Maximising Vitamin C Retention in Cooked Vegetables

Swagat Ranjan Behera[1*], Riya Pandey[1] and Shaili[2]
[1]Ph. D. Scholar, Department of Vegetable Science, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand
[2]M. Sc. Scholar, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh
*Corresponding Author: swgtbehera@gmail.com

Vitamin C, also known as L-ascorbic acid (Fig. 1), is a water-soluble vitamin found in various fruits and vegetables. It is renowned for its essential role in human health, serving as a potent antioxidant, supporting the immune system, aiding in wound healing and promoting the absorption of non-heme iron from plant-based foods.

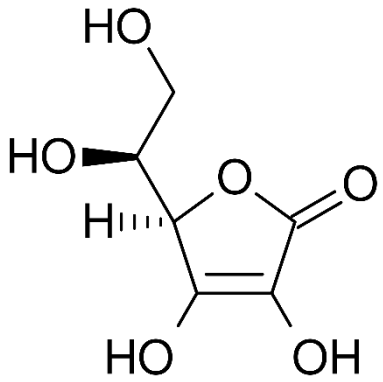

Fig. 1: Molecular structure of L-ascorbic acid

Understanding the importance of vitamin C

Before delving into the effects of processing, it is essential to understand the significance of vitamin C in the human diet. This water-soluble vitamin has a range of critical functions, *viz.*

i. **Antioxidant protection:** Vitamin C acts as a powerful antioxidant, neutralising harmful free radicals in the body, thus protecting cells from oxidative damage. This protective role is essential in preventing chronic diseases, including heart disease and certain types of cancer.

ii. **Immune system support:** It enhances the production of white blood cells and supports the immune system to resist infections.

iii. **Collagen production:** It is necessary for the synthesis of collagen, a major protein crucial for maintaining skin health, wound healing and the structural integrity of various connective tissues in the body (Pullar and Vissers, 2017).

iv. **Iron absorption:** Vitamin C enhances the absorption of non-heme iron from plant-based foods, making it especially valuable for individuals following vegetarian or vegan diets.

v. **Calcium absorption:** It promotes formation, growth and easy healing (when broken) of bones (Aghajanian *et al.*, 2015).

This vitamin cannot be synthesised in the human body, therefore, it needs to be taken through food or food supplements, like capsules or tablets. The recommended dietary allowance (RDA) for vitamin C as directed by FSSAI, is given below:

Group	Category/Age	Body weight (kg)	Ascorbic acid (mg/day)
Men	Sedentary work	60	40
	Moderate work		
	Heavy work		
Women	Sedentary work	55	40
	Moderate work		
	Heavy work		
	Pregnant		60
	Lactating (0-6 months)		80
	Lactating (6-12 months)		
Infants	0-6 months	5.4	25
	6-12 months	8.4	
Children	1-3 years	12.9	40
	4-6 years	18.0	
	7-9 years	25.1	
Boys	10-12 years	34.3	40
Girls		35.0	
Boys	13-15 years	47.6	40
Girls		46.6	
Boys	16-17 years	55.4	40
Girls		52.1	

Vegetables have a special and important position in human nutrition. A healthy balanced diet involving vegetables is the best way to get vitamin C. Vegetables like drumstick, bell pepper, chilli, tomato, broccoli and green leafy vegetables, like spinach, are a rich source of this vitamin. These vegetables are consumed both fresh and processed. It is important to note that much of the vitamin C is destroyed during processing operations like heat treatment (cooking), freezing and canning (Fabbri and Crosby, 2016).

With deficiency of vitamin C, scurvy disease develops. It occurs in people with unhealthy eating habits, indigestion problems, or when they have not consumed fresh fruits and vegetables for a long time (Al-Breiki and Al-Zoabi, 2014). The aim of this article is to explore the factors that influence the retention of vitamin C in vegetables during cooking and provide strategies to maximise its preservation.

Factors affecting vitamin C retention

The retention of vitamin C in vegetables during cooking is influenced by several factors, including temperature, cooking time, pH and the type of vegetable, as follows:

a) **Temperature:** Vitamin C is temperature-liable, *i.e.*, sensitive to heat, and its degradation accelerates as the cooking temperature increases. Ascorbic acid begins to degrade at temperatures above 70°C (158°F). The higher the cooking temperature and the longer the exposure to heat, the more is the loss of vitamin C. The loss of vitamin C can occur through various processes, including oxidation and thermal degradation. The extent of vitamin C degradation depends on the specific vegetable and cooking method.

b) **Cooking time:** The longer vegetables are exposed to heat, the more vitamin C is lost. Boiling vegetables for an extended period can lead to a significant reduction in vitamin C content, as the vitamin leaches into the cooking water and is susceptible to heat degradation (Lee and Kader, 2000).

c) **pH level:** The pH level of the cooking medium can also impact vitamin C retention. An acidic environment helps to stabilize vitamin C to some extent. However, cooking in alkaline conditions, such as when using baking soda or an excessive amount of water, can lead to increased vitamin C loss.

d) **Type of vegetable:** Different vegetables have varying levels of vitamin C and respond differently to cooking methods. For example, leafy greens like spinach and kale are more sensitive to heat and may lose vitamin C rapidly, while other vegetables like bell peppers and broccoli tend to retain more vitamin C when cooked.

e) **Cutting and peeling:** The surface area and the extent of cutting or peeling can influence the vitamin C content. Cutting vegetables into smaller pieces or peeling them can expose more of their surface to heat and oxygen, leading to greater vitamin C loss.

Strategies to maximise vitamin C retention in vegetables

Now that we understand the factors that affect vitamin C retention during cooking, let us explore the strategies to maximise its preservation:

i. **Use of gentle cooking methods:** One of the most effective ways to retain vitamin C in vegetables is to use gentle cooking methods. These methods minimise exposure to high temperatures and reduce the loss of vitamin C. Some recommended cooking methods include:

   a) **Steaming:** Steaming vegetables involves cooking them with the steam from boiling water. This method is particularly gentle on vitamin C as it avoids direct contact with water, which can leach the vitamin into the cooking liquid.

   b) **Microwaving:** Microwave cooking is a quick and gentle method that can help retain vitamin C in vegetables.

   c) **Sautéing or Stir-frying:** These methods involve cooking vegetables quickly at high temperatures in a small amount of oil. The short cooking time minimizes vitamin C loss.

When it comes to vitamin C retention, steaming appeared to be the most sparing method (Tincheva, 2019). According to Agbemafle *et al.* (2012), there was a reduction of 85% in vitamin C in boiled cabbage, while the highest loss of vitamin C was observed for boiling (52%) in cauliflower by Ahmed and Ali (2013). Tincheva (2019) recorded maximum retention of vitamin C in steamed red potatoes and the least levels in boiled red peppers.

ii. **Use of minimal water:** When boiling vegetables, it is essential to use as little water as possible. Excess water can leach vitamin C from the vegetables into the cooking liquid. To minimize vitamin C loss, these guidelines may be followed:

a) **Using small amount of water:** Add just enough water to cover the vegetables. This reduces the contact between the vegetables and the cooking liquid.

b) **Reusing the cooking water:** If you do boil vegetables, consider using the cooking water in soups, sauces, or gravies to retain some of the lost nutrients.

iii. **Cooking vegetables in their skin:** Leaving the skin on when cooking certain vegetables can help retain more vitamin C. For instance, potatoes and carrots have a significant portion of their vitamin C content in the skin. Boiling or steaming them with the skin intact can help preserve more of the nutrient.

iv. **Using an acidic cooking medium:** Cooking vegetables in an acidic medium can help stabilise vitamin C and reduce its loss during cooking. Adding a small amount of lemon juice or vinegar to the cooking water when boiling vegetables can help preserve the vitamin. Adding lemon juice to the blanching water significantly reduced the loss of vitamin C in *Amaranthus hybridus*, *Bidens pilosa* and *Cleome gynandra* (Mkandawire and Masamba, 2014). This could be due to the presence of organic acids present in the lemon juice which are known to minimise vitamin C losses.

v. **Minimising cutting and peeling:** Reducing the surface area of vegetables that are cut or peeled can minimize vitamin C loss. If you need to cut or peel vegetables, try to do so just before cooking to preserve more of the vitamin. Additionally, cutting vegetables into larger pieces can help reduce vitamin C exposure to heat and oxygen.

vi. **Consuming the cooking liquid:** In some cases, it may be beneficial to consume the cooking liquid along with the vegetables. The cooking liquid can contain some of the leached vitamin C, and incorporating it into soups, sauces, or other dishes can help maintain the nutrient's intake.

vii. **Choosing fresh vegetables:** The freshness of the vegetables can also impact their vitamin C content. Freshly harvested and stored vegetables generally contain more vitamin C than those that have been stored for extended periods. Fresh, locally-sourced produce should be opted for, whenever possible, to maximise vitamin C intake.

viii. **Avoiding overcooking:** Overcooking vegetables can lead to a significant loss of vitamin C. To prevent overcooking, the cooking time should be closely monitored and cooking of vegetables should be avoided until they become excessively soft. Vegetables should retain their vibrant colour and a slight crunch to indicate that they are adequately cooked while preserving the vitamin.

ix. **Proper storage:** The way vegetables are stored can also influence their vitamin C content. Exposure to air, light and heat can lead to vitamin C degradation. To maximise retention, vegetables should be stored in a cool, dark place, and airtight containers or plastic wrap should be used to minimise exposure to air.

Conclusion

Vitamin C is a vital nutrient found in vegetables, and it plays a crucial role in maintaining human health. However, the vitamin C content of vegetables can be significantly influenced by various

cooking methods. Gentle cooking methods like steaming, microwaving, and stir-frying are effective in retaining vitamin C, while using minimal water, keeping the skin on and adding acidic mediums can also help. Additionally, avoiding overcooking and consuming cooking liquid are practical strategies to preserve vitamin C. By understanding the impact of cooking on vitamin C content and making informed choices, individuals can continue to enjoy the nutritional benefits of vegetables while ensuring that their vitamin C intake remains adequate for a healthy diet.

References

Agbemafle, R., Obodai, E., Adukpo E., & Amprako, D. (2012). Effects of boiling time on the concentrations of vitamin c and beta-carotene in five selected green vegetables consumed in Ghana; *Pelagia Research Library Advances in Applied Science Research*, **3**(5): 2815-2820.

Aghajanian, P., Hall, S., Wongworawat, M. D., & Mohan, S. (2015). The roles and mechanisms of actions of vitamin C in bone: new developments. *Journal of Bone and Mineral Research*, **30**(11): 1945-1955.

Ahmed, F. A., & Ali, R. F. (2013). Bioactive compounds and antioxidant activity of fresh and processed white cauliflower. *BioMed Research International*.

Al-Breiki, S. H., & Al-Zoabi, N. M. (2014). Scurvy as the tip of the iceberg. *Journal of Dermatology & Dermatologic Surgery*, **18**(1-2): 46-48.

Fabbri, A. D., & Crosby, G. A. (2016). A review of the impact of preparation and cooking on the nutritional quality of vegetables and legumes. *International Journal of Gastronomy and Food Science*, **3**: 2-11.

Lee, S. K., & Kader, A. A. (2000). Preharvest and postharvest factors influencing vitamin C content of horticultural crops. *Postharvest Biology and Technology*, **20**(3): 207-220.

Mkandawire, K. T., & Masamba, K. G. (2014). Effect of lemon juice treatment and sun drying on vitamin C retention in three steam and water blanched indigenous vegetables over six weeks storage period. *African Journal of Food Science*, **8**(6): 316-321.

Pullar, J. M., Carr, A. C., & Vissers, M. (2017). The roles of vitamin C in skin health. *Nutrients*, **9**(8): 866.

Tincheva, P. A. (2019). The effect of heating on the vitamin C content of selected vegetables. *World Journal of Advanced Research and Reviews*, **3**(3): 027-032.

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