylindrica* Pans., vitamin C levels were from 130, 340, 350, 440, 490 and 140 mg kg⁻¹ respectively (Table 1).

Table 1. Quantity of vitamin C in fresh Thai vegetables.

Thai vegetables	vitamin C content (mg kg ⁻¹)
Eggplant, <i>Solanum melongena</i> L.	130 ± 1.00
Kajon flowers, <i>Telosma minor</i> Craib	340 ± 0.58
Lettuce, <i>Lactuca sativa</i> L.	350 ± 1.00
Butterfly pea flowers, <i>Clitoria ternatea</i> Linn	340 ± 0.58
Acacia, <i>Acacia farnesiana</i> (L.) Willd	440 ± 0.58
Spinach, <i>Spinacia oleracea</i> L.	490 ± 0.58
Zucchini, <i>Cucurbita</i> L. var. <i>cylindrica</i> Pans.	140 ± 0.58

According to findings of the present study, spinach exhibited the highest vitamin C concentration of any fresh or cooked vegetable. The human body is unable to produce enough vitamin C to satisfy its requirements. Vitamin C is necessary for the immune system and antioxidants. If the body is given the proper amount of vitamin C, by consuming fruits and vegetables, it may be absorbed by the body. Vitamin C is necessary for the body to function correctly. Immunity and growth are aided by vitamin C. As an antioxidant, vitamin C is good for the skin and the digestive system. Humans require a proper amount of vitamin C. Vegetables provide the majority of the vitamin C that humans need. Nutrient-dense foods like eggplants offer a lot of fiber, vitamins, and minerals. In addition to antioxidants, eggplants contain a wide range of vitamins, minerals, and other nutrients. Chemicals known as antioxidants aid the body in defending itself against dangerous particles called free radicals (Chong 2005).

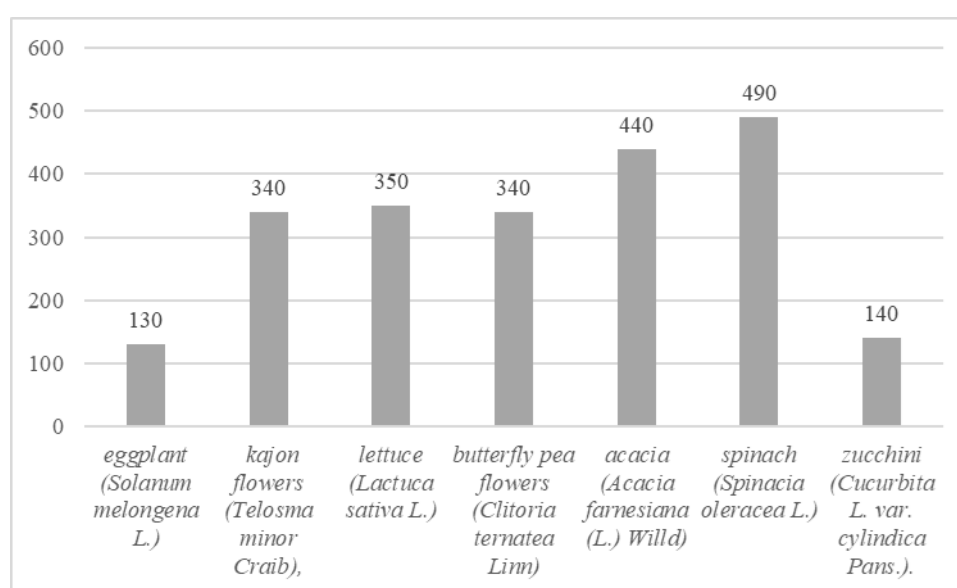


Fig. 1. Comparison of vitamin C in fresh Thai vegetables.

Vitamin C is transformed into acid. If vitamin C levels are too high, salicylic acid—or other extremely acidic and less soluble in urine—increases the risk of kidney stones. Due to the body's inability to eliminate uric acid, it builds up around the joints. Gout risk may be increased by vitamin C's potential to promote inflammation. (Deekshika *et al.* 2015). The human body can only store a limited amount of vitamin C. Scurvy syndrome appears in adults and can last from one month to more than six months in a vitamin C-deficient diet, based on prior vitamin C intake (Douglas *et al.* 2008). This makes them aware of the differences in vitamin C content between fruits and vegetables, which will be beneficial to consumers (Mussa & El Sharaa 2014). Coriander has the highest vitamin C concentration of any fresh vegetable. Vitamin C benefits both as antioxidants and enhancing the body's immune system. The following vegetables were picked from samples of those often consumed in Kalasin, Thailand. Ascorbic acid, often known as vitamin C, is a water-soluble chemical. It can be delivered to the body's tissues by dissolving it in water, however, since it does not store well, it should be managed on a regular basis by dietary intake or supplements. Antioxidants are advantageous plant compounds that support human body's fight against damage from free radicals. These offer some heart, eye, and skin protection as well as defense against a number of cancers, including prostate cancer. Studies show that the plant's epidermis contains the highest concentration of antioxidants. Zucchini could have a bit more levels than those that are bright green. It can help digestive system in a variety of ways. Zucchini may help people with type 2 diabetes by lowering blood sugar levels. It is also beneficial to heart health. Its high fiber content may be the deciding factor. According to observational studies, people who ingest more fiber are less likely to develop heart disease. Pectin, a type of soluble fiber found in zucchini, appears to be especially beneficial in decreasing total and "bad" LDL cholesterol levels. Regular eating of zucchini may help with weight loss. According to scientific definition, eggplant is a berry that is often used as a vegetable in cooking (Sharma & Kaushik 2021). Although it is commonly considered to as veggies, it is technically fruiting, since produces by flowering plants and contain seeds. There are countless varieties in various sizes and hues. Furthermore, while eggplants are most commonly deep violet in hue, they can also be red, green, or even black (Gürbüz *et al.* 2018). In addition to vitamin C, some vegetables may also contain other substances such as anthocyanins found in aubergines, which is particularly useful. Several test tube experiments have proven that it is effective in protecting cells from free radical damage (Hossain *et al.* 2018). While these results are encouraging, it is crucial to highlight that present research is limited to animal and test tube investigations. More research is needed to determine how eggplants affect human heart health (Naeem, M. Y., & Ugur, S., 2019).

Kajon flowers and gourami flowers are two easy-to-find local vegetables. It is commonly utilized in the preparation of a wide range of dishes, primarily since edible flowers are employed. Apart from how magnificent the blossoms are (Suwanaruang 2021). The leaves are slightly crimson in color. The blossoms are yellowish green and clustered in clusters similar to ubi flowers. The oval fruit has a pleasant aroma and can be consumed as a vegetable. To aid in spreading, the seeds are hairy and have a spear-shaped, pointed end (Chairatudomkul 2008). Through immigration, the variant gradually spread to Polynesia and other parts of the world (Cayleff 2016). Lettuce, *Lactuca sativa* L., boost our immunity while also protecting our cells from free radical damage. It exhibits anti-inflammatory and anti-cancer properties due to contain antioxidants such as lutein, zeaxanthin, and quercetin. Constipation is less prone to arise as a result of its high fiber content. These also contain little calories, which is advantageous for those attempting to lose weight (Kim *et al.* 2016). This is owing to the numerous myths surrounding a plant-based diet. There are various plant-based foods that are high in protein. Plant-based proteins, in fact, offer fewer calories per serving than animal-based proteins, making them a suitable alternative for those attempting to lose weight (Shi *et al.* 2022). The Egyptians were the first to cultivate lettuce, as it was scientifically known. They utilized the leaves of this important vegetable, as well as the seeds, to manufacture oil. The plant was treasured in Egyptian culture and held cultural and religious significance. Later, the Greeks and Romans grew this crop as well. They are also among the most widely planted lettuce kinds globally. They are colorful due to a chemical known as anthocyanins. Furthermore, red leaf lettuce is an important ingredient in many recipes, since they can regenerate after being cut (Yang *et al.* 2022). Butterfly pea flowers are also used to produce herbal tea, often with lemongrass, honey, and lemon, as well as cosmetics and natural colours for food, beverages, and textiles. As the acidity changes, so does the color of the pea blossom tea. The butterfly pea blossom is well-known for its therapeutic properties and has been connected to a range of potential health benefits, making it a popular ingredient in speciality cocktails (Jamil *et al.* 2018). More research is needed, however, to determine the potential effects of butterfly pea flower on long-term blood sugar regulation (Permatasari *et al.* 2022). This plant is one-of-a-kind for a multitude of reasons, but its changing properties account for a considerable percentage of its present

popularity. When steeped in boiling water, the butterfly pea blossom takes on a striking blue tint, distinguishing it from other teas. Once adding lemon or any acid, the tea magically shifts from blue to a vibrant violet. The lemon changes the pH of the tea, causing it to change color (Singh *et al.* 2022). Furthermore, it is rich in history, symbolism, and health benefits. The advantages of butterfly pea tea are caused by the active ingredient, acetylcholine, which promotes memory and is required for brain function (Marpaung *et al.* 2020). Acacia: The fiber supplement is available in its powder form. Acacia fiber has various health benefits due to its high soluble fiber content, including enhanced heart health, diabetes protection, and relief from symptoms of irritable bowel syndrome (IBS). It can also control appetite and maintain intestinal health. However, there is limited evidence to support many of these health benefits. People who eat more fiber have a lower risk of acquiring heart disease. Fiber benefits the heart by decreasing cholesterol. Soluble fiber, in particular, decreases cholesterol by limiting cholesterol absorption in the intestine and increasing bile excretion- a chemical formed from cholesterol in the liver that aids in the digestion of fat in food. Although acacia fiber is high in soluble fiber, data is mixed on whether it can benefit heart health by lowering cholesterol (Nambiar *et al.* 2015). The FDA has classified a naturally occurring plant fiber as a dietary fiber that has been proved to have favorable physiological effects in humans. (Zhang *et al.* 2014). Spinach is one of the best dietary sources of quercetin and zeaxanthin. Similar to lutein, zeaxanthin can improve eye health. Spinach is extremely healthy and has been linked to a variety of health benefits. It has been demonstrated that it improves blood pressure, oxidative stress, and eye health. Free radicals are byproducts of metabolism (Ferreira *et al.* 2020). Both human and animal studies back up its findings. The carotenoids zeaxanthin and lutein, which give some plants their color, are rich in spinach (Miyata *et al.* 2012). They also slowed effects against tumor growth. Several human studies have linked spinach consumption to a decreased risk of prostate cancer. As a result, it may interact with blood-thinning medications. People who take blood thinners such as warfarin should see their doctor before eating a lot of spinach (Abu Al-Qumboz *et al.* 2019).

CONCLUSION

In this study, the amounts of vitamin C in fresh vegetables sold at the agricultural market in Mueang District, Kalasin Province, Thailand were measured. The vegetables chosen for this study were eggplant, kaffir flower, lettuce, butterfly pea blossom, acacia, spinach, and zucchini, since they were widely available, simple to grow, and well-liked by customers in Kalasin Province. Vitamin C levels in fresh vegetables range from 130, 340, 350, 440, 490, and 140 mg kg⁻¹, respectively. by a value of 490 mg kg⁻¹, spinach, *Spinacia oleracea* L. had the highest concentration of vitamin C. followed by Acacia, *Acacia farnesiana* (L.) Willd., lettuce, *Lactuca sativa* L., butterfly pea flowers, *Clitoria ternatea* Linn., kajon flowers, *Telosma minor* Craib), and zucchini, (*Cucurbita* L. var. *cylindrica* Pan.), respectively.

Conflict of interest

The authors have no conflicts of interest.

Data available

The author confirms that the data were significant in obtaining to this finding.

REFERENCES

- Abu Al-Qumboz, MN & Abu-Naser, SS 2019, Spinach expert system: diseases and symptoms. International Journal of Academic Information Systems Research (IJASIR), 3: 16-22.
- Balan, D, Pele, M, Artimon, M & Luta, G 2005, Bioactive compounds in sea buckthorn fruits and in some products obtained by their processing. Revue de Cytologie et de Biologie Végétales-Le Botaniste, 28: 364-368.
- Bradshaw, MP, Barril, C, Clark, AC, Prenzler, PD & Scollary, GR 2011, Ascorbic acid: A review of its chemistry and reactivity in relation to a wine environment. Critical Reviews in Food Science and Nutrition, 51: 479-498.
- Bradshaw MP, Barril C, Clark AC *et al.* 2011, Ascorbic acid: A review of its chemistry and reactivity in relation to a wine environment. Critical Reviews in Food Science and Nutrition, 51: 479-498.
- Cayleff, SE 2016, Nature's path: A history of naturopathic healing in America. JHU Press.

- Chairatudomkul, S 2008, Cultural routes as heritage in Thailand: Case studies of King Narai's Royal procession route and Buddha's footprint pilgrimage route. Unpublished PhD Dissertation, Silpakorn University, Thailand.
- Chong, M 2005, Perception of the risks and benefits of Bt eggplant by Indian farmers. *Journal of Risk Research*, 8(7-8), 617-634.
- Deekshika B, Praveena LB, Hemanth S *et al.* 2015, Estimation of ascorbic acid content in fruits and vegetables from Hyderabad, India for a theoretical assessment of vitamin C activity. *International Journal of Current Microbiology and Applied Sciences*, 4: 96-99.
- Douglas RM, Hemilä H & Chalker E, *et al.* 2008, Cochrane review: Vitamin C for preventing and treating the common cold. *EBCH*. 3: 672-720.
- du Toit, R, Volsteedt, Y & Apostolides, Z 2001, Comparison of the antioxidant content of fruits, vegetables and teas measured as vitamin C equivalents. *Toxicology*, 166: 63-69.
- Ferreira, J F, da Silva Filho, J B, Liu, X & Sandhu, D 2020, Spinach plants favor the absorption of K⁺ over Na⁺ regardless of salinity, and may benefit from Na⁺ when K⁺ is deficient in the soil. *Plants*, 9: 507.
- Frei, B, Birlouez-Aragon, I & Lykkesfeldt, J 2012, What is the optimum intake of vitamin C in humans? *Critical Reviews in Food Science and Nutrition*, 52: 815-829.
- Fukushima, R & Yamazaki, E 2010, Vitamin C requirement in surgical patients. *Current Opinion in Clinical Nutrition & Metabolic Care*, 13: 669-676.
- Gürbüz, N, Uluişik, S, Frary, A, Frary, A & Doğanlar, S 2018, Health benefits and bioactive compounds of eggplant. *Food Chemistry*, 268: 602-610.
- Jamil, N, Zairi, MNM, Nasim, NAIM & Pa'ee, F 2018, Influences of environmental conditions to phytoconstituents in *Clitoria ternatea* (butterfly pea flower): A review. *Journal of Science and Technology*, 10(2).
- Kim, MJ, Moon, Y, Tou, J C, Mou, B & Waterland, NL 2016, Nutritional value, bioactive compounds and health benefits of lettuce (*Lactuca sativa* L.). *Journal of Food Composition and Analysis*, 49, 19-34.
- Levine, M, Rumsey, SC, Daruwala, R, Park, J B & Wang, Y 1999, Criteria and recommendations for vitamin C intake. *Jama*, 281(15), 1415-1423.
- Levine, M, Wang, Y, Padayatty, SJ & Morrow, J 2001, A new recommended dietary allowance of vitamin C for healthy young women. *Proceedings of the National Academy of Sciences*, 98: 9842-9846.
- Liu, RH 2003, Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *The American Journal of Clinical Nutrition*, 78: 517S-520S.
- Miyata, K, Noguchi, K & Terashima, I 2012, Cost and benefit of the repair of photodamaged photosystem II in spinach leaves: roles of acclimation to growth light. *Photosynthesis Research*, 113: 165-180.
- Moser, MA & Chun, OK 2016, Vitamin C and heart health: A review based on findings from epidemiologic studies. *International Journal of Molecular Sciences*, 17(8): 1328.
- Marpaung, AM, Lee, M & Kartawiria, IS 2020, The development of butterfly pea (*Clitoria ternatea*) flower powder drink by co-crystallization. *Indonesian Food Science & Technology Journal*, 3: 34-37.
- Morris, JB 2021, Multivariate analysis of butterfly pea (*Clitoria ternatea* L.) Genotypes with potentially healthy nutraceuticals and uses. *Journal of Dietary Supplements*, 1-10.
- Mussa, SB, El Sharaa I 2014, Analysis of Vitamin C (ascorbic acid) Contents packed fruit juice by UV-spectrophotometry and redox titration methods OSR. *Journal of Applied Physics*. 6: 46-52.
- Naeem, MY & Ugur, S 2019, Nutritional content and health benefits of eggplant. *Turkish Journal of Agriculture-Food Science and Technology*, 7(sp3), 31-36.
- Nambiar, ES, Harwood, CE & Kien, ND 2015, Acacia plantations in Vietnam: Research and knowledge application to secure a sustainable future. *Southern Forests: A Journal of Forest Science*, 77: 1-10.
- Pacier, C & Martirosyan, DM 2015, Vitamin C: optimal dosages, supplementation and use in disease prevention. *Functional Foods in Health and Disease*, 5: 89-107.
- Padayatty, SJ, Katz, A, Wang, Y, Eck, P, Kwon, O, Lee, JH & Levine, M 2003, Vitamin C as an antioxidant: evaluation of its role in disease prevention. *Journal of the American college of Nutrition*, 22: 18-35.
- Permatasari, HK, Nurkolis, F, Gunawan, WB, Yusuf, VM, Yusuf, M, Kusuma, RJ & Tsopmo, A 2022, Modulation of gut microbiota and markers of metabolic syndrome in mice on cholesterol and fat enriched diet by butterfly pea flower kombucha. *Current Research in Food Science*, 5: 1251-1265.

- Pisoschi AM, Danet AF, Kalinowski S *et al.* 2008, Ascorbic acid determination in commercial fruit juice samples by cyclic voltammetry. *Journal of Automated Methods and Management in Chemistry*, 3: 1-7.
- Pisoschi AM, Pop A, Negulescu GP *et al.* 2011, Determination of ascorbic acid content of some fruit juices and wine by voltammetry performed at Pt and carbon paste electrodes. *Molecules* 16:1349-1365.
- Pullar, JM, Carr, AC & Vissers, MC 2017, The roles of vitamin C in skin health. *Nutrients*, 9(8), 866.
- Rickman, JC, Barrett, DM, & Bruhn, CM 2007, Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds. *Journal of the Science of Food and Agriculture*, 87(6), 930-944.
- Rekha C, Poornima G, Manasa M *et al.* 2012, Ascorbic acid, total phenol content and antioxidant activity of fresh juices of four ripe and unripe citrus fruits. *Chemical Science Transactions*, 1(2):303-310.
- Sharma, M & Kaushik, P 2021, Biochemical composition of eggplant fruits: A review. *Applied Sciences*, 11(15): 7078.
- Shi, M, Gu, J, Wu, H, Rauf, A, Emran, T B, Khan, Z & Suleria, HA 2022, Phytochemicals, Nutrition, Metabolism, Bioavailability, and Health Benefits in Lettuce—A Comprehensive Review. *Antioxidants*, 11(6), 1158.
- Suwanaruang, T 2021, Vitamin C content of local Thai fresh vegetables for the immune system body and antioxidants.
- Singh, R, Yu, CC, Chen, G W, Chen, CH, Sinaki, NY, Lin, J & Koksel, F 2022, Butterfly Pea Flower as a Novel Ingredient to Produce Antioxidant-Enriched Yellow Pea-Based Breakfast Cereals. *Foods*, 11(21), 3447.
- Salem, HB, Makkar, HPS, Nefzaoui, A, Hassayoun, L & Abidi, S 2005, Benefit from the association of small amounts of tannin-rich shrub foliage (*Acacia cyanophylla* Lindl.) with soya bean meal given as supplements to Barbarine sheep fed on oaten hay. *Animal Feed Science and Technology*, 122(1-2), 173-186.
- Shelton, AM, Hossain, MJ, Paranjape, V, Azad, AK, Rahman, ML, Khan, ASMMR & McCandless, L 2018, Bt eggplant project in Bangladesh: History, present status, and future direction. *Frontiers in Bioengineering and Biotechnology*, 106.
- Verdini RA, Lagier CM 2004, Studying current-potential curves using bipotentiometric iodometric back-titration for the determination of ascorbic acid in fruits and vegetables. *Journal of Chemical Education*, 81(10): 1482.
- Yang, X, Gil, M I, Yang, Q & Tomás-Barberán, FA 2022, Bioactive compounds in lettuce: Highlighting the benefits to human health and impacts of preharvest and postharvest practices. *Comprehensive Reviews in Food Science and Food Safety*, 21(1), 4-45.
- Zhang, Q, Achal, V, Xu, Y & Xiang, WN 2014, Aquaculture wastewater quality improvement by water spinach (*Ipomoea aquatica* Forsskal) floating bed and ecological benefit assessment in ecological agriculture district. *Aquacultural Engineering*, 60: 48-55.

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