Nutrition and Dietary Supplements

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REVIEW

Quality and Nutrient Loss in the Cooking Vegetable and Its Implications for Food and Nutrition Security in Ethiopia: A Review

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Abstract: Africans are leaving a period of increased unpredictability of new and emerging crises, from the pandemic to war and climate catastrophes. Only if we invest in boosting our capacity to respond to various crises will Africans be able to survive and thrive. Ethiopia is pursuing diversification of its food and nutrition security. However, preparation and consumption problems contribute to a health risk linked to malnutrition. Thus, the purpose of this review is to scrutinize preparation methods, evaluate nutrient losses, and outline future agendas. Vegetable preparation is neglected in Ethiopia, and the methods, cooking standards, and nutrient loss are all not identified. Likewise, the health risks and fate of malnutrition in the country are increasing extraordinarily. Ethiopian traditions of vegetable cooking are not supported by technology, food makers are not equipped with training, and the government is not concerned about the problems. Vitamins and minerals are entirely lost from vegetables during the cooking process, leading to the development of health risks such as stunting, wasting, and underweight problems. The government does not monitor, check, and evaluate cooked vegetables. Hence, Ethiopia should set cooking standards, and of all methods scrutinized, 2–5 minutes (leafy), 5–10 minutes (roots and tubers), and 3–8 minutes (stem) are recommended by many scholars as the standard for cooking vegetables.

Keywords: cooking standards, cooking vegetables, malnutrition causes, nutrition, school feeding

Introduction

Vegetables are an important source of many nutrients, such as potassium, dietary fiber, vitamin A, and vitamin C, and they can lower blood pressure, reduce the risk of heart disease and stroke, and help to prevent certain tumors.[1] It reduces the risk of eye and digestive problems, has a positive effect on blood sugar, and helps control appetite.[2]

Vegetables are called protective foods because they play an important role in a balanced diet, as their consumption prevents various diseases and, in addition to energy, they also provide important protective nutrients such as minerals and vitamins.[3] A healthy diet is essential for good health and nutrition and protects against many chronic noncommunicable diseases, such as heart disease, diabetes and cancer.[4] Vegetables are an excellent source of vitamins, minerals, other phytochemicals, and micronutrients, and eating vegetables daily is important for good health and provides antioxidants and fiber. Studies show that,[5] people who eat five or more servings of vegetables a day are less likely to develop many diseases, including cancer and heart disease. There are different types of vegetable preparation methods across the world, and six techniques have been described by many scholars,[6] namely, sautéing, blanching, steaming, boiling, frying, and freezing. According to the researchers,[7] each method has its own positive and negative aspects related to the quality of the vegetables during preparation.

The term frying means frying vegetables into small pieces and involves the transfer of heat from cooking materials called pans to vegetables, and it has its own meaning in achieving the ideal quality of cooked vegetables.[8] If anyone has ever parched onions or cherry tomatoes and softened peppers (known as siggo in Ethiopia), toss them over pasta for a quick and healthy dinner and probably sauté them first.[9] At the same time, if anyone is skipping more than one vegetable at a time, experts recommend knowing which vegetables to jump first.[10] However, it is recommended to sauté

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the toughest vegetables first, and the most common examples are carrots or cauliflower. Professionals have also said that,[11] onions take some time to cook, while zucchini and squash take less time and garlic takes even less time. Therefore, to maintain the optimum amount of essential nutrients from those vegetables, the method of preparation and the time taken during preparation are important. Experts strongly disapprove[12] of very high temperatures during the cooking process and make sure that vegetables do not burn. In particular, it is recommended to cook the onions for only 10 minutes so that they keep their shape.[13] Research reports have indicated that[14] the onion flavor is more pronounced than that of caramelized onion because caramelized onions are cooked over low heat for approximately 40–50 minutes until completely broken. When the onions are sautéed, they should give the dish flavor and color (soup, tomato sauce), and the yellow color is a very pleasant variety and ideal for caramelizing.[14] In general, many writers have come to the conclusion that,[2] the time of the sauté depends on the type of vegetable that is harvested, the materials used for cooking, and the temperature level that we will use and that vegetables (such as spinach and kale) are 2 to 4 minutes, while firmer vegetables (such as carrots and broccoli) can take up to 10 minutes. However, the application of these standards is not reported by Ethiopia, and there are no survey data or figures on the country's prospects. It is clear that smaller pieces of vegetables cook faster than larger pieces, and to cook vegetables faster, nutritionists suggest chopping or cutting into small, even pieces.[15] However, for roasting many vegetables, such as squash and cruciferous vegetables, cutting them into 1- or 2-inch pieces will help speed up the cooking process.[8] Likewise, the thickness of the slices also determines the speed and level of temperature to use, which is why these things can affect some nutritional value.[16]

Nutritionists define cooking as cooking vegetables in water heated to the boiling point (100°C), and liquid boiling at high temperatures creates large bubbles at the bottom of the pan, rising rapidly and breaking the surface of the liquid.[17] This can be achieved by eating cooked vegetables that are juicy and contain important nutrients, such as antioxidant and anti-inflammatory properties.[18] Anti-inflammatory compounds for acne prevention and vegetable cooking minimize and maximize the diversity of nutrients in different types of produce.[19] Whether eaten raw, cooked, microwaved, steamed, or roasted (among other cooking methods), these vegetables provide nutritional benefits.[20] Cooking helps breakdown the vegetable's cell walls and releases more nutrients, and cooking broccoli loses 5–10% of its total minerals.[8] Many nutritionists have reported that[21] frying changes the structure of volatile nutrients such as proteins, vitamins, and antioxidants, and certain compounds produced during the roasting process, such as trans-fatty acid and acrylamide, pose a risk to public health. Frying has little or no effect on the protein or mineral content of fried foods, while the dietary fiber content of potatoes increases after frying due to the formation of resistant starch.[21] Fat-soluble vitamins, such as vitamins A and E, are usually depleted when vegetables are roasted, and compared to developed countries, low- and middle-income countries such as Ethiopia lack almost all the ingredients needed to prepare and cook vegetables.[22] In African countries, foods that are boiled include vegetables, pulses such as peas and beans, tubers such as potatoes and cassava, and grains such as rice. For instance, in northern Uganda, groundnut is added to boiled dishes as a sauce. Boiling, steaming, and broiling are also utilized to prepare different vegetable crops in Africa, including sub-Saharan countries. Malnutrition is a major problem, especially in low-income countries, and includes low vegetable consumption, social and cultural consequences, and low income.[23] However, nutritional depletion of vegetables according to proper cooking practices is a major problem and has not been studied and well documented in sub-Saharan countries such as Ethiopia.[24] All cooking methods are traditionally used without regard to vitamins, minerals, carotenoids, and other important nutrients,[25] and no studies have even been conducted to establish national cooking standards for major vegetable crops. Malnutrition restrictions are rampant in Ethiopia, including stunting, wasting and underweight.[26] The contribution of vegetable preparation to improving nutrition, especially in developing countries, including Ethiopia, has not yet been established. Traditional Ethiopian food-making experiences, especially for vegetables, are not yet well studied and documented.[27] The global population is booming dramatically and expected to exceed 9 billion by 2050, which in turn requires doubling food production to feed this population; thus, food and nutrition security is a global top priority (zero hunger challenge). In this regard, the methods of preparation of vegetables, the degree of loss of nutrients, and alternative solutions are not discussed. Thus, the purpose of this review is to scrutinize the important methods of vegetable preparation, evaluate nutrients and the level of nutrient loss, and define future research agendas.

Methodology

During the process of conducting a literature search for this review, the author has used different strategies, and reputable journals from Scopus, Web of Science, and PubMed databases have been also used for the write-up of this review.

Overview of Vegetable Consumption in Ethiopia

The World Health Organization endorses consuming at least 400 g of vegetables per day.[28] However, global vegetable consumption does not meet World Health Organization recommendations, and one study found that only 10% of adults ate the recommended amount of vegetables.[29] China is the largest consumer of vegetables in the world (50%), and Latvia (44%), Romania (41%), and Hungary (30%) consume the fewest vegetables.[30] Eighty percent of Italians and 78% of Portuguese say they eat a variety of vegetables every day.[31] Although only okra and maize are common in Africa, tomatoes, cucumbers, mustard, pumpkin, carrots, and spinach are sometimes used as vegetables.[32] Life without vegetables is still possible, and some Tuaregs live with very limited amounts of vegetables common in arctic and desert regions.[33] According to the statistics of the Ethiopian Central agency report, the arable land in Ethiopia is 453,608.8 hectares, and the annual production is 1,812,461.35 tons. It should be noted that vegetables represent approximately 1.43% of the total agricultural area of the country, including all urban and rural settlements.[34] However, the consumption of vegetables in Ethiopia is very low, and only 1.5% of Ethiopians consume the World Health Organization recommended serving of 5 servings per day, and women consume slightly more (1.0–8%).[35] Compared to men (1.2%), this relationship is in unadulterated divergence to Ethiopia's geographical location, capacity, and capabilities, as we know much about Ethiopia's potential resources.

Vegetable Preparation Method

In general, blanching, dehydrating, canning, freezing, fermenting, pickling, and irradiation techniques are common steps in the preparation of vegetables.[36] Blanching is mainly used to inactivate enzymes that brown, cause texture changes and bad taste and is used to peel fruit, vegetables, and nuts because steam peeling creates less pollution.[37] Dehydration is used to extend the shelf life of food by removing water content, and it is also one of the oldest and most widely used food preservation methods, predating many modern methods such as canning and freezing.[38]

Canning is a method of sterilizing foods, including vegetables, by heating them in airtight containers to produce a commercially sterilized product that keeps foods at room temperature for months or even years while maintaining food safety and organoleptic quality.[39]

Freezing is a method of preserving vegetables (food) by lowering the temperature to inhibit the growth of microorganisms,[40] and the method has been used in cold regions for centuries. As early as 1842, a patent was granted in Britain for freezing food by immersion in ice and brine.

Fermentation is used to produce lactic acid, which is found in acidic foods such as pickles, kombucha, kimchi, and yogurt and in the production of alcoholic beverages such as wine and beer.[41] Pickling is the soaking of food in a solution of salt, acid, or alcohol and is compatible with most foods, including fruits, vegetables, seafood, etc.[39]

Irradiation is used to reduce or eliminate the risk of food-borne pests and diseases and to prevent or delay the decline and maturation or germination of plants.[42] Depending on the dose, some or all existing organisms, microbes, bacteria, and viruses are destroyed, delayed or unable to reproduce.[43] The culinary report states that,[25] vegetables must be cooked very carefully to obtain the required level of minerals and vitamins because careless cooking of vegetables destroys the plant's cell wall, releasing more nutrients bound to the cell wall. Cooked vegetables may contain more antioxidants than raw vegetables, including beta-carotene, lutein and lycopene.[44] However, studies have shown that,[45] most overcooked and raw vegetables are not nutritionally important and should not be eaten.

Since most vegetable items consumed by humans are subjected to a multitude of preparatory methods, how the vegetable is cooked becomes the greatest consideration as far as vegetable and nutritive value correlations are concerned.[46] An overgeneralization of cooking would be the application of varying degrees of thermal energy to vegetable ingredients for varying amounts of time. However, a high degree of variation is possible as far as varying cooking time and heating intensity for different cooking methods are concerned. Subsequently, cooking vegetables may determine not only the nutrition content but also the nutrition biochemistry.[47] Therefore, on the one hand, cooking

vegetables has a significant influence on the nutritional contents of the diet. These effects have significant implications for the nutritional components of vegetables, namely, protein, polyphenols, polysaccharides, flavonoids, total antioxidants, free amino acids, and carotenoid contents, which are important nutrients for life.[48] The B-carotene content of some selected vegetables is different, which is due to the implications of cooking (Table 1).

Nutrition and Associated Factors

The Impact of Culture on Nutrition in Ethiopia

Although many authors report that,[49] Ethiopian meals are rich in vegetables, such as carrots, beets, tomatoes, red onions, mushrooms, cabbage, cabbage, and beets, the country suffers mainly from four problems of malnutrition, namely, acute and chronic malnutrition, anemia of iron deficiency (IDA), vitamin A deficiency (VAD) and iodine deficiency disorder (IDD). Hence, the poor preparation techniques of vegetables and the lack of skills in society are likely reasons for this finding.[50] In Ethiopia, almost all people are not familiar with the techniques of cooking vegetables, so all houses cook vegetables in the traditional way, regardless of the nature or type of vegetable.[51] This, in turn, depletes and negatively affects the levels of vitamins, essential minerals, antioxidants, carotenoids, and other macro- and microelements, exposing the society to a variety of problems.[52] On the other hand, the low intake of micronutrients reflects the fact that the Ethiopian diet is still mainly composed of cereals and legumes.[35] Moreover, the variety of vegetables alone does not guarantee better nutrition; rather, it is the method and degree of preparation of the vegetables that is important.[53] Another factor affecting the diet in Ethiopia is religion, which has a major impact on Ethiopian life. In Ethiopia, almost 2/3 of the Ethiopian population identifies as Orthodox Christian, and there is also a large Muslim population; others adhere to an ancient form of Judaism.[54] Ethiopian religions have a significant impact on vegetable consumption, and people with strong religious beliefs are more likely to buy fat-free, sugar-free, or gluten-free foods than natural or organic foods.[27] Religious beliefs influence a person's value system, traditions, and food practices, which in turn can influence food choices, and the degree of a person's devotion to his religion can influence whether he adopts the eating habits of that religion. Therefore, religious issues can have a major impact on the food we buy, sell and consume.[55] For example, Muslims will not eat meat such as beef or lamb that has not been slaughtered according to the halal method, while those of the Jewish religion will only eat kosher food.[56] Most religious leaders, including patriarchs, priests, archbishops, pastors, sheikhs, and ustazes, make no effort to advise their followers on growing, preparing, and eating vegetables. Rather than offering advice, some leaders are trying to demonize trends in vegetable consumption and growing practices that influence nutrition safety strategies. Ranging from material technologies to implicit ideologies and symbols, socio-cultural nurturing factors follow an original pattern.[57] Ethiopia is a multicultural and multiethnic country, and the impact of culture on health is huge.[58] It influences perceptions of health, illness and death, beliefs about the causes of illness, approaches to health promotion, how illness and pain are experienced and expressed, where patients seek help, and what types of treatment patients prefer. Cultural differences can play an important role in human nutrition and must be taken into account in clinical and public health interventions, especially in areas with high immigrant density. Culture shapes food and eating habits and food preferences and determines what constitutes a good meal and how, when, and where to eat. According to the existing Ethiopian culture,[59] the repeated consumption of meat is an attribution and characterization

Table 1 The Effect of Cooking on the B-Carotene Content of Some Vegetables Consumed in Ethiopia

Type of Vegetables	B-Carotene Content (Nano/100gm)		Cooking Methods	References
	Raw	Cooked		
Kale	6100.45	4400.08	Sautéing	[128]
Carrot	5800.09	4300.30	Steaming, Boiling, braising	[129]
Spinach	800.12	500.18	Steaming and blanching	[130]
Cabbage	46.97	12.47	Boiling or blanching	[130]
Tomato	200.29	-		
Pumpkin	200.63	-		

Note: Own collection and synthesis.

of wealth, while the consumption of vegetables is an identification of a poor society. Clearly, red meat has more protein than other foods, including vegetables. However, this does not mean that vegetables are not nutritionally important. Culture can have a significant effect on which foods are accessible and which foods we choose to eat. According to the Nutrition for Oral Health and oral manifestations report,[60] cultural factors such as insufficient exposure to fluoride, life in a poor or disadvantaged country, insufficient access to good dental care, unhealthy diet, poor oral hygiene, tobacco use and excessive alcohol consumption increase the risk of dental health poverty.

Nutrition in Ethiopia - The Impact of Economic Factors

Economic factors are important because they can affect personal food preferences, status, and health, and economic decisions such as price and income affect people's food choices, including vegetables.[61] The economy influences not only food choices but also the types of kitchen equipment purchased to prepare vegetables.[62] Some cooking utensils are available in most Ethiopian households but have not been scientifically proven to improve and maintain the cooking quality of vegetables.[63] Additionally, the cost of vegetables is a barrier for low-income families, including those in Ethiopia, to make healthier food choices.[64] Many researchers report that,[65] people of higher socioeconomic status are more likely to have healthier food choices, while those of a lower social class have nutrient profiles that are less consistent with dietary recommendations or dietary guidelines, which contributes to their poorer state of health. For example, in Africa (Ethiopia, Eritrea, Sudan, Nigeria, and others), the root causes of malnutrition are poverty, inadequate food production, inadequate food intake, ignorance and unequal distribution of food, poor food storage techniques, improper food preparation, food restrictions and taboos and poor hygiene.

Employment, wages, price/inflation, interest rates, and consumer confidence are the economic factors that influence consumer demand the most, and poverty increases the risk of malnutrition.[66] Poor people are more likely to suffer from various forms of malnutrition; in addition, malnutrition increases healthcare costs, reduces productivity, and slows economic growth, potentially perpetuating a cycle of poverty and disease.[67]

Nutrition awareness and experience are extremely low in Ethiopia, and most societies, both urban and rural, have no knowledge of nutrition.[68] The Ethiopian government and social institutions do not actively promote food and its social and economic benefits.[69] According to the researchers,[70] diet has a significant socioeconomic impact, and the poorer a country's economy is, the poorer its diet, and apart from higher education, no education sector in Ethiopia has addressed nutrition and related issues. Overcooked vegetables will not make you ooh and aah because they lose their visual appeal, become mushy, and lose much of their natural flavor.[71] Cooking destroys some of the nutritional value of vegetables; for example, vitamin C is destroyed by heat, so the longer you cook, especially at high temperatures, the less vitamin C will remain.[72] Cooked vegetables may experience undesirable changes in color, texture, and flavor, and for most authors,[73] it is better that vegetables are clear and flavorful with some crunch rather than burnt and limp, and the water-soluble vitamins are lost in the cooking water and the vegetables lose more vitamin C, thiamine, riboflavin, vitamins B6 and B12, niacin and folate. Water-soluble vitamins C and B, which can lose up to 50% and 60% of their effectiveness when cooking vegetables, are two of the most vulnerable to loss.[74] According to the research results,[75] some minerals are lost in the water during cooking; however, they survive better than vitamins and to a lesser extent, so the economic level somehow affects nutrition and related aspects.

The Impact of Media on Food Preparation

Researchers reported that,[76] the first phase of nutrition and media, began in the early 1900s and included the discovery of vitamins, the elucidation of many basic nutritional needs, and the widespread teaching of nutritional principles in medical schools. According to expert descriptions,[27] nutrition communication has been defined as the process by which nutritional knowledge is converted into dietary change. Clearly, nutrition education gives students important skills they can use to improve their health throughout life and involves teaching nutrition-related information that empowers individuals, families, and communities to make healthy food choices and how to respond to preparation.[77] According to expert reports,[78] the media is still the main source of nutrition information in various parts of the world, such as in the developed world, and it is recognized that the media plays a large role in raising awareness and conveying messages around nutrition. Good nutrition and healthy eating diets for the masses and in leading advocacy efforts to ensure that

nutrition remains a political priority and that the right policies and governance structures are in place.[79] They largely determine what consumers hear, read, and believe about food and health. While nutrition education activities typically focus on educating individuals on proper cooking methods for vegetables, healthy eating habits, and lifestyles, communication recognizes that the eating behaviors of an individual are the product of its continuous interaction with the environment.[80] As many critics suggest,[81] food companies use social media to market their products by targeting societal demands, such as the cooking method. Scientists[82] are increasingly concerned that nutrition-related content on social media makes us think differently not only about food but also about the preparation techniques and the materials used to prepare it. Some activities in Ethiopia were also carried out in Ethiopian media and social media. For example, Giordana's Kitchen Show, Chef, Yohannes Show, Mama's Kitchen, and others are some of the leading food preparation shows trying to produce programs for cooking vegetables, considering the positive and negative effects on minerals, vitamins, carotenoids and other essential nutrients. Mass media in Ethiopia include radio, television, and the Internet, which remain under the control of the Ethiopian government, as well as private newspapers and magazines.[83] Ten radio stations, eight ante meridiem (AM) and two shortwave stations are licensed to operate in Ethiopia, but no radio or television has programs on food preparation, including cooking vegetables. In addition, the influence of media on food preparation (vegetable preparation) is still unstudied and not well documented, so Ethiopia should focus heavily on its media and use it for food preparation technologies.[84]

On the other hand, these media report the social, economic, and political problems of malnutrition and related national problems, which are necessarily ambiguous.[85]

Malnutrition Causes and Risks

Research results show that,[86] poverty increases the risk of malnutrition and the risk of malnutrition and that poor people are more likely to be affected by various forms of malnutrition. Malnutrition also increases healthcare costs, reduces productivity, and slows economic growth, which can continue a cycle of poverty and disease.[87] There is a mutual link between malnutrition and poverty, creating a vicious circle in which one feeds the other. Malnutrition creates poverty by reducing the economic potential of the population, and in the same way, poverty reinforces malnutrition by increasing the risk of food insecurity.[88] Malnutrition refers to the intake of too little or too much of certain nutrients and can lead to serious health problems, including stunted growth, eye problems, diabetes, and heart disease.[35] Experts have shown that,[89] malnutrition is caused by a lack of nutrients, either due to poor diet or problems absorbing nutrients from food or improper cooking techniques. Improper eating habits and bad cooking habits are boldly mentioned by various authors as causes of malnutrition.[90] It is clear that malnutrition makes children more vulnerable to frequent infections, increases the severity of these infections, and prolongs the healing process.[91] According to nutritionists,[92] by 2030, there will be an estimated 129 million children under 5 whose growth will be stunted due to malnutrition if the severity of malnutrition persists, and with this major challenge, the lack of proper preparation of vegetables can go a long way.

Malnutrition and School Feeding in Ethiopia

Worldwide, approximately 165 million children under the age of 5 are stunted, and outcomes associated with dwarfism include increased risk of death, increased risk of disease, developmental delay, decreased school performance and learning, and decreased child productivity life processes.[93] It is recognized that the brain develops rapidly at a young age; however, malnutrition at this stage disrupts sleeping and makes the child tired of the whole day at school.[94] However, without adequate nutrients, the brain does not develop properly, which has long-term effects on learning. Preschool malnutrition can affect cognitive outcomes in school-aged children and adolescents, and, for example, clinical studies have found an association between vitamin B_{12} deficiency at an early age and lower scores on cognitive tests in adolescence.[95] In addition, malnutrition is considered an urgent problem that affects children's ability to learn and leads to low levels of performance in school.[96]

Food education provides accurate information about food so that people can make the best choices about nutritional value, cooking methods, food quality and safety, storage and processing, and healthy eating.[97] Malnutrition has a negative impact on the learning and physical development of children and seriously affects the productivity of adults

and the economic development of society as a whole.[98] Children of illiterate mothers are three times more likely to be malnourished than children of mothers who study in the adult group, and adult mothers have 34% fewer children than illiterate mothers.[99] Thus, nutritional facts emphasize creativity, communication, collaboration, and critical thinking as important factors, and good nutrition ensures that students come to school ready to learn, and children who are food insecure are more likely to miss and fail grades than children who are food secure.[100]

Food insecurity has been shown to reduce children's chances of graduating from high school, and therefore, properly and expertly prepared vegetables can enhance their performance.[101] School meal programs can provide low-cost nutrition interventions as well as opportunities to practice healthy eating and food safety, and in food-poor communities such as Ethiopia, these programs help fight malnutrition and send children to school.[102] Nutrition education is a powerful tool to improve and change the eating habits of students.[103] Thus, it prevents the dietary risk of stomach cancer and other chronic diseases, and the combination of educational strategies to promote voluntary adoption of food choices, along with appropriate preparation methods, is beneficial for health and well-being.[104] In Ethiopia, 11 million people across the country are recognized as responsible for food and nutrition.[35] However, in Ethiopia, Addis Ababa launched a school meal program through a government system, and recently, the Oromia zone has been trying to feed some students in many schools. Remarkably, Ethiopia has reported a total of 21,418,000 students in primary and secondary education.

Vegetable Preparation and Malnutrition Problems in Ethiopia

In Ethiopia, the habit of food preparation in general and vegetable preparation in particular is not well researched and documented. The methods of vegetable preparation, the level of nutrient loss, and alternative solutions have not been studied.[105] As vegetables require knowledge, skill, and practical experience, food makers and consumers should understand the methods. The research authors said that,[8] different vegetables require different cooking methods, and the cooking method can be considered based on the impact on essential nutrients, vitamins, and essential carotenoid content. Remarkably, in Ethiopia, most vegetables are cooked using traditional methods, and green vegetables, such as cabbage, lettuce, Swiss chard, kale, spinach, and parsnips, are prepared without regard to loss of nutrients, and most vegetables are cooked indefinitely. In rural areas of Ethiopia, headed cabbage is cooked for more than three hours, rendering the vegetable nutritionally irrelevant to the body.[106] Therefore, along with cultural factors, income problems, and other factors, poor cooking traditions contribute greatly to the malnutrition problem in Ethiopia. Food preparation and related institutes are not established in most areas of Ethiopia, and thus, the wider communities are not aware of vegetable preparation. Even the government systems of Ethiopia have no segments in their structures that can provide information about food preparation. Similarly, Ethiopia's religious and other social institutions, such as Equb, Eddir, Senbete, and Mahiber (for Ethiopians only), are not also concerned about food preparation, and its implications for malnutrition are a national headache in Ethiopia.[55] Some Ethiopian hotels have standardized vegetable cooking materials, such as multipurpose bakeware, spice grinders, pressure cooks, good knives, large cutting boards, mixing bowls, wooden spoons and spatulas, measuring cups, tongs, and drying ovens. Similarly, different types of vegetable cooking materials are used for vegetable preparation in restaurants, cafeterias, government (universities, colleges, sports academies, hospitals), and nongovernmental offices. However, at the household level, the types of materials (kitchen tools and equipment) used for vegetable cooking are not selected on the basis of the type and nature of the vegetables. In most Ethiopian households, similar cooking materials are used for vegetable preparation, such as clay-made and steel-made dishes.[107] Additionally, women are using the same type of cooking materials for different food preparation purposes, such as Ethiopian shiro-wot (It is made of pulse crops especially pea, bean, chick pea powder with a mix of spices (onion, garlic, oil, salt, water, green pepper, tomato) Ethiopian tibs (It is made of red meat with a mix of spices (onion, garlic, rose marry, butter, oil, salt, green pepper), and vegetable cooking. Therefore, in one way or another way, the concept of vegetable preparation is not extensively addressed by the wider Ethiopian community. At the household level, athletes are also trying to use the right types of cooking materials to attain the required amount of essential nutrients from vegetables.[108] For example, famous Ethiopian athletes such as Haile Gebrselassie, Tirunesh Dibaba, Kenenisa Bekele, Derartu Tulu, and others are mentioned by different scholars that they are warning athletes regarding nutrition, and for this vegetable consumption, it is the first and foremost experience. Athletes must take optimal amounts of nutrients from vegetables and other recommended foodstuffs, and they are advised to use properly cooked and prepared vegetable crops.[24] At the same time, patients in hospitals, clinics, and other health

institutions are suggested to eat properly cooked vegetables, as these contain powerful healing nutrients, and several health officers have reported that vegetable consumption is the first remedial treatment to be initiated.[109] Many experiences have also been reported from Ethiopian military sectors, although the limitations are too wide. In Ethiopia, more than 65 million people are not accessible to electricity, and power is not used for food preparation, including vegetables.[110] Hence, standardized vegetable cooking and maintenance technologies, such as drying ovens, sterilizers, autoclaves, refrigerators, and other household materials, do not exist in more than 65 million people in Ethiopia. Currently, Ethiopia is building different energy sources, such as dams (Ethiopian Great Renaissance dams such as GERD), geothermal energy, wind energy, solar energy, and biogas energy, which can solve the scarcity of power (deep-rooted problems of Ethiopians) in multidimensional ways. When the absence of power is resolved in a wider scope, food preparation (vegetable preparation) technologies can also be enhanced either to follow the standard or better experience in cooking vegetables. Excluding some hotels and restaurants in Ethiopia, all communities in the country are using fuel wood and charcoal for the cooking of vegetables and other food preparations, meaning that the level of temperature and overall quality of the vegetables are not maintained with standard procedures.[111] This severely deteriorates the quality and contents of essential minerals, antioxidants, vitamins, and carotenoids. Except in the higher education institutions and some of the technical, vocational, and educational institutions, all elementary and secondary schools are not educating food preparation, and the course is not included in the curriculum at all. This is a critical link that has been missed by the education sector in Ethiopia. However, the malnutrition problem is extremely hindering the performance of learners from nurseries to universities and gradually to country development.[112] Researchers have proposed that,[113] tackling malnutrition should be a global agenda, and the goal of the world should be similar to that of cancer, climate change, and others. Within the current situation, education quality is extremely poor in Ethiopia, which can be related to malnutrition problems caused by a lack of awareness of vegetable preparation since vegetables can have significant quantities of vitamins, essential minerals, and carotenoids. Although some research has been performed on other factors that contribute to malnutrition problems, the contribution of overcooking vegetables has not yet been studied in Ethiopia. Remarkably, governmental and nongovernmental organizations that are investing and working in nutrition areas are not trying to provide training and demonstrate vegetable preparation and related problems.[114] Simply, their thought mainly focuses on balanced diet consumption, and even they are not capable of cooking vegetables for their home consumption. Therefore, the problem is multifaceted in Ethiopia in particular and Africa in general. There are many nutrition projects designed for malnutrition reduction in Ethiopia, and these are not involved in vegetable preparation issues; thus, vegetable preparation training, workshops, conferences, and academic debates are not carried out.[115] The other major problem is that the trends, experience, reality, facts, level, and status of vegetable cooking and preparation in Ethiopia have not yet been researched, and no document has been prepared, which in turn is increasing the exertion.

Cooking Vegetables - The Most Common Malnutrition Problems

As many writers have acknowledged,[45] overcooking vegetables leads to the greatest loss of nutrients, while proper cooking techniques preserve the nutritional value of foods more effectively. Vitamin C is an important nutrient that is easily destroyed by cooking, and even when cutting or mincing vegetables, some vitamin C is lost.[116] Vitamin C has also been reported[40] to be lost when vegetables are washed after cutting and when cut vegetables are exposed to the air for a long time before cooking. For example, it has been reported that,[117] carrots should remain bright orange, although their color can fade slightly if overcooked and cause a loss of nutrients. Globally, standards for cooking carrots with different cooking methods range from 5 to 15 minutes,[118] and in Ethiopia, the total experience of cooking vegetables is still unknown (Table 2). However, malnutrition-related problems in Ethiopia are much higher than the World Health Organization average.[119] Ethiopia is largely called by sub-Saharan Africa as the country most affected by stunting (38%), wasting (10%), underweight (24%), and vitamin and mineral deficiencies (60–70%) overall (Table 2), and for this large barrier in Ethiopia, vegetable cooking problems account for the largest share. Similarly, overcooking broccoli has been reported[120] to cause it to break apart, lose color, diminish flavor, lead to the loss of many nutrients, and contribute to malnutrition issues (Table 3). Its cooking standard has also been established in Ethiopia but has not yet been identified. Problems with cooking cauliflower are said to make it mushy and crumbly, and it also gives off a sulfurous smell rather than cooks, and the longer the cooking time, the stronger the smell generally mentioned by various scholars.[121]

Therefore, like any vegetable, overcooking can also reduce the nutritional value of this super vegetable (Table 3), and overcooking will cause it to fall apart and lose its color, flavor, and nutrients. Cooking spinach longer makes the leaves slimy and the bitter taste more prominent, and the researchers suggested,[122] not reheating cooked spinach after refrigerating it. Because spinach loses so much volume when cooked, a cup of cooked spinach contains far more leafy greens, which more than compensates for the loss of water-soluble vitamins.[123] Overall, many writers have reported that,[105] cooking has the strongest effect on heat-sensitive nutrients. Regarding the cabbage crop, it has also been reported that,[124] overcooking causes a mushy, sticky, and very unpleasant odor (Table 3), and the odor is caused by sulfur compounds released when the cabbage is overcooked. However, malnutrition-related problems in Ethiopia are much higher than the World Health Organization average, and for this large difficulty in Ethiopia, vegetable cooking problems take the largest part.

Food Security - The Importance of Nutrition

According to the definition of food security scientists,[125] food security is necessary to maintain an optimal nutritional status, and the emphasis of the definition is on the need for nutritious food as well as food in adequate amounts (in calories) and of adequate quality (in terms of variety and micronutrient composition). Food security means that people always have access to safe and nutritious food for an active and healthy life, and it is also about making appropriate use and absorption of nutrients from food for a healthy and active life.[126] Therefore, affordability and utilization are

Table 2 Cooking Standards of Selected Vegetables and Figures of Malnutrition in Ethiopia and the World

Cooking Methods	List of Vegetables	Cooking Standards (Minute)	Malnutrition Percentage in Ethiopia and WHO Average (*)				References
			Stunting Percentage	Wasting Percentage	Underweight Percentage	Vitamin and Mineral Deficiency	
Boiling	Broccoli	6–8	38% (21.9*)	10% (7.3*)	24% (9.7*)	60–70% (31*)	[130]
	Cauliflower	5–10					
	Cabbage	12–15					
	Asparagus	1–10					
	Beetroot	45–1 hr.					
	Carrot	4–12					
	Lettuce	10–12					
	Leek	18–25					
	Spinach	3–5					
Steaming	Broccoli	10–12	38% (21.9*)	10% (7.3*)	24% (9.7*)	60–70% (31*)	
	Cauliflower	4–8					
	Cabbage	6–8					
	Asparagus	4–5					
	Beetroot	30 −40					
	Carrot	10–12					
	Lettuce	20					
	Leek	10					
	Spinach	3					

(*Continued*)

Table 2 (Continued).

Cooking Methods	List of Vegetables	Cooking Standards (Minute)	Malnutrition Percentage in Ethiopia and WHO Average (*)				References
			Stunting Percentage	Wasting Percentage	Underweight Percentage	Vitamin and Mineral Deficiency	
Blanching	Broccoli	30–60	38% (21.9*)	10% (7.3*)	24% (9.7*)	60–70% (31*)	
	Cauliflower	2					
	Cabbage	3–5					
	Asparagus	3–4					
	Beetroot	5					
	Carrot	3					
	Lettuce	1					
	Leek	30					
	Spinach	2					
Stir-frying	Broccoli	4–5	38% (21.9*)	10% (7.3*)	24% (9.7*)	60–70% (31*)	
	Cauliflower	5					
	Cabbage	8–12					
	Asparagus	3					
	Beetroot	15–20					
	Carrot	9–10					
	Lettuce	10–12					
	Leek	8–10					
	Spinach	30–60					
Sauteing	Broccoli	3–4	38% (21.9*)	10% (7.3*)	24% (9.7*)	60–70% (31*)	
	Cauliflower	6					
	Cabbage	10–15					
	Asparagus	3–4					
	Beetroot	30–60					
	Carrot	7–8					
	Lettuce	10–12					
	Leek	10–15					
	Spinach	3–5					

Note: Own collection and synthesis.
Abbreviation: *WHO, World Health Organization.

important for food and nutrient security. Thus, the problem is not only in the supply chain but also in the preparation process. The World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) are more concerned with food and nutritional security, and nothing starts with food preparation technology and related processing methods. The contribution of culinary problems, especially in vegetables, has not yet been studied and reported by the World Health Organization and the United Nations Food and Agriculture Organization.[27] To ensure

Table 3 The Impact of Cooking on Selected Vegetables and Associated Problems

List of Vegetables	Losses Due to Cooking Problems								
	Broccoli	**Cauliflower**	**Cabbage**	**Asparagus**	**Beetroot**	**Carrot**	**Lettuce**	**Leek**	**Spinach**
Effects of cooking problems	Loss of >50% Vit.C and B	Loss of minerals and antioxidants	Vitamin loss	Loss of heat sensitive nutrients like Vit. C	Loss of Soluble fiber	Loss of Soluble fiber	Loss of >50% Vit.C	–	Loss of >50% Vit.C
	Texture, flavor, color and nutrient content loss	Mushy and loss a lot of their natural flavor	Decrease the amount of K, Mg Ca, and sodium	Minerals antioxidants and fiber Oxidative damage	–	–	Loss of Anthocyanins	Loss of Vit A, C, and K	–

Note: Own collection and synthesis.
Abbreviation: Vit., vitamins.

sustainable food and food products for the rest of the world, these large organizations must pay close attention to food preparation techniques in general and vegetables in particular. Researchers have reported that,[127] cooking vegetables can change the amount of nutrients we obtain when we eat them, but this is not always negative.

Conclusion

Food and nutrition security is under great intimidation with a changing population. However, population growth and food and nutrition issues are not advancing in parallel. This review entails that with inappropriate methods of cooking vegetables, the quality of vegetables (taste, color, flavor, and aroma) and the content of nutrients such as vitamins, minerals, carotenoids and antioxidants can be affected, but the degree of nutrient loss can vary depending on the type of vegetable, preparation methods, materials used in cooking, and the level of knowledge and skill of the food maker. Leafy greens are more sensitive to different cooking methods than stem, root, and tuber vegetables. Even with the same cooking method, nutrient loss varies from vegetable to vegetable and species to species. Overcooking vegetables can damage high levels of essential nutrients, and vegetable cooking is very old in Ethiopia and, except for a few hotels, the whole practice is traditional. Consequently, vegetable cookers must take a number of precautions to ensure the quality and safety of the food prepared in Ethiopia. Additionally, the government and other stakeholders should take steps to provide training and research to prevent nutrient loss and pay attention to health insurance.

Data Sharing Statement

The dataset that supports the findings of this review is included in the article.

Ethics Approval and Informed Consent

Not applicable.

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