

The effect of different cooking methods in Nutrients Retention – A Narrative Review

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Abstract

Nutrients are vital chemical compounds that sustain physiological functions and promote overall health. However, their stability is often compromised during food processing and cooking. This review article provides a comprehensive overview of the impact of traditional (boiling, steaming, frying, roasting) and modern (microwaving, vacuum cooking, infrared heating, ultrasonic assisted) cooking methods on nutrient retention. A structured literature search was conducted across databases such as PubMed, Google Scholar, ScienceDirect, and Scopus, with eligible studies selected based on predefined inclusion and exclusion criteria. Findings indicate that nutrient loss is particularly pronounced in water-soluble and heat-sensitive vitamins, such as vitamin C and folate, when foods are boiled or subjected to prolonged heat exposure. In contrast, techniques like steaming, microwaving, and sous vide demonstrate superior nutrient preservation by minimizing direct contact with water, reducing oxygen exposure, and using lower or controlled temperatures. Frying and roasting enhance sensory qualities but may degrade certain micronutrients or increase undesirable compounds when not optimized. Emerging technologies, including infrared and ultrasonic-assisted cooking, show promising results in enhancing nutrient retention, though further research is needed for widespread application. Overall, the choice of cooking method plays a crucial role in determining the nutritional quality of meals. Adopting cooking practices that balance food safety, palatability, and nutrient preservation can contribute significantly to public health nutrition and chronic disease prevention.

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Introduction

Nutrients are chemical compounds essential for sustaining physiological functions and maintaining health physiological processes. These compounds are best obtained through a balanced and varied diet that provides all essential nutrients in appropriate quantities. Nutrients are generally classified into six major categories: carbohydrates, proteins, lipids, vitamins, minerals, and water. Among them, carbohydrates, lipids, and proteins are referred to as macronutrients, as they are required in larger quantities and primarily serve as the body's energy source. In contrast, micronutrients which include vitamins and minerals are needed in smaller amounts but play critical roles in regulating metabolic processes and maintaining overall health **(Ward, 2014)**. Vitamins, a key group of micronutrients, are further categorized based on their solubility. Water-soluble vitamins include the B-complex group (B1, B2, B3, B5, B6, B7, B9, B12) and vitamin C. These are not significantly stored in the body and therefore must be consumed regularly through the diet. On the other hand, fat-soluble vitamins A, D, E, and K are absorbed along with dietary fats and can be stored in body tissues for extended periods **(Ward, 2014) (Morris AL, 2023)**. However, the nutritional composition of food can be altered during various stages of processing and preparation. Cooking methods can have a significant impact on the retention of nutrients. Nutrient retention refers to the extent to which essential nutrients are preserved in food throughout the stages of the food supply chain from harvest and storage to preparation and cooking. Effective nutrient retention strategies are essential for maximizing the health benefits of the foods we consume **(Parvati, 2023)**. The concept of nutritional retention is particularly significant in public health nutrition, as the mere presence of nutrients in raw ingredients does not guarantee their availability in the final, consumed product. Therefore, the methods employed in cooking must be carefully chosen to balance food safety, palatability, and nutritional integrity. While cooking is necessary to improve the digestibility and safety of food by eliminating harmful microorganisms **(Seongeung Lee, 2017)**.

The aim of this review is to critically evaluate existing literature on the effects of different cooking methods—both traditional (boiling, steaming, frying, roasting) and modern (microwaving, vacuum cooking, infrared, ultrasonic-assisted)—on nutrient retention. By comparing evidence across methods, this review seeks to highlight strategies that maximize nutrient preservation, thereby contributing to healthier food preparation practices and improved nutritional outcomes.

Materials and Methods

This article is a narrative review based on available scientific literature discussing the impact of cooking methods on nutrient retention. Information was gathered from electronic databases such as PubMed, Google Scholar, ScienceDirect, and Scopus, along with reference lists of relevant papers. Both traditional cooking practices (boiling, steaming, frying, roasting) and modern techniques (microwaving, vacuum cooking, infrared, ultrasonic assisted) were considered.

The evidence was organized by nutrient type, including water-soluble vitamins, fat-soluble vitamins, and minerals, and narratively summarized to highlight general trends in nutrient loss or retention with different cooking methods, rather than following a structured or systematic review approach.

Inclusion and Exclusion criteria

For this review, priority was given to peer-reviewed articles and publications from government or recognized health organizations that discussed the nutritional impact of different cooking methods, such as boiling, steaming, frying, and microwaving. Reports and studies without scientific backing, those published in languages other than English, or those focusing primarily on food preservation and packaging rather than cooking techniques were not considered.

Review

Cooking Methods

Cooking is an important part in the preparation of the food, in which food undergoes various physical, chemical, and sensory changes. Cooking is a method which majorly involve heat processing which tend to affect nutritional quality of the food (**Emmanuel OK, 2025**). However, cooking is also an important process to eliminate all the microorganisms to make food safe for consumption (**Alice Njolke Mafe, 2024**) and to enhance the flavour taste and aroma (**Emmanuel OK, 2025**). Cooking can be of different methods which were broadly classified as Traditional cooking methods and Modern cooking methods (**Sun S, 2020**). The traditional cooking methods namely Boiling, steaming, frying, and roasting. Whereas modern cooking methods includes Microwave heating, vacuum cooking, infrared heating, and ultrasonic-assisted cooking technologies are rapidly developing in day-to-day life (**Wangxin Liu, 2023**).

Boiling

Boiling is one of the popular and basic cooking methods especially in cooking fresh or frozen vegetables (**Sarah Coe, 2022**) throughout the world.

Boiling method involves immersing the food in liquids like water or broth and heated to its boiling point (100° C), **(Emmanuel OK, 2025)** makes the food soft and palatable as the food goes through several physical and chemical changes **(Arif Mehmood, 2020)**. Loss of Water-soluble and Heat sensitive vitamins such as Vitamin-C and Folate is more common when food is cooked in a large volume of water with high temperature for excessive period of time **(Sarah Coe, 2022)**. However, several studies have showed that the nutrient loss is more in the boiling method, when compared other traditional cooking method **(Moyo, 2024)** the nutrients have been leached out in the water in which the food has been cooked, to retain the lost nutrients, the broth can be used in further cooking process.

Steaming

Steaming is one of the popular yet traditional cooking **(Martyna Lubinska-Szczygeł, 2019)** it is process by which that cooks food using hot steam from boiling water, without direct contact, typically at around 100°C. It helps retain natural flavour, texture, and colour while minimizing nutrient loss, particularly preserving water-soluble vitamins like vitamin C and folate better than boiling or frying **(Seongeung Lee, 2017)**. Effect of different cooking methods on the content of vitamins and true retention in selected vegetables,. Steaming also eliminates the need for added fats and improves food digestibility by softening fibres. Modern steam ovens offer precise control, enhancing nutrient retention and cooking consistency **(Yun-Sang Choi, 2016)**.

Roasting

Roasting is a dry heat cooking method that uses high temperatures (typically above 150°C) to cook food evenly through ovens or hot air circulation **(Sruthi, 2021)**. It enhances flavor and texture via the Maillard reaction and caramelization **(Kalpataru Ayurveda, 2025)** and generally preserves nutrients better than moist-heat methods, though prolonged exposure can degrade heat-sensitive compounds **(Sandra Zavadlav, 2020)**. Advanced techniques like superheated steam and convection roasting further reduce nutrient loss while improving product quality **(Wahidu Zzaman et al., 2023; Jeong et al., 2022)**. Overall, roasting delivers improved sensory qualities and nutritional value compared to conventional cooking methods.

Frying

Frying is a high-temperature dry-heat cooking method that involves submerging food in hot oil or applying a thin layer of oil in a pan, enabling rapid and efficient cooking through direct heat and fat conduction **(E. K. Oke, Frying of Food: A Critical Review, 2017)**. It enhances the flavour, aroma, and texture of food by promoting browning reactions such as the Maillard reaction and caramelization **(Sabrina Lobefaro, 2021)**.

While frying can result in some nutrient loss especially thermolabile vitamins like vitamin C the quick cooking time helps retain certain heat-stable nutrients (**Barakat, 2014**). However, excessive absorption of oil during deep-frying raises concerns regarding fat content and potential formation of harmful compounds like acrylamide when starchy foods are overcooked (**William Yesid Díaz-Ávila, 2024**). Optimized techniques like shallow-frying or using thermostatically controlled fryers can reduce oil uptake and improve overall health outcomes (**Abdulla Al Faruqa, 2022**).

Microwave Cooking

Microwave cooking is a convenient and widely used method that utilizes electromagnetic waves to directly heat water molecules within food, resulting in rapid cooking with minimal external heat (**Xuan Deng, 2022**). This method helps preserve the colour, texture, and nutritional quality of the food due to the shorter cooking time and reduced use of water (**Sabrina Lobefaro, 2021**). Unlike boiling, microwave cooking significantly reduces nutrient loss, especially water-soluble vitamins like vitamin C and B-complex, as it eliminates the need to immerse the food in water (**Paulina GUZIKa, 2021**). However, uneven heating and possible formation of hot spots require proper stirring or rotating of the food to ensure uniform cooking.

Vacuum Cooking

Vacuum cooking, popularly known as sous vide, involves placing food in vacuum-sealed plastic pouches and cooking it in a temperature-controlled water bath for an extended period (**Baldwin, 2011**) (**Stanko Stankov, 2020**). This method ensures precise temperature control and minimal exposure to oxygen, which results in enhanced retention of nutrients, flavour, and moisture compared to traditional cooking techniques. Studies indicate that vacuum cooking minimizes nutrient degradation, (**Ward, 2014**) specially of heat-sensitive vitamins and antioxidants, due to lower cooking temperatures (usually between 55–85°C) and absence of direct contact with boiling water (**Sandra Zavadlav, 2020**). While this method is time-consuming, it offers superior texture, flavour, and nutritional quality in prepared dishes.

Infrared Heating

Infrared heating is a dry heat method that uses radiant energy to cook food without any physical contact with the heat source. This technique enables efficient surface heating and rapid energy transfer (**Leena Tyagi, 2020**). Infrared cooking preserves more nutrients than methods involving water or oil and is particularly effective in reducing cooking time while maintaining food quality (**Helen, 2024**).

Although the heating effect is predominantly on the surface, proper calibration of infrared wavelength and intensity permits even cooking and minimizes overheating or burning (**Olugbenga Abiola Fakayodea, 2025**). In contrast to boiling, infrared heating retains most vitamins and minerals, as there is no leaching into cooking liquids.

Ultra-sonic Assisted

Ultrasonic-assisted cooking is a modern cooking technique increasingly used for preparing vegetables, meats, and soups. It involves applying ultrasonic waves (20–100 kHz) through a liquid medium like water or broth, which creates microscopic bubbles that help tenderize the food and enhance flavor (**Monica Gallo, 2018**). This method allows for cooking at lower temperatures and shorter times, leading to better texture and nutrient retention (**Wangxin Liu, 2023**). Unlike boiling, ultrasonic cooking causes less nutrient loss, as fewer vitamins and minerals leach into the liquid. To retain the maximum nutrition, the broth can be reused in further cooking.

Conclusion

In recent years, the global rise in obesity rates has prompted a renewed interest in home-cooked meals. Health professionals and dietary guidelines across countries have started to advocate for more frequent home cooking, highlighting its potential to improve dietary quality, control portion sizes, and reduce the intake of ultra-processed foods high in added sugars, fats, and sodium (**Sarah Coe, 2022**). While home cooking is generally associated with better nutrition, it also presents a critical challenge: ensuring nutrient retention during meal preparation. Therefore, the methods employed in cooking must be carefully chosen to balance food safety, palatability, and nutritional integrity. Techniques such as steaming, microwaving, and stir-frying have been found to preserve more nutrients compared to boiling or deep frying. Moreover, the presence of dietary fats can enhance the absorption of fat-soluble vitamins, whereas avoiding excessive water or heat can help retain water-soluble vitamins (**Seongeung Lee, 2017**).

In conclusion, while a balanced diet forms the foundation of good nutrition, the retention of nutrients through proper food handling and cooking techniques plays a crucial role in ensuring the nutritional adequacy of meals. As awareness grows around the link between diet and chronic disease prevention, incorporating strategies for optimal nutrient preservation is becoming an essential component of healthy eating practices.

Table 1: Nutrients Retention in Traditional and Modern cooking Methods

Cooking Method	Type	Nutrients Affected	Effect on Nutrients	Nutrient's retention
Boiling	Traditional	Water-soluble vitamins (B-complex, Vitamin C), minerals	High nutrient loss due to leaching into water	Nutrients can be partially recovered if cooking water (broth) is reused
Steaming	Traditional	Water-soluble vitamins (Vitamin C, folate), antioxidants	Nutrients retained better than in boiling methods	This method preserves maximum of the delicate vitamins in vegetables as the food is not in direct contact with the boiling water
Frying	Traditional	Fat-soluble vitamins (A, D, E, K), some B-vitamins	Moderate to high loss depending on oil temperature and duration	This method enhances absorption of fat-soluble vitamins like A,D,E and K, as this method requires fat but can degrade heat-sensitive ones
Roasting	Traditional	Water- and fat-soluble vitamins	Moderate retention can cause browning and flavour enhancement	This method preserves maximum nutrients when done in low temperature
Microwaving	Modern	Water-soluble vitamins (especially Vitamin C, B1, B9)	Good nutrient retention due to short cooking time and minimal water use	Microwaving is one of the easiest and nutrient-friendly cooking methods, which retains all the essential nutrients.
Vacuum cooking (sous-vide)	Modern	Almost all nutrients	Excellent retention due to low temperature and no contact with air or excess water	Water soluble and heat sensitive nutrients are retained completely
Infrared heating	Modern	Heat-sensitive vitamins	Generally good retention	Water soluble vitamins are retained, further research required
Ultrasound-assisted cooking	Modern	Antioxidants, polyphenols, vitamins	Emerging method; can enhance extraction and retention	Still under research, not widely used in domestic cooking

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