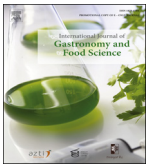

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Review Article

A review of the impact of preparation and cooking on the nutritional quality of vegetables and legumes

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Abstract

Vegetables and legumes represent one of the most important components of the human diet. Being informed about their characteristics can improve the health benefits, helping to reduce the risk of cardiovascular disease, type II diabetes and some cancers. Recent studies have demonstrated that the method of preparation and cooking can improve the nutrition quality of food. These two steps induce several changes and interactions among its constituents, in some cases positive, in others negative. Therefore, knowing the changes occurring in food from preparation to table is essential not only for scientific research, but also for the consumer, who can make decisions about how to prepare and cook a selected number of healthy legumes and vegetables. The purpose of this review was to evaluate the most recent studies and draw conclusions that will enable the consumer to make decisions about how to maximize nutrient content of plant foods and identify the critical phases during preparation and cooking, when the nutrients might be lost. For such, some nutrients of specific legumes (peas and beans) and vegetables (broccoli, potatoes and onions) were selected.

Keywords: Vegetables; Legumes; Preparation; Cooking methods; Nutritional quality

Contents

Introduction

The nutritional quality provided by vegetables and legumes consumption has been intensely reviewed (Block et al., 1992; He et al., 2007; Tiwari and Cummins, 2013). Legumes and

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vegetables are rich sources of proteins, fats, carbohydrates, minerals, antioxidants, fiber and water, as well as being excellent sources of β-carotene (provitamin A), thiamin (B1), riboflavin (B2), niacin, pyridoxine (B6), pantothenic acid, folic acid (folacin), ascorbic acid, and vitamin E and K (Karmas and Harris, 1988; Prodanov et al., 2004).

Recent studies have shown there are several ways to enhance the availability of healthy nutrients through proper selection of the method of cooking. According to these studies, the most common methods used for cooking legumes and vegetables are: steaming, roasting, boiling, frying, sautéing, *sous vide*, microwave and pressure-cooking. Besides that, the authors also considered in their researches, factors related to common domestic processing, including: washing, peeling, cutting, chopping and soaking (Tiwari and Cummins, 2013). Such information has been studied for specific vegetables such as: broccoli (Dos Reis et al., 2015; Bongoni et al., 2014; Kahlon et al., 2012; Mahn and Reyes, 2012; Martínez-Hernández et al., 2013; Miglio et al., 2008; Murador et al., 2014; Pellegrini et al., 2010; Poelman et al., 2013; Yuan et al., 2009), onion (Cavagnaro and Galmarini, 2012; Lee et al., 2008; Németh et al., 2003; Rodrigues et al., 2009; Wilson and Demmig-Adams, 2007), potato (Blessington et al., 2010; García-Segovia et al., 2008; Lachman et al., 2012, 2013; Micklander et al., 2008; Perla et al., 2012) and legumes such as beans (Ramírez-Cárdenas et al., 2010; Saikia et al., 1999; Schoeninger et al., 2014; Siqueira et al., 2013; Taiwo and Akanbi, 1997; Wang et al., 2010a) and peas (Azarnia et al., 2011; Duhan et al., 2002, 2004; Habiba, 2002; Koplík et al., 2004; Wang et al., 2008). It is known that nutrient losses occur in the preparation and cooking phases, and understanding how and why these losses occur can help the consumer, chef and food processor limit losses and enhance the nutritional quality of the food.

Many reports have found significant differences among the cooking methods. Kahlon et al. (2007) studied how cooking could influence in vitro bile acid binding by various vegetables. It has been demonstrated that bile acid binding lowers the levels of cholesterol in the blood, helping to reduce the risk of heart disease. In their first study they found that steam cooking improved bile acid binding by beets, eggplant, asparagus, carrots, green beans and cauliflower when compared to the same vegetables uncooked. In their next study, the authors obtained similar results by steaming collard greens, kale, mustard greens, broccoli, Brussel sprouts, spinach, green bell pepper and cabbage (Kahlon et al., 2008). After four years, the authors studied some of the same vegetables of the second study using other cooking methods (sautéing, boiling, steaming). They concluded that sautéing was the cooking method with the most health potential (binding bile acids) for mustard greens, kale, broccoli, cabbage and green bell pepper, with steaming the best method used for collard greens (Kahlon et al., 2012).

Changes in temperature can modify the flavor, texture and appearance of food, but this is not the only way that these modifications can occur. The processing method applied to the foods is another parameter that can modify food, and encompasses the entire spectrum from the strength of a knife to that of a processor. The cutting or processing damages the cell structure, as well as heating or freezing (America's Test Kitchen and Crosby, 2012).

As reported by Fennema (1996) without accurate information about conditions and methods of food processing, storage and handling, it is difficult to predict the influence and the retention of many vitamins, which emphasizes the great need for more research in this field.

Of the main factors that consumers consider when selecting food for cooking at home (flavor, texture, nutrition, cost, safety, convenience), flavor has been shown to be the most important (Azarnia et al., 2011; Lee et al., 2009; Van Boekel et al., 2010; Yoo et al., 2012). Enhancing the flavor of legumes and vegetables through preparation and cooking can increase the consumption of these healthy foods, especially among children (Poelman et al., 2013).

Since the early part of the twentieth century many studies have been conducted to investigate the impact of preparation and cooking methods on the stability of nutrients in food. The results of these studies vary widely leading the consumer to question the best ways of preparing and cooking foods in order to maintain the nutritional qualities, especially in legumes and vegetables. Many other researchers have shown that growth conditions of vegetables and legumes also have a significant impact on their nutrient content (Elmore et al., 2010; Kopsell et al., 2003; Lee et al., 2009; Wang et al., 2010b), but this factor will not be reviewed in this paper, which focuses on the impact of preparation and cooking on nutrient content. Therefore, the objective of this review is to evaluate the most recent studies and draw conclusions that will enable: (a) the consumer to make decisions about how to maximize nutrient content of plant foods and (b) identify the critical phases during preparation and cooking, when nutrients might be lost. For such, some nutrients of specific legumes (peas and beans) and vegetables (broccoli, potatoes and onions) were selected. The selection was based on the increased interest in these foods, according to the USDA (2010), as well as their availability in most of the world.

Vegetables and legumes: potential health benefits

The consumption of fresh food has grown considerably in recent years largely due to the fact that vegetables, legumes and fruits have been associated with many health recommendations (Hagen et al., 2009; Slavin and Lloyd, 2012; Storey and Anderson, 2014; Tiwari and Cummins, 2013). According to the Institute of Medicine, Food and Nutrition Board (IOM, 2005), dietary fiber intake could lower the risk of coronary disease and cancer. The World Health Organization (WHO/FAO, 2005) recommends a minimum of 400 g of fruit and vegetables per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases, as well as for the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries. Block et al. (1992) have confirmed this fact, by evaluating 200 studies that examined the relationship between fruit and vegetable intake