Comparative study of Thiamine and Ascorbic acid in selected leafy vegetables

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Abstract

Leafy vegetables, commonly consumed daily in food are one of the major sources of vitamins. These vegetables also contain an abundance of carotenoids, antioxidants that protect cells and play roles in blocking the early stages of cancer. They also contain high levels of fiber, iron, magnesium, potassium and calcium. Furthermore, greens have very little carbohydrates, sodium and cholesterol. The dark greens supply a significant amount of folate, ascorbic acid, vitamin B that promotes heart health and helps prevent certain birth defects. Eating leafy vegetables is vital to a healthy, balanced diet. It is very beneficial to determine the concentration level of individual vitamins present in leafy vegetables for the regulation of a balanced diet. In this study, we aimed to quantify the content of Ascorbic Acid (Vitamin C) and Thiamine (Vitamin B_1) in five different green leafy vegetables: *Spinacia oleracea* (spinach), *Amaranthus cruentus* (amaranth), *Trigonella foenum-graecum* (fenugreek), *Basella alba* (Malabar spinach), and *Coriandrum sativum* (coriander), utilizing a titration method with 5% DCIP for Ascorbic Acid and alkalimetry method for Thiamine. Our preliminary findings suggest variability in the vitamin content among the tested leafy vegetables. This research underscores the importance of incorporating a variety of leafy vegetables into the diet and highlights the need for standardized nutrient quantification methods. The highest and lowest concentration of vitamin B_1 and vitamin C was observed in *Trigonella foenum-graecum* (fenugreek), *Spinacia oleracea* (spinach) and *Basella alba* (Bachala), *Amaranthus cruentus* (Amaranth) respectively.

Keywords: *Spinacia oleracea* (spinach), *Coriandrum sativm* (coriander), *Amaranthus cruentus* (amaranth), *Trigonella foenum-graecum* (Fenugreek), *Basella alba* (bachala), Ascorbic Acid (vitamin c), Thiamine (Vitamin B_1).

Introduction

Vitamins are indispensable micronutrients that play critical roles in numerous biological processes essential for maintaining health and preventing diseases. Unlike macronutrients, such as carbohydrates, proteins, and fats, which serve as energy sources and building blocks for the body, vitamins facilitate a myriad of biochemical reactions without being consumed themselves. They are classified into two categories: fat-soluble vitamins (A, D, E, and K), which can be stored in the body's fatty tissues, and water-soluble vitamins (C and the B-vitamins), which must be regularly replenished due to their rapid excretion from the body.

Ascorbic Acid, commonly known as Vitamin C, is a water-soluble vitamin renowned for its antioxidant properties and its role in collagen synthesis (Smirnoff, N., & Wheeler, G. L. (2000). Ascorbic acid in plants: Biosynthesis and function. Critical Reviews in Biochemistry and Molecular Biology, 35(4), 291-314).Collagen, a structural protein, is vital for the health and repair of tissues, making Ascorbic Acid crucial for wound healing, skin health, and the maintenance of bones and teeth. Beyond its structural roles, Vit- C enhances the absorption of iron from plant-based foods, contributing to the prevention of iron-deficiency anemia, particularly significant in vegetarian and vegan diets. Its deficiency, historically known as scurvy, characterized by bleeding gums, weakness, and bruising, underscores the essential nature of Ascorbic Acid in the diet.

Ascorbic Acid, beyond its well-known roles in human health, plays crucial roles in plant health and development (Padayatty, S. J., & Levine, M. (2016). Vitamin C: The known and the unknown and Goldilocks. Oral Diseases, 22(6), 463-493) .In plants, it functions as a major antioxidant, protecting the plant cells from oxidative stress caused by various environmental pressures such as UV radiation, temperature extremes, and drought. Its role in photosynthesis and the synthesis of plant hormones underscores the interconnectedness of Vitamin C's functions across different biological kingdoms.

Thiamine plays a pivotal role in energy metabolism, acting as a coenzyme in the catabolism of sugars and amino acids. This Vit - B1 is crucial for the proper function of the cardiovascular and nervous systems (Bettendorff, L., & Wins, P. (2013). Thiamine: A key molecule in health and disease. Metabolic Brain Disease, 28(2), 227-2370). It aids in the production of the neurotransmitter acetylcholine, which is involved in muscle contraction and heart function

(Rapala-Kozik, M. (2011). Thiamine (vitamin B1): Metabolism, functions and deficiency. Pharmacological Reports, 63(4), 851-858). Thiamine's deficiency leads to beriberi, manifesting in either wet (cardiovascular) or dry (neurological) forms, and Wernicke-Korsakoff syndrome, a severe neurological disorder often associated with alcoholism.

Research has shown that Thiamine can also enhance plant resistance to biotic and abiotic stresses, including pathogens and physical stressors like salinity and drought. This protective role is attributed to Thiamine's ability to induce systemic acquired resistance, a plant-wide response to stress that involves the activation of a variety of defensive pathways. By boosting Thiamine levels, plants can better withstand environmental challenges, leading to implications for sustainable agriculture practices focused on reducing chemical inputs.

Green leafy vegetables represent a diverse group of plants that are rich sources of vitamins, minerals, and dietary fiber. These vegetables, including spinach, kale, Swiss chard, and collard greens, are not only low in calories but also high in folate, Vitamin K, calcium, iron, and phytochemicals with antioxidant properties. Their inclusion in the diet supports a multitude of health benefits, ranging from reduced risk of chronic diseases to improved digestive health and weight management.The content of Ascorbic Acid and Thiamine in green leafy vegetables can vary significantly depending on the species, cultivar, and environmental conditions under which they are grown. Factors such as soil quality, exposure to sunlight, and water availability can influence the nutritional composition of these plants. Moreover, agricultural practices, including the use of fertilizers and pesticides, also play a role in determining the final vitamin content of these vegetables.

The nutritional quality of green leafy vegetables, particularly in terms of their Vitamin C and B1 content, can be significantly influenced by agricultural practices. Organic farming, for instance, often emphasizes soil health and biodiversity, which can lead to higher levels of certain nutrients in crops. Crop rotation, intercropping, and the use of compost and organic fertilizers are practices that not only support sustainable agriculture but also can enhance the nutritional profile of green leafy vegetables. Advancements in agricultural technology, including controlled environment agriculture (CEA), offer opportunities to optimize the growth conditions of plants, potentially maximizing their nutritional value. By precisely controlling light, temperature, humidity, and CO2 levels, CEA can increase the concentration of vitamins and other beneficial phytochemicals in green leafy vegetables.

To maximize the health benefits of green leafy vegetables, concerted efforts from policymakers, educators, and community leaders are necessary. Nutritional guidelines and policies that promote the consumption of a variety of vegetables can encourage healthier eating patterns. School and community programs that educate about the benefits of vegetable consumption and provide hands-on experiences with gardening can foster a greater appreciation for these nutritious foods.Integrating traditional knowledge with scientific research in the cultivation and use of green leafy vegetables can also play a role in preserving biodiversity and cultural heritage while addressing nutritional needs. Collaborative efforts that bridge agricultural development, nutrition education, and environmental sustainability are essential for promoting the growth and consumption of green leafy vegetables worldwide.

to its antioxidant properties, are areas of ongoing research. The plant's adaptability to cooler climates and nutritional versatility make it a staple in various culinary traditions globally.

Materials and methods

Chemicals required:

Standard Thiamine

Blue thymol brom indicator (0.04%)

Standard ascorbic acid

NaOH(0.1N)

Oxalic acid solution (4%)

DCIP Solution (5%)

Sodium bicarbonate

2.2.1 Selection and collection of leafy vegetables:

Leafy Vegetables for analysis of vitamin B1 and vit C content was purchased from Mehdipatnam Market and brought to the laboratory. Washed thoroughly with water and dried using blotting paper. Each green leafy vegetable sample (spinach, amaranth, fenugreek, bachala, and coriander) is prepared by macerating 1 gram of the vegetable with 10ml distilled water using a mortar and pestle. The macerate is then filtered using Whatman filter paper to obtain a clear extract.

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Thiamine (vitamin B_1)

For the blank titration, 1 ml of the standard thiamine solution was added to a conical flask along with 3 drops of thymol blue indicator. The mixture is titrated until a light blue (end point) is observed.Sample Titration for Thiamine: 1 ml of each vegetable sample extract was added to separate conical flasks, along with 3 drops of thymol blue indicator. Each sample was titrated, and the endpoint is noted when the solution turns light blue.

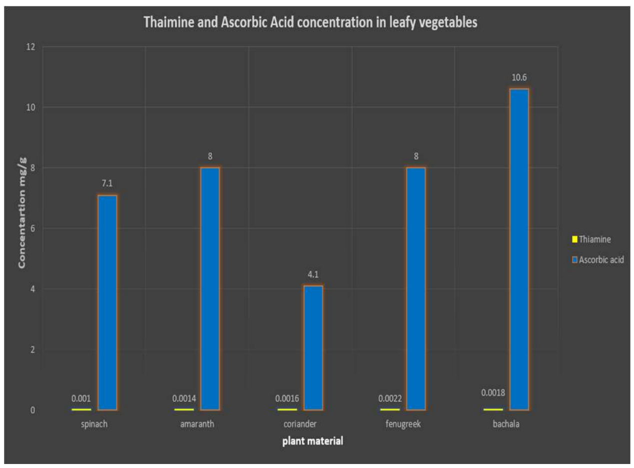
Ascorbic Acid (vitamin c)

For the blank titration, 0.5 ml of the standard ascorbic acid solution is mixed with 1 ml of oxalic acid. The mixture is titrated against the DCIP solution until a onion peel pink end point is observed. Sample Titration for Ascorbic Acid: 0.5 ml of each vegetable sample extract is mixed with 1 ml of oxalic acid in separate conical flasks. Each sample is titrated against the DCIP solution, noting the end point when the solution turns onion peel pink.

Results and Discussion

In selected leafy vegetables concentration of Thiamine (vitamin B_1) in *Spinacia oleracea* (spinach) 0.001mg/g, *Amaranthus cruentus* (Amaranthus) 0.0014mg/g, *Coriandrum sativum* (Coriander) 0.0016mg/g, *Trigonella foenum graecum* (Fenugreek) 0.0022mg/g, *Basella alba* (Bachala) 0.0018mg/g and concentration of Ascorbic acid in *Spinacia oleracea* (spinach) 7.1mg/g, *Coriandrum sativum* (coriander) 8mg/g, *Amaranthus cruentus* (Amaranthus) 4.1 mg/g, *Trigonella foenum graecum* (Fenugreek) 8mg/g, *Basella alba* (Bachala) 10.6mg/g.

This research article has extensively explored the critical roles of vitamins, particularly Ascorbic Acid (Vitamin C) and Thiamine (Vitamin B_1), in both human and plant health. The study underscores the indispensable nature of these vitamins in facilitating essential biochemical reactions, supporting structural integrity, and enhancing resistance to environmental stresses. The investigation into the vitamin content of green leafy vegetables, including spinach, amaranth, fenugreek, bachala, and coriander, has provided valuable insights into the nutritional benefits these plants offer and the factors influencing their vitamin composition.



Graph 1: Thiamine and Ascorbic acid concentration in selected leafy vegetables

Our findings have implications for both public health and agricultural practices. The study reinforces the importance of including a variety of green leafy vegetables in diets to combat micronutrient deficiencies and promote overall health. Furthermore, the research supports the adoption of sustainable agricultural practices, such as organic farming and controlled environment agriculture, to enhance the nutritional quality of crops while minimizing environmental impact.

The study also opens avenues for future research, particularly in optimizing agricultural practices to increase the bioavailability of essential vitamins and exploring the potential of these vegetables in mitigating chronic diseases through diet. Collaborative efforts between agricultural scientists, nutritionists, and policymakers are crucial to translate these findings into strategies that promote the cultivation and consumption of nutritionally rich green leafy vegetables, contributing to global health and food secure

Conclusion

The research article, focusing on the nutritional analysis and health implications of green leafy vegetables, has explored the critical roles of vitamins, particularly Ascorbic Acid (Vitamin C) and Thiamine (Vitamin B1), in both human and plant health. Through the study of *Spinacia oleracea* (spinach), *Amaranthus cruentus* (amaranth), *Trigonella foenum-graecum* (fenugreek), *Basella alba* (Malabar spinach), and *Coriandrum sativum* (coriander), we have uncovered the intrinsic value these plants hold in contributing to a balanced diet and addressing nutritional deficiencies.

The investigation highlighted the antioxidant properties of Ascorbic Acid, essential for collagen synthesis and iron absorption, and the pivotal role of Thiamine in energy metabolism and neurological function. These findings underscore the importance of green leafy vegetables in preventing diseases related to vitamin deficiencies, such as scurvy and beriberi, and in promoting overall health and well-being.

Our research also delved into the agricultural practices that influence the nutritional content of these vegetables, revealing that organic farming and controlled environment agriculture (CEA) can enhance the levels of essential nutrients. This insight is crucial for developing sustainable agriculture practices that not only support environmental health but also improve the nutritional quality of food crops.

Furthermore, the study has demonstrated the global significance of green leafy vegetables in nutrition and sustainable diets. In regions facing malnutrition and micronutrient deficiencies, these vegetables offer a vital source of essential vitamins and minerals. The promotion of green leafy vegetables, through nutritional education and policies that support their production and consumption, is therefore essential for improving public health outcomes worldwide. the indispensable role of green leafy vegetables in human nutrition and plant health. The enhanced understanding of their nutritional benefits, coupled with advances in agricultural practices, paves the way for innovative strategies to combat malnutrition and promote sustainable food systems.

Future research should continue to explore the complex interactions between agricultural methods, environmental conditions, and the nutritional composition of green leafy vegetables to optimize their health benefits and accessibility for populations around the globe.

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