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Hamdy A. El-Bassel
National Nutrition Institute, h.elbassel17@gmail.com

Hany H. El-Gazzar
National Nutrition Institute

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Original Article

Comparable study between organic and nonorganic vegetables in their contents of some nutritive components

Hamdy A. El-Bassel[a], Hany H. El-Gazzar[b]

Departments of [a]Nutrition and Biochemistry and [b]Nutrition and Food Science, National Nutrition Institute, Cairo, Egypt

Abstract

Background

There is no doubt that vegetables play an essential role in human growth as they provide the human body the necessary needs of vitamins and minerals. Several analytical methods have been set up and improved to determine the quantity of vitamins and minerals in different fruits and vegetables. The purpose of this study is to evaluate the quantities of vitamins and minerals in organic and nonorganic vegetables in Egyptian. The results showed that organic tomatoes, eggplant, lettuce, squash, carrots, and cabbage had significantly higher content of vitamin C, vitamin E, β-carotene, phosphorus, and calcium. However, nonorganic vegetables showed significantly higher content of protein than the organic vegetables.

Objective

To identify which vegetables, organic or nonorganic, contain a higher level of vitamins and minerals.

Results

Organic crops contained a higher significant level of vitamin C, vitamin E, β-carotene, phosphorus, and calcium, whereas it contained less protein level than nonorganic crops.

Conclusion

The difference between organic and nonorganic content may be related to the type of soil and the method of cultivation.

Keywords: Cabbage, carrots, organic agriculture, plant nutrients, soil fertility, vitamins

Introduction

Vitamins are essential group of food components that must be provided to the human in sufficient amounts. The main sources of vitamins are fruits, vegetables, meats, and fish [1]. Green leafy vegetables provide humans with adequate amounts of many vitamins and minerals. They are rich sources of oil, carbohydrates, carotene, ascorbic acid, retinol, riboflavin, folic acid, and minerals like calcium, iron, zinc, magnesium, manganese, and selenium [2]. Production of vegetables may be performed by adopting different systems [3]. The conventional system is characterized by a high use of chemical pesticides, where the use of these inputs is justified to increase productivity, quality, and resistance to pests and diseases [4,5]. Organic production entails growing of crops without synthetic pesticides and should be produced from organisms that have not been genetically modified or have undergone ionizing radiation [6]. Organic fertilizers are derived from plant or animal materials. Raw materials commonly used in organic fertilizers include animal manure, postharvest plant materials, and organic waste. These materials are converted into compost [7]. In organic farming, the use of chemical-synthetic pesticides and readily soluble mineral fertilizers is not allowed [8]. In 2015, more than 50.9 million hectares, in 179 countries around the world, were cultivated organically [9]. In the 28 countries forming the EU, the fraction of organically cultivated land of total agricultural area has been steadily increasing over the past three decades. Overall, 0.1, 0.6, 3.6,

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Correspondence to: Hamdy A. El-Bassel, Assistant Consultant of Nutrition and Biochemistry, National Nutrition Institute, Cairo, Egypt, Tel: 0111881032. E-mail: h.elbassel17@gmail.com

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and 6.2% of agricultural land were organic in 1985, 1995, 2005, and 2015, respectively, equaling 11.2 million hectares in 2015 [10]. In conventional agricultural management, many minerals (P, K, and N) are commonly used in the form of soluble chemical fertilizers, so a higher quantity of such minerals in conventional products than in the organic alternatives could be expected. However, different results were obtained considering levels of minerals in organic and conventional fruit and vegetables [11]. The influence of climate on nutritional value of vegetables and fruit was reported by Kays [12]. A positive correlation between protein content and level of applied nitrogen fertilizer was found. However, the quality of protein, measured as a ratio of essential amino acids, had been shown to decrease with increasing of applications of nitrogen fertilizer in some crops [13]. Higher levels of nitrogen lead to a higher protein–carbohydrate ratio and, therefore, a decline of the carbohydrate content. The level of nitrogen influences the vitamin contents of vegetables and fruits. A negative correlation between vitamin C content and the level of applied nitrogen fertilizer has been reported [7,13].

Materials and methods

All materials and reagents used in this work were laboratory-grade pure chemicals.

Samples

Vegetables are widely consumed by Egyptians during summer, winter seasons, and all over the year, and some of these vegetables were used for determination of vitamin and mineral content.

The selected vegetables were as follows:

- Squashes and eggplants were selected to represent summer vegetables.
- Cabbages and carrots were selected to represent winter vegetables.
- Tomatoes and lettuces were selected to represent vegetables that are used all over the year.

The organic vegetables were purchased from the ministry of agriculture, whereas nonorganic (conventional) vegetables from Metro market and send to the Laboratory of the Pesticides Residue and Heavy metals at the Agriculture Research Centre for analysis.

Sample preparation

The samples were washed in tap water to eliminate any surface contaminants. Analysis of vitamin C was made immediately after the acquisition of the products. Vegetables' liquid extract was based on the procedure proposed by Brubacher *et al.* [14]. Fluid extract was kept at 4 ± 1°C, and other analyses were done on the fifth day after purchase. Five representative samples for each vegetable (organic and conventional) were obtained and analyzed in triplicate.

Determination of protein

The determination of the protein content of food depends on the determination of nitrogen by Kjeldahl method [15], which is multiplying by a factor of 6.25 to obtain the true protein [16].

Determination of vitamins

Vitamin C was determined in vegetables according to Fontannaz *et al.*[17] using high performance liquid chromatography, and vitamin E was determined according to Bustamante-Rangel *et al.*[18] using liquid chromatography–electrospray ionization-mass spectrometry for the determination of tocopherols and tocotrienols in food, and also high performance liquid chromatography was used for the determination of β-carotene according to Barba *et al.* [19].

Determination of minerals

Phosphorus was determined using spectrophotometric method described by Szydlowska-Czerniak and Szlyk [20]. Calcium was determined according to AOAC [21].

Result and discussion

In the past 25 year, the demand for organic food has increased rapidly in many developed countries. This study is designed to publish comparative measurements of organic and nonorganic nutrient content of vegetables.

In this study, Table 1 shows the nonorganic vegetables have higher protein content than the organic, ranging from 0.76% for cabbages to 18% for carrot. These results are in agreement with results reported by Kumpulainen[22] who stated that when a plant is presented with a lot of nitrogen, it increases protein production. Organically managed soils generally present plants with lower amounts of nitrogen than chemically fertilized soils, so organic crops would have less protein but of a higher quality than comparable conventional crops. Across 18 matched pairs, nitrate levels in the nonorganic samples were higher in 83% of the pairs (undesirable), whereas protein levels were higher in 85% of the nonorganic samples [23]. Gorenjak *et al.*[24] found that the mean of nitrate content was significantly lower in organically cultivated lettuce (1258 ± 1018.3 mg/kg) than in nonorganic products (1359 ± 960.6 mg/kg).

Vitamin C is a potent antioxidant that has important roles in the transport and uptake of nonheme iron at the mucosa, the reduction of folic acid intermediates, and the synthesis of cortisol. Its deficiency includes fragility to blood capillaries, gum decay, and scurvy [25]. Table 2 shows the results of the comparison of vitamin C content between nonorganic and organic tomatoes, lettuces, carrot, cabbage, eggplant, and squashes. It was found that the organic vegetables have higher vitamin C content than the nonorganic ones, ranged from 8.6% for carrot to 23.7% for cabbage. These results are consistence with those observed by Williams[26] and Magkos *et al.* [27], who reported that the vegetables produced under organic systems frequently had higher contents of vitamin C, when compared with those produced conventionally. Another study by Ismail and Fun[28] also showed that the ascorbic acid content was found to be significantly lower in lettuce grown conventionally compared with the organically grown ones. Moreover, the study by Sikora *et al.*[29] concluded that organic carrots contained significantly more ascorbic acid. These results differ than those observed by Fernanda de Oliveira *et al.*[30] who reported that the conventional lettuce samples had a higher ascorbic acid value than organic samples, and there is no significance different in carrot samples. Changes in the management of chemicals and agricultural practices are likely to affect the content of agricultural nutrients [31].

Vitamin E is a strong antioxidant that helps to protect cells from damage by free radicals and it is vital to the formation and normal function of red blood cells and muscles [32]. In this study, Table 3 showed a significant increase in vitamin E content in organic vegetables compared with nonorganic ones. It was found that the organic vegetables have higher vitamin E content than the nonorganic ones, ranging from 15.6% for squashes to 47.8% for lettuces. Hunter *et al.*[33] demonstrated that organic plant foods (vegetables, legumes, and fruit) were found to have a 5.7% higher content of vitamins and minerals than their conventionally grown counterparts. In addition, Jensen *et al.*[34] concluded that organic food contained higher levels of vitamin E, vitamin C, and phosphorus and lower content of pesticides than conventional food.

Vitamin A is important for normal vision, gene expression, growth, and immune function by its maintenance of epithelial cell functions (Lukaski, 2004) [35]. Our results in Table 4 show that organic vegetables have higher β-carotene content than nonorganic ones. It was found that the organic vegetables has higher β-carotene content than the nonorganic ones, ranging from 18.5% for carrot to 39% for tomatoes. Our results are similar to the study by Sikora *et al.*[29] who showed that organic carrots contained significantly more ascorbic acid, carotenoids, and phenolic acids in comparison with the nonorganic ones. The study by Ismail and Fun[28] also showed that organic cabbage has higher vitamin C, β-carotene, and riboflavin contents than nonorganic one. Caris-Veyrat *et al.*[36] found higher β-carotene content in organically grown tomatoes than conventional one. The study by Cacek and Lagner[37] demonstrated that potassium fertilizer can reduce the amount of β-carotene because of the transfer of most β-carotenes into lycopene.

Phosphorus is a mineral that represents 1% of a total body weight. It is considered the second most abundant element in the body. It is present in within every cell in the body. Most of the phosphorus in the body is concentrated in the bones and teeth. Table 5 shows the studied organic vegetables have higher phosphorus content than nonorganic ones, ranging from 13% for eggplant to 43% for squashes. These results are similar to the result conducted by Dangour *et al.*[38] who concluded that phosphorous significantly higher in organically produced crops than conventional ones. The study by Ilić *et al.*[39] found significantly greater concentrations of P, K, Ca, and Mg in organic tomatoes compared with conventional ones.

Table 1: Mean±SD of crude protein in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (g/100 g)	±SD (*n*=15)	Mean (g/100 g)	±SD (*n*=15)
Tomatoes	1.110	0.0062	1.082	0.0063
Lettuces	1.144	0.0063	1.051	0.0053
Carrots	1.230	0.0067	1.043	0.0062
Cabbages	1.317	0.0059	1.304	0.0053
Eggplants	1.760	0.0044	1.693	0.0047
Squashes	1.336	0.0044	1.302	0.0052

Table 2: Mean±SD of vitamin C (ascorbic acid) in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (mg/100 g)	±SD (*n*=15)	Mean (mg/100 g)	±SD (*n*=15)
Tomatoes	22.28	0.0034	24.426	0.0038
Lettuces	10.835	0.0040	11.843	0.0041
Carrots	8.819	0.0025	9.573	0.0029
Cabbages	36.550	0.0031	45.227	0.0029
Eggplants	7.445	0.0021	8.311	0.0021
Squashes	12.118	0.0055	13.374	0.0043

Table 3: Mean±SD of vitamin E (α-tocopherol) in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (mg/100 g)	±SD (*n*=15)	Mean (mg/100 g)	±SD (*n*=15)
Tomatoes	0.663	0.0025	0.950	0.0027
Lettuces	0.592	0.0031	0.875	0.0027
Carrots	0.829	0.003	1.119	0.003
Cabbages	0.208	0.0026	0.262	0.0032
Eggplants	0.348	0.0029	0.432	0.0029
Squashes	0.198	0.0028	0.229	0.003

Table 4: Mean±SD of β-carotene in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (mg/100 g)	±SD (*n*=15)	Mean (mg/100 g)	±SD (*n*=15)
Tomatoes	0.79825	0.0055	1.110	0.0065
Lettuces	1.115	0.0039	1.473	0.0054
Carrots	10.831	0.0035	12.875	0.0049
Cabbages	0.135	0.0058	0.1872	0.0054
Eggplants	0.053	0.0052	0.063	0.0049
Squashes	0.044	0.0051	0.056	0.0052

Organic crops contained significantly more vitamin C, iron, magnesium, and phosphorus and significantly less nitrates than conventional crops, as reported by Virginia [40].

Calcium functions as a constituent of bones and teeth and regulates nerve and muscle function [41]. Table 6 shows the calcium content in conventional and organic tomatoes, lettuces, carrot, cabbage, eggplant, and squashes vegetables. It was found that organic vegetables have higher calcium content than conventional ones, ranging from 11.5% for cabbage to 64% for eggplant. These results are in line with the study by Ordonez-Santos *et al.*[42] who demonstrated that the calcium content in organic tomatoes (15.97–23.13 mg/100 g) is higher in conventional tomatoes (11.4–16.78%). Moreover, Kelly and Bateman[43] found significantly greater concentrations of Ca and Mg in organic tomatoes. The results from the study by Masamba and Nguyen[44] showed significant differences in calcium and potassium content in organically and conventionally grown cabbage, carrots, cos lettuce, and Valencia oranges.

Conclusion

The findings of this study have revealed that tomatoes, eggplant, lettuce, squash, carrots, and cabbage organically grown have higher nutrition content of vitamin C, vitamin E, β-carotene, phosphorous, and calcium but less crude protein content than those nonorganically produced. It is highly recommended that future studies on organically and nonorganically grown produce should attempt to address confounding factors such as climate, soil type, crop type, fertilizer application, postharvest treatment, method of handling, and other factors before valid conclusions can be made.

Table 5: Mean±SD of phosphorus in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (mg/100 g)	±SD (n=15)	Mean (mg/100 g)	±SD (n=15)
Tomatoes	31.06	2.14	36.78	1.75
Lettuces	34.80	1.78	45.61	3.21
Carrots	41.72	2.19	54.56	3.15
Cabbages	32.15	2.39	37.54	2.76
Eggplants	23.81	1.89	26.97	3.07
Squashes	31.65	2.14	45.42	2.91

Table 6: Mean±SD of calcium in some organic and nonorganic vegetables

	Under nonorganic condition		Under organic condition	
	Mean (mg/100 g)	±SD (n=15)	Mean (g/100 g)	±SD (n=15)
Tomatoes	15.21	1.61	20.08	2.85
Lettuces	30.93	2.91	39.57	2.65
Carrots	35.93	1.95	46.04	2.37
Cabbages	40.21	2.78	44.82	1.23
Eggplants	17.29	1.27	28.37	1.99
Squashes	24.51	1.76	31.77	1.27

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Conflicts of interest
There are no conflicts of interest.

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