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## Nutritional quality of organic and conventionally grown broccoli (*Brassica oleracea* L var. *italica*)

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### Abstract

In the present investigation, the nutritional quality parameters of organic and inorganic broccoli were studied. It is evident from the data that organically produced broccoli has higher TSS (15.90 °B), total sugars (3.73%) and reducing sugars (2.50%) than conventional (inorganic) broccoli. Whereas, higher carotenoids (1.90 mg/100g), pectin (1.81%) and ash content (9.10%) as well as minerals were also recorded in organic broccoli as compared to conventional broccoli. Whereas, higher ascorbic acid (81.92 mg/100g), chlorophyll (3.10 mg/g), fibre (0.71%) and starch (1.92%) were observed in inorganically produced broccoli as compared to organic broccoli. The data showed that organic broccoli have almost similar content of chemical and mineral composition, therefore this crop could be exploit for the development of new fortified food products in food industry.

**Keywords:** Broccoli, organic, nutritional value, carotenoids, minerals

### Introduction

Broccoli (*Brassica oleracea* L var. *italica*) is one of the most popular exotic vegetable belongs to the family Brassicaceae grown for its edible flower heads which are used as a vegetable. It is native to Mediterranean region and has been considered as Italian vegetable. Broccoli is also known as the Crown Jewel of Nutrition because it posses all the chemical, functional and nutraceutical compounds namely vitamins, minerals, secondary metabolites and antioxidant proclaiming its exceptional health benefits. The edible portion of broccoli is inflorescence composed of flower buds and florets which has a high moisture content, proteins, vitamin C, vitamin A, dietary fibre and is low in fats and carbohydrates. As most of green vegetables, broccoli is a good source of minerals, such as calcium, magnesium, phosphorus, potassium, iron, zinc, sodium and selenium (Kmiecik *et al.*, 2007; Vasanthi *et al.*, 2009) [6, 12]. Besides this, edible portion of broccoli is rich source of bioactive components including isothiocyanates, glucosinolates, flavonoids, polyphenols, carotenoids, antioxidant vitamins and selenium (Nestle 1997; Vasanthi *et al.*, 2009; Mahn and Reyes, 2011) [9, 12, 7].

Broccoli has been reported as the one of main sources of natural antioxidants i.e., phenolic compounds, vitamins and chemopreventive compounds i.e., glucosinolates and their degradation products, isothiocyanates (Campas-Baypoli *et al.*, 2009) [2]. The major phytochemicals present in broccoli are sulphur containing compounds, which includes glucosinolate dithiolthiones indoles, glucoraphanin S-methyl cysteine sulfoxide isothiocyanates and indole-3-carbinol etc. The major isothiocyanate found in broccoli is sulforaphane, which comes from the hydrolysis of glucoraphanin by myrosinase. Sulforaphane acts as an indirect antioxidant by neutralizing the effect of free radicals, as well as a modulator of phases I and II detoxification enzymes (Moreno *et al.*, 2006; Sivakumar *et al.*, 2007) [8, 11]. Broccoli is considered as a low-glycemic food which helps to normalize blood sugar and is one of the keys to weight loss in controlling the body's response to insulin due to potential efficacy of sulforaphane and other bioactive compounds (Bahadoran *et al.*, 2012) [1].

The nutritional quality of food raised by organic farming in comparison to conventional farming is a new current topic that continues to attract interest of consumers with regard to organic foods not only as better, but also as safer, more hygienic and free of chemical residues and artificial ingredients. Due to free of chemical residues consumers appear to be willing to pay the premium price that organic products command (Winter and Davis, 2006) [13]. The information about the nutritive value and bioactive compounds of conventional and organic broccoli is relatively scarce and therefore more research in this area might be desirable.

## Materials and Methods

The study was conducted in the Department of Food Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India. In this study the organically and inorganically (Using NPK fertilizers) produced broccoli were procured from experimental farm, Department of Vegetable Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India. The randomly selected broccoli was analyzed for various physico-chemical and mineral characteristics.

### Physico-chemical and mineral analysis

Both organic and conventional (using NPK fertilizers) produced broccoli heads were analyzed for various physico-chemical and mineral characteristics as per standard procedures. The total soluble solids in the broccoli were measured with the help of hand refractometer. Moisture, ash, ascorbic acid, carotenoids, chlorophyll, starch and minerals (K, Ca, Mg) were determined using standard methods given by Ranganna (2009) [10]. Sugars were estimated by Lane and Eynon method given by Ranganna (2009) [10]. Fiber content was determined by the method given by Gould (1978) [4]. For the estimation of pectin, Carre and Hanes (1922) method as described by Ranganna (2009) [10] was followed. The data pertaining to physico-chemical and minerals characteristics obtained in this study were replicated three times.

## Results and Discussion

### Physico-chemical and mineral analysis

The chemical and mineral characteristics of both inorganically (Conventional) and organically produced broccoli were analyzed in this study are presented in Table 1. No significant differences were observed in visual colour of both organic and inorganic broccoli. Inorganically (Conventional) produced broccoli contained higher  $83.20 \pm 0.81$  per cent moisture than  $83.00 \pm 0.50$  organically produced broccoli. However, higher TSS, total sugars and reducing sugars were recorded in organic broccoli as  $15.90 \pm 0.07$  °B,  $3.73 \pm 0.13$  and  $2.50 \pm 0.20$  per cent, whereas conventional broccoli contained lower TSS, total sugars and reducing sugars as  $14.20 \pm 0.10$  °B,  $2.86 \pm 0.25$  and  $1.74 \pm 0.13$  per cent, respectively. Chaterjee *et al.* (2005) [3] have also reported similar trend in total sugars and reducing sugars of broccoli.

The ascorbic acid, chlorophyll, fibre and starch content of conventional produced broccoli were found to be higher as  $81.92 \pm 0.45$  mg/100 g,  $3.10 \pm 0.11$  mg/g,  $0.71 \pm 0.06$  per cent and  $1.92 \pm 0.21$  per cent as compared to organic broccoli as  $76.58 \pm 0.28$  mg/100 g,  $2.38 \pm 0.16$  mg/g,  $0.23 \pm 0.03$  per cent and  $1.62 \pm 0.20$  per cent, respectively. Chaterjee *et al.* (2005) [3] have also reported similar trend of chlorophyll in broccoli. Our results of ascorbic acid were in accordance with reported results by Kandil and Gad (2009) [5] in broccoli. Whereas, higher carotenoids, pectin and ash content were recorded in organic broccoli as  $1.90 \pm 0.08$  mg/100 g,  $1.81 \pm 0.14$  per cent and  $9.10 \pm 0.10$  per cent, whereas conventional broccoli contained lower carotenoids, pectin and ash content as  $1.73 \pm 0.10$  mg/100 g,  $1.71 \pm 0.17$  per cent and  $8.20 \pm 0.11$  per cent, respectively. Data in Table 1 also depicts that conventional broccoli contained lower K, Ca and Mg content than organically produced broccoli. Our results for minerals content are in conformity with earlier reported results by Kandil and Gad (2009) [5] in organic and inorganic broccoli with certain variations which could be due to environmental conditions and varieties.

**Table 1:** Variation in physico-chemical and mineral composition of organic and conventionally produced broccoli

Parameters	Conventional	Organic
	Mean± S.D.	Mean± S.D.
Colour	Dark greenish	Dark greenish
Moisture (%)	$83.20 \pm 0.81$	$83.00 \pm 0.50$
TSS (°B)	$14.20 \pm 0.10$	$15.90 \pm 0.07$
Titrateable acidity (% citric acid)	$0.40 \pm 0.02$	$0.37 \pm 0.01$
Total sugars (%)	$2.86 \pm 0.25$	$3.73 \pm 0.13$
Reducing sugars (%)	$1.74 \pm 0.13$	$2.50 \pm 0.20$
Ascorbic acid (mg/100 g)	$81.92 \pm 0.45$	$76.58 \pm 0.28$
Chlorophyll (mg/g)	$3.10 \pm 0.11$	$2.38 \pm 0.16$
Carotenoids (mg/100 g)	$1.73 \pm 0.10$	$1.90 \pm 0.08$
Fiber (%)	$0.71 \pm 0.06$	$0.23 \pm 0.03$
Pectin (%)	$1.71 \pm 0.17$	$1.81 \pm 0.14$
Starch (%)	$1.92 \pm 0.21$	$1.62 \pm 0.20$
Ash (%)	$8.20 \pm 0.11$	$9.10 \pm 0.10$
<b>Minerals (mg/100 g)</b>		
K	$28.00 \pm 0.10$	$28.10 \pm 0.36$
Ca	$38.93 \pm 0.10$	$45.50 \pm 0.24$
Mg	$1.15 \pm 0.08$	$1.41 \pm 0.09$

## Conclusion

It was concluded that not much differences were found in physico-chemical and mineral composition of broccoli produced organically and inorganically. Higher TSS, total sugars, reducing sugars carotenoids, pectin and ash content as well as minerals were recorded in organic broccoli as compared to conventional broccoli. Whereas, ascorbic acid, chlorophyll, fibre and starch content of conventional produced broccoli were found to be higher than organic broccoli. As organically produced broccoli is rich in various phytochemicals and minerals, vitamins and anti-oxidants that have proven health benefits, so could be exploit in food industry for the development of new functional food products by the application of various processing techniques.

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