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Effect of Blanching Process and Frozen Storage on Bioactive Compounds and Some Quality Parameters of Organic and Conventional Green Bean

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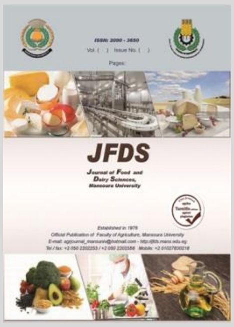

ABSTRACT

A great global interest in organic cultivation not only helps in enhancing the availability of nutrients but also reduces dependency upon external inputs as it near to nature. The market for organic foods and other products has grown rapidly due to consumers often find organic foods to be more nutritious and healthier than conventional foods. Therefore, this study was designed to evaluate the phytochemical and bioactive compounds of green bean (*Phaseolus vulgaris* L.), which produced either organically or conventionally, as well as, the effect of different technological processes and frozen storage period at -18ºC for 6 months on phytochemical and bioactive compounds content of their products were studied Organically grown green beans had higher contents of total sugars, minerals, all bioactive compounds and antioxidant activity than conventional ones. Pyrogallol was the predominant compound of both organic and conventional green beans (7.58 and 6.71 mg/ 100g, respectively), followed by chlorogenic and ellagic acids. There were variations in flavonoid individuals between organic and conventional green beans whereas, organic green beans had the highest content (6.06 mg/100gm) comparing with conventional green beans (4.67 mg/100gm).A greater stability of nutritional parameters for frozen organic green bean samples compared to frozen conventional samples during the storage period at -18°C. Furthermore, levels of bioactive compounds in both organic and conventional green bean samples were slightly affected by steam blanching than boiling blanching process and practically remained unchanged throughout the entire storage period at – 18 °C for 4 months and then gradually declined.

Keywords: Organic green beans, Bioactive compounds, Organic products, Antioxidat activities

INTRODUCTION

Nowadays, consumers turned to organic farming vegetable products due to the low confidence in food quality, many food scandals (such as the use of heavy metals, industrial pesticides and contamination with mineral fertilizers) (Dangour *et al*., 2010). Organic vegetables are expected to possess lower agrochemical contaminants and higher macro-, micronutrients and bioactive compounds than these of conventionally grown substitutes (Magkos *et al.*, 2003).

Organically grown fruits and vegetables may result in plant foods with higher natural antioxidants content. These natural antioxidants are mainly polyphenols, carotenoids and vitamins (E and C), exhibit a wide range of biological effects, including anticarcinogenic, anti-inflammatory, antimicrobial, antioxidant, antihypertensive and immune -modulating (Talhaoui *et al*., 2015 and Xu *et al*., 2017).

As of 2019, nearly 70,000,000 hectares (170,000,000 acres) worldwide were organically cultivated, accounting for about 1.4 percent of the world's total agricultural land (Willer and Lernoud, 2019). In 2014, Egypt's organically grown area increased by 36.04 thousand feddens, reaching about 0.16% of the total area cultivated organically in the world. As well as, Egypt had 790 organic farms, accounting for around 0.035% of the total number of organic farms worldwide and the area cultivated organically accounted for around 2.3 % of Egypt's overall agricultural land (Soleiman and Abd-Elhamed, 2018).

Green bean (*Phaseolus vulgaris* L.) is an herbaceous annual plant belonging to the family Fabaceae. Green beans are annual or multi-annual plants cultivated for their edible green pods or seeds (Abed El-Hakim, 2017). The total worldwide cultivated area of green beans is 1,579,489 hectares, producing 23,276,716 tons, as reported by FAO (2020). In Egypt, the cultivated area of green beans is 33,296 fedden, producing 132,264 tons (EAS-MALR, 2018-2019).

Green beans are a major cash crop, important not only for export but also for local market, where it is an important protein source with high nutritional value (Shalaby *et al*., 2016), a good amino acids profile (high lysine) and contains complex carbohydrates, dietary fibers, important vitamins (B complex vitamin) and minerals as well as antioxidants and polyphenols (Derbyshire, 2011). Organically produced foods contain phenolic compounds and ascorbic acid more than conventional ones (Faller and Fialho, 2010). Abu-Zahra (2016) found that total soluble solids, dry matter, anthocyanins, ascorbic acid and total phenols contents were higher in organic crops versus conventional crops. Moreover, Mastura *et al*. (2017) stated that the total phenols content in eight types of organic and conventional green beans ranged from 144.0 to 453.77 and 135.71 to 395.38 mg GAE/100g, respectively on dry matter. While, the antioxidant activity of raw green beans varied from 594.27 to 1712 by DPPH and 645.14to 2229 by ABTS µmol TE/100g, for both organic and inorganic respectively.

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In recent years, consumers have become increasingly aware of the nutritional benefits brought by the regular consumption of organic vegetable products, which reduces the risk of health problems and diseases. High-quality raw materials are essential since minimally processed produce is highly perishable and susceptible to quality deterioration. So, it was necessary to turn to use organic vegetables in food processing, to extend the shelf life and maintain the quality of the products without emitting dangerous chemicals. Therefore, this study was designed to evaluate the phytochemical and bioactive compounds of organic and conventional green beans, as well as, to study the effect of different technological processes on the phytochemical and bioactive compounds content of their product.

MATERIALS AND METHODS

Materials

- Organically grown green beans (*Phaseolus vulgaris* L. *cv. Polista*) were obtained from Central Laboratory for Organic Agriculture, ARC, Giza. Conventional grown green beans, was purchased from a private farm in Giza city, Egypt.
- All chemicals (analytical grade) were purchased from Elgomhouria pharmaceuticals Co., Cairo, Egypt. - 2.2-diphenyl-1-1picryl-hydrazyl (DPPH), Folin- Ciocalteu reagent, gallic acid and quercitin were obtained from Sigma-Aldrich Chime, Steinheim, Germany.

Methods

Preparation and technological process of green beans

Green bean pods of both organically and conventional grown green beans, at the immature physiological stage (green-skin-color), were sorted after removing the inedible parts with a sharp knife and washed with tap water, then dried on a paper towel to remove excess water, then cut into equal small pieces and divided into two portions. One portion was blanched in boiled water for 4 min. and the second portion was blanched by steaming for 6 min. All blanched samples were cooled in iced water to 20±1°C and packed in polyethylene bags separately. The two blanched green bean samples were frozen at –18±1°C and stored for analysis at periodic intervals of 0, 2, 4 and 6 months.

Analytical methods

- Moisture, ash, total solids, total soluble solids (TSS), titraitable acidity contents as well as, total, reducing and non-reducing sugars were determined according to the methods described by the A.O.A.C (2012).
- Minerals were detected, after dry ashing, according to the method described in the A.O.A.C. (2012), using atomic absorption (Perkin –Elmer, Model 3300, USA).
- Both chlorophyll (A and B) and total carotenoids of all samples were determined according to the methods described by Holm (1954) and Wetstein (1957).
- Ascorbic acid was quantitatively determined by 2, 6-dichlorophenol indophenol dye according to the method described by Ranganna (1977).
- Total phenolic compounds content was determined using Folin-Ciocalteau reagent according to the method described by Maurya and Singh (2010) and phenolic compounds were fractionated and identified by HPLC Hewllet Packared (series 1050) in FTRI, according to the method described by Goupy *et al.* (1999).
- Total flavonoids content was determined according to the method described by Jia *et al.* (1999) and flavonoid compounds were fractionated by HPLC Hewllet Packared (series 1050) in FTRI, according to the method of Loon *et al*. (2005).
- The antioxidant activity of samples was determined by the 2, 2'-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity according to the colorimetric method of Brand-Williams *et al*. (1995), and by measuring the inhibition of hydroperoxides formed from linoleic acid oxidation (Dapkevicius *et al*., 1998).
- The statistical data analysis was carried out using one way analysis of variance (ANOVA) under a significant level of 0.05 for the whole results using the statistical program CoStat (Ver. 6.400) and data were treated as complete randomization design according to Steel *et al*. (1997). To ascertain the significance among means of different samples, LSD test was applied.

RESULTS AND DISCUSSION

Chemical constituents of fresh organic and conventional green beans

Some chemical constituents of fresh organic and conventional green beans were determined and the results are shown in Table (1).

Table 1. Chemical constituents of fresh organic and conventional green beans

Samples* Constituents %	Organic green beans	Conventional green beans	LSD ≥ 0.05
Moisture content	90.40^a ±1.38	90.74^a ± 0.23	2.24
Ash	0.56^a ±0.05	0.53^a ±0.09	0.17
Total solids	9.60^a ±0.15	9.26^a ±0.24	0.45
TSS	4.54^a ±0.02	4.44^a ±0.07	0.11
Titratable acidity	0.13^b ±0.01	0.18^a ±0.02	0.03
pH values	4.49^a ±0.04	4.38^b ±0.05	0.10
Total sugars	4.38^a ±0.22	3.08^b ±0.18	0.46
Reducing sugars	3.26^a ±0.18	2.34^b ±0.14	0.37
Non reducing sugars	1.12^a ±0.1	0.74^b ±0.03	0.17
Minerals (mg/100g)			
K	1711.74	1420.42	-
Mg	181.21	160.62	-
Na	171.11	153.96	-
Ca	129.34	110.84	-
Fe	5.89	5.30	-
Zn	2.97	2.32	-

*** On wet weight basis**
Values are the mean of three independent determinations.
Different small letters in the same row indicate significant differences (P<0.05).

Results show that, no variation in moisture, ash, total solids and total soluble solids contents. While, there were slight differences (P<0.05) in total acidity %, pH values, total, reducing and non-reducing sugars contents for conventional and organic green beans which had the highest contents of the total, reducing and non-reducing sugars (4.38, 3.26 and 1.12 %, respectively) than conventional ones. These results are in agreement with those reported by Matt *et al*. (2011) and Jakopic *et al*. (2013) which decided that the sugar content of organic green beans was higher than conventional ones. Meanwhile, fresh conventional green beans had a slightly increased of total acidity than organic ones. On the other hand, organically grown green beans had the highest content of all minerals comparing with conventional ones. These results are in agreement with the data reported by Abu-Zahra (2016). These might result from greater microorganism activity in soils with organic management. Active substances produced by soil microorganisms are adsorbable by soil minerals, increasing their accessibility to plant roots (Worthington, 2001). From data in Table (1), it could be clearly concluded that, organic green beans had higher contents of total sugars and minerals than those of conventional ones.

Bioactive compounds and antioxidant activity of fresh organic and conventional green beans

Data in presented Table (2), reveal that fresh organic green beans had the highest contents of chlorophyll a, b and total carotenoids (411.05, 274.84 and 160.23 mg/100g, respectively) comparing with their contents in conventional green

beans. Obtained data were in the range of values recorded by Abd El-hakim *et al*. (2017), and are in agreement with those reported by Rossetto *et al*. (2015). The fact that nitrogen is a component of the chlorophyll molecule and is the primary component of all amino acids in proteins, which serve as a structural substance for green plastidates, may account for the favourable effect of organic green beans on chlorophyll concentrations.

Organically grown green beans had the highest contents of ascorbic acid, total phenols and flavonoids which were 45.88, 280.25 and 37.36 mg/100g, respectively comparing with conventional ones (29.98, 234.10 and 32.76 mg/100g, respectively). These results are in agreement with those reported by Faller and Fialho (2010), Filiz *et al.* (2017) and Mastura *et al*. (2017). Some tomato varietals grown organically may have more vitamin C content than tomatoes grown conventionally. Ammonium nitrogen (NH4+) may not have as much of an effect on vitamin C levels as nitrate nitrogen (NO3-) (Hallmann, 2012). As well as, without chemical pesticides, plants might be subjected to more stressful situations, which would cause them to produce more polyphenols and other natural defensive substances. There are more easily available nitrogen sources produced by conventional farming methods that use synthetic fertilisers, which could expedite plant development, but no secondary metabolites for growth. (Winter and Davis, 2006).

Table 2. Bioactive compounds and antioxidant activity of fresh organic and conventional green beans

Samples *Constituents(mg/100g)	Organic green beans	Conventional green beans	LSD ≥ 0.05
Chlorophyll A	411.05^{a}±0.23	388.35^{b}±0.36	0.68
Chlorophyll B	274.84^{a}±0.14	256.00^{b}±0.5	0.83
Total carotenoids	160.23^{a}±0.22	112.46^{b}±0.16	0.44
Ascorbic acid	45.88^{a}±0.09	29.98^{b}±0.02	0.15
Total phenols	280.25^{a}±0.09	234.10^{b}±0.26	0.44
Total flavonoids	37.36^{a}±0.16	32.76^{b}±0.28	0.52
Antioxidant activity % (by-DPPH)	44.90^{a}±0.1	31.20^{b}±0.36	0.60
Antioxidant activity % (by β–carotene)	32.87^{a}±0.05	24.77^{b}±0.21	0.35

*** On dry weight basis.**
Values are the mean of three independent determinations.
Different small letters in the same row indicate significant differences (*P*<0.05).

Data in Table (2) also reveal that, the organic green beans had the highest values (44.90%) of antioxidant activity by DPPH comparing with conventional green beans which was 31.20%. As well as, the DPPH procedure recorded the highest values comparing with β- carotene procedure and the different values of each antioxidant capacity assays resulted from the different mechanisms of each procedure. So, it could be clearly concluded that organically grown green beans had a higher content of all bioactive compounds and antioxidant activity than conventional ones.

Fractionation of phenolic compounds of fresh organic and conventional green beans

Twenty-three phenolic compounds were fractionated and identified by HPLC as shown in Table (3). Pyrogallol was the predominant compound of both organic and conventional green beans (7.58 and 6.71 mg/ 100g, respectively), followed by chlorogenic and ellagic acids. Alpha-coumaric and benzoic acids were also detected in significant amounts of both fresh organic and conventional green beans comparing with other phenolic compounds detected in immovable amounts. Furthermore, organic green beans had higher contents of total phenolic acids (18.15 mg/100g) than conventional ones which recorded 13.91 mg/100g. Data on total phenols found using the Folin-Ciocalteu method, which were higher than those found using the HPLC method, support these conclusions. The HPLC method only provided 50 to 60 percent of the amount assessed by the Folin-Ciocalteu method (Ferreira *et al.*, 2002).These results are in agreement with those reported by Abu-Zahra (2016) and Mastura *et al*. (2017).

Table 3. Fractionation of phenolic compounds of fresh organic and conventional green beans

Samples * Phenolic compounds (mg/100g)	Organic green beans	Conventional green beans
Gallic acid	0.08	0.03
Pyrogallol	7.58	6.71
4-Amino-benzoic acid	0.12	0.07
Protocatechoie	0.30	0.28
Catechine	0.38	0.29
Chlorogenic acid	2.01	1.53
Catechol	0.30	0.13
Epicatechein	0.39	0.46
Caffeine	0.17	0.07
P-OH-benzoic acid	0.48	0.17
Caffeic acid	0.07	0.01
Vanillic acid	0.12	0.13
P-Coumaric acid	0.38	0.06
Ferulic acid	0.25	0.11
Iso-Ferulic acid	0.12	0.04
Reversetrol	0.04	0.01
Ellagic acid	2.01	1.21
Alpha-Coumaric acid	1.43	1.12
Benzoic acid	1.30	1.17
3, 4, 5 -methoxy-cinnamic	0.14	0.01
Coumarin	0.04	0.01
Salycilic acid	0.34	0.26
Cinnamic acid	0.10	0.03
Total	18.15	13.91

*** On wet weight basis.**

Fractionation of flavonoid compounds of fresh organic and conventional green beans

Ten flavonoid compounds were separated and identified by HPLC and the results are presented in Table (4). Rosmarinic, luteolin and hesperidin were the major flavonoid compounds found in organic green beans (1.59, 1.52 and 1.18 mg/100g, respectively). Rutin and narengin were detected in moderate amounts comparing with other flavonoids. On the other hand, hesperidin was the predominant flavonoid compound in conventional green beans (3.7 mg/100g). But, luteolin and narengin were detected in moderate amounts comparing with other flavonoid compounds.

Furthermore, there were variations in flavonoid individuals between organic and conventional green beans. Organic green beans had the highest content (6.06 mg/100gm) of total flavonoid compounds comparing with conventional green beans (4.67 mg/100gm). These results are in accordance with those reported by Lima and Vianello (2011) who found that some organic vegetables have higher content of flavonoids comparing with the same products coming from conventional cultivation. The variations in flavonoid concentrations are likely brought about by the absence of fertilisers in organic farming. Due to a lack of synthetic pesticides and highly soluble fertilisers, organic crops may have a higher phenol content than conventional ones as a means of enhancing plant tolerance. In addition to farming system techniques, genetics, fertilisation control, soil biology, and environmental stress are other factors that affect the accumulation of polyphenols in fruits and vegetables. (Mazzoni *et al*., 2020).

Table 4. Fractionation of flavonoid compounds of fresh organic and conventional green beans

Samples*Flavonoid compounds (mg/100g)	Organic green beans	Conventional green beans
Luteolin	1.52	0.32
Narengin	0.41	0.43
Rutin	0.64	0.09
Hesperidin	1.18	3.70
Rosmarinic	1.59	0.02
Quercetrin	0.11	0.02
Quercetin	0.18	0.02
Naringenin	0.07	0.01
Hespertin	0.22	0.05
Kaempferol	0.15	0.01
Total	6.06	4.67

***On wet weight basis.**

Effect of some technological processes (blanching and freezing) on bioactive compounds and antioxidant activity of organic and conventional green beans during storage periods

The effects of the boiling and steaming blanching processes on the phytochemical compounds of organic and conventional green beans during storage periods at –18ºC for 6 months were evaluated and the results are shown in Table (5). The results reveal that chlorophyll a and b contents of organic green beans had markedly decreased with losing percentages 9.0 and 15.0%,respectively while highly significant decresses occurred in conventional green beans with losing percentages 10.0 and 15.95% after the boiling process. On the other hand, the losing percentages were 8.5 ; 14.0 % and 8.0 ; 14.5 %, respectively for organic and conventional green beans after the steaming process. This decrease is attributed to blanching temperature that converts chlorophyll a and b to phetophytin a and b through the Mg substitution of the chlorophyll by hydrogen (Turkmen *et al*., 2006). The color loss is accelerated by high temperature and exposure to oxygen during processing and the boiling method resulted in the highest loss of chlorophyll a and b content comparing with the steaming method. Furthermore, organic green beans were less sensitive to heating (boiling and steaming) as well as during storage periods at –18ºC for 6 months than those of conventional origin.

Concerning the total carotenoids content which is the most stable form of the thermodynamic point of view, it found to be very heat stable and had slightly decreased during storage period at -18ºC for 6 months. These results are in agreement with those reported by Oruňa- Concha *et al*. (1997) and Bamidele *et al*. (2017). Carotene losses were offset due to blanching beans before freezing considerably reduces the decreases in lutein and β- carotene contents due to lipoxygenase deactivation by blanching.

The blanching processes of organic green beans caused a highly significant reduction (27.98% loss) of ascorbic acid content during the boiling process comparing with the steaming process (22.47% loss). Furthermore, the most ascorbic acid reduction observed for conventional green bean samples with losing percentages were 34.22 and 29.05%, respectively for boiling and steaming processes. The losses during blanching have been postulated due to leaching into the blanching medium and thermal degradation of ascorbic acid to dehydro-ascorbic acid and further oxidation (Davey *et al*., 2000 and Chuah *et al.*, 2008).

The blanching process caused significant increases in the total phenols content (280.25 mg GAE/100g) after boiling and steaming processes being 316.81 and 319.03 mg GAE/100g, respectively for organic green beans and from 234.1 mg GAE/100g to 255.61 and 289.96 mg GAE/100g, respectively for conventional ones (Table, 5). Moreover, a similar increase in total flavonoids content and antioxidant activity was observed after the boiling and steaming processes. Domestic cooking methods can increase the polyphenol content in vegetables, including flavonoid and antioxidant capacity, because extractable parts of these molecules are reinforced by plant tissue disruption when subjected to high temperatures (Turkmen *et al*., 2005). Also, from the same table, it could be clearly seen that both steam and boiling blanching methods caused positive significant effects on the total phenols and flavonoids content as well as, the antioxidant activity of organic and conventional green beans samples, whereas, the steaming method resulted in the lowest changed of bioactive compounds content comparing with the boiling method. This may be due to the final exposure to heating by hot vapor, while, steaming has a softer effect on the structure of the food matrix than exposure to heating by boiling (Palermo *et al*., 2013 and Preti *et al*., 2017).

Generally, it could be concluded that greater stability of nutritional parameters for frozen organic green bean samples compared to frozen conventional samples during the storage period at -18°C. Furthermore, levels of bioactive compounds in both organic and conventional green bean samples were slightly affected by steam blanching than boiling blanching and practically remained unchanged throughout the entire storage period at – 18 °C for 4 months and then gradually declined.

Table 5. Effect of blanching process on bioactive compounds and antioxidant activity of frozen organic and conventional green beans during storage periods

Treatments *Constituents (mg/100g)	**Organic green beans**									**LSD ≥ 0.05**
	Storage period (months)									
	Boiling water					**Steam**				
	Fresh	**Zero**	**2**	**4**	**6**	**Zero**	**2**	**4**	**6**	
Chlorophyll A	411.05^{a} ±0.23	374.05^{b} ±1.75	367.16^{c} ±0.83	351.32^{f} ±0.29	346.12^{h} ±1.10	376.11^{a} ±0.38	361.19^{d} ±0.58	354.14^{e} ±0.92	349.44^{g} ±1.55	1.56
Chlorophyll B	274.84^{a} ±0.14	233.61^{b} ±1.06	225.15^{d} ±1.07	213.64^{f} ±0.70	202.24^{h} ±0.72	236.36^{a} ±0.84	226.98^{c} ±1.10	215.85^{e} ±0.99	207.53^{g} ±0.93	1.40
Total carotenoids	160.23^{a} ±0.22	152.28^{ab} ±1.21	151.78^{bc} ±0.63	149.07^{d} ±0.57	148.61^{d} ±0.50	153.00^{a} ±1.06	151.28^{bc}± 0.34	150.90^{c} ±0.37	148.90^{d} ±0.31	1.05
Ascorbic acid	45.88^{a} ±0.09	33.04^{ab} ±4.76	29.78^{bcd} ±0.00	27.84^{cd} ±3.28	25.62^{d} ±1.89	35.57^{a} ±1.04	31.32^{abc} ±2.85	29.71^{bcd} ±1.49	28.32^{cd}± 3.82	3.30
Total phenols	280.25^{d} ±0.09	316.81^{a} ±5.76	295.27^{c} ±6.05	289.28^{c} ±8.04	274.66d ±5.28	319.03a ±3.79	305.93b ±2.61	289.52c ±5.22	278.77^{d} ±5.17	8.07
Total flavonoids	37.36^{c} ±0.16	40.81^{ab} ±0.68	39.03^{abc} ±0.59	38.78^{abc} ±0.35	37.94^{c} ±1.06	41.01^{a} ±0.59	39.08^{abc} ±0.70	38.70^{bc} ±2.03	37.26^{c} ±0.74	1.44
Antioxidant activity % (DPPH)	44.9^{e} ±0.10	53.79^{b} ±0.23	51.85^{c} ±0.65	48.95^{d} ±0.22	45.13^{e} ±0.22	55.42^{a} ±0.67	53.09^{b} ±0.99	51.93^{c} ±0.93	49.06^{d} ±0.66	0.95
Antioxidant activity % by β – carotene	32.87^{f} ±0.05	40.34^{bc} ±0.25	39.35^{cd} ±0.77	38.35^{de} ±0.60	38.39^{de} ±0.48	41.57^{a} ±1.12	40.45^{b} ±0.48	38.42^{de} ±0.43	37.50^{e} ±0.31	0.91

Treatments * Constituents (mg/100g)	Conventional green beans									LSD ≥ 0.05
	Storage period (months)									
	Boiling water					Steam				
	Fresh	Zero	2	4	6	Zero	2	4	6	
Chlorophyll A	388.35^{a} ±0.36	349.51^{c} ±0.43	341.22^{e} ±0.63	338.10^{g} ±0.77	331.73^{h} ±1.04	357.28^{a} ±0.51	350.78^{b} ±0.29	346.94^{d} ±0.24	340.12^{f} ±0.49	0.93
Chlorophyll B	256^{a} ±0.5	215.15^{b} ±0.46	206.33^{c} ±1.18	197.92^{e} ±0.48	186.39^{g} ±0.53	218.88^{a} ±0.54	200.12^{d} ±1.18	196.55^{e} ±0.93	190.71^{f} ±2.52	1.78
Total Carotenoids	112.46^{a} ±0.16	106.82^{a} ±0.35	105.49^{b} ±0.88	104.06^{cd}± 0.37	102.72^{ef}± 0.95	107.96^{a} ±0.49	105.36^{bc} ±0.75	103.89^{de}± 1.23	101.91^{f} ±0.54	1.12
Ascorbic acid	29.98^{a} ±0.02	19.72^{ab} ±1.12	18.24^{ab} ±3.71	17.11^{ab} ±1.56	16.45^{b} ±1.27	21.27^{a} ±2.36	18.68^{ab} ±3.07	18.93^{ab} ±3.44	17.49^{ab} ±1.25	3.61
Total phenols	234.1^{def} ±0.26	255.61^{b} ±6.23	243.40^{bcd} ±8.32	234.92^{cde}± 1.53	221.94^{e}± 10.54	289.96^{a} ±8.88	249.45^{bc} ±15.54	238.26^{bcd} ^{e}±5.37	228.25^{de} ±15.60	14.95
Total flavonoids	32.76^{de} ± 0.28	35.10^{ab} ±0.42	33.98^{bc} ±0.83	32.69^{cd} ±2.21	32.27^{d} ±0.40	35.95^{a} ±0.42	34.60^{ab} ±0.63	34.25^{bc} ±0.33	32.94^{cd} ±0.32	1.37
Antioxidant activity% (DPPH)	31.2^{e} ± 0.36	36.34^{ab} ±0.31	33.14^{d} ±0.37	30.21^{e} ±0.22	29.71^{e} ±0.63	36.64^{a} ±0.53	35.51^{b} ±0.52	34.46^{c} ±0.37	33.48^{d} ±0.74	0.77
Antioxidant activity % (β – carotene)	24.77^{d} ± 0.21	30.12^{a} ±0.76	29.82^{ab} ±1.95	28.51^{abc} ±0.72	27.61^{c} ±0.56	30.07^{ab} ±0.81	29.37^{ab} ±0.83	28.46^{bc} ±0.32	27.55^{c} ±0.74	1.41

***On wet weight basis**

Values are the mean of three independent determinations. **Different small letters in the same row indicate significant differences (*P*<0.05).**

Effect of blanching process on phenolic acid compounds content of organic and conventional green beans

The effect of blanching process (boiling and steaming) on phenolic compound fractions of organic and conventional green beans samples was studied and the results are presented in Table (6). Steam blanching process of organic and conventional green beans samples had a slight effect to reduce the total phenolic compounds content comparing with the boiling process. Pyrogallol was the major phenolic compound detected in blanching organic and conventional green beans which decreased to 5.00, 5.73 mg/100g and 4.74 and 5.11 mg/100g, respectively in boiling and steamed organic and conventional green beans. Meanwhile, α-coumaric acid increased to 2.82 and 1.79 mg/100g, respectively in boiling and steamed organic green beans. These results are closed to those reported with Preti *et al.* (2017), who reported that both steaming and boiling methods of cooking significantly affected the total polyphenols content and antioxidant activity of green beans, but the boiling method resulted in the highest loss of total polyphenols content comparing with the steaming method.

Generally, from the obtained data, blanched organic and conventional green beans by steaming process had a higher content of total phenolic acids (15.59 and 12.71 mg/100g, respectively) comparing with the boiling process (14.82 and 10.22 mg/100g).

Table 6. Effect of blanching processes on phenolic acid compounds content in organic and conventional green beans

Samples *Phenolic acids(mg/100 g)	**Organic green beans**			**Conventional green beans**		
	Fresh	**Boiling**	**Steaming**	**Fresh**	**Boiling**	**Steaming**
Gallic acid	0.08	0.14	0.02	0.03	0.13	0.04
Pyrogallol	7.58	5.00	5.73	6.71	4.74	5.11
4-Amino-benzoic acid	0.12	0.04	0.02	0.07	0.04	0.03
Protocatchuic	0.30	0.23	0.29	0.28	0.54	0.77
Catechein	0.38	0.42	0.39	0.29	0.86	1.70
Chlorogenic acid	2.01	0.88	1.41	1.53	0.65	0.31
Catechol	0.30	0.15	0.18	0.13	0.17	0.29
Epicatechein	0.39	0.22	0.16	0.46	0.34	0.57
Caffeine	0.17	0.10	0.07	0.07	0.07	0.11
P-OH-benzoic	0.48	0.24	0.18	0.17	0.17	0.31
Caffeic acid	0.07	0.05	0.03	0.01	0.04	0.08
Vanillic acid	0.12	0.08	0.14	0.13	0.18	0.34
P-Coumaric acid	0.38	0.24	0.29	0.06	0.09	0.12
Ferulic acid	0.25	0.16	0.07	0.11	0.03	0.32
Iso-Ferulic	0.12	0.51	0.85	0.04	0.04	0.13
Reversetrol	0.04	0.35	0.18	0.01	0.02	0.03
Ellagic acid	2.01	1.63	0.72	1.21	0.66	0.73
α -Coumaric acid	1.43	2.82	1.79	1.12	0.04	0.07
Benzoic acid	1.30	0.16	1.98	1.17	0.62	0.70
3,4,5-methoxy-cinnamic	0.14	0.14	0.07	0.01	0.02	0.03
Coumarin	0.04	0.67	0.41	0.01	0.10	0.03
Salycilic acid	0.34	0.55	0.58	0.26	0.52	0.68
Cinnamic acid	0.10	0.04	0.03	0.03	0.14	0.21
Total	18.15	14.82	15.59	13.91	10.22	12.71

***On wet weight basis**

Effect of blanching process on flavonoid compounds content of organic and conventional green beans

Ten flavonoid compounds were separated and identified by HPLC and the results are shown in Table (7). Hesperidin increased to 3.15 ; 3.27 and 5.05 and 4.83 mg/100g, respectively in boiling and steamed organic and conventional green beans. While, narengin increased to 1.72 ; 1.11 and 0.48 ; 1.30 mg/100g, respectively in boiling and steamed organic and conventional green beans.These results are compatible with those reported by Turkmen *et al.* (2005),who reported that domestic cooking methods can increase the flavonoids content in vegetables, including antioxidant capacity, because extractable parts of these molecules are reinforced by plant tissue disruption when subjected to high temperatures.

Table 7. Effect of blanching processes on flavonoid compounds content of organic and conventional green beans

Samples Flavonoids compounds (mg/100 g)	Organic green beans			Conventional green beans		
	Fresh	Boiling	Steaming	Fresh	Boiling	Steaming
Luteolin	1.52	0.88	2.34	0.32	0.80	1.31
Narengin	0.41	1.72	1.11	0.43	0.48	1.30
Rutin	0.64	1.64	1.40	0.09	0.13	1.31
Hesperidin	1.18	3.15	3.27	3.7	5.05	4.83
Rosmarinic	1.59	0.64	0.02	0.02	0.05	0.14
Quercetrin	0.11	2.50	1.87	0.02	0.06	0.13
Quercetin	0.18	0.03	0.31	0.02	0.14	0.23
Naringenin	0.07	0.07	0.16	0.01	0.17	0.62
Hespertin	0.22	0.17	0.32	0.05	0.08	0.11
Kaempferol	0.15	0.10	0.31	0.01	0.02	0.11
Total	6.07	10.90	11.11	4.67	6.98	10.09

***On wet weight basis**

Generally, steam blanching had a positive effect to increase flavonoid compounds content in both organic and conventional green beans than boiling water, as well as, the organic green beans had a highly increasing rate comparing with conventional ones. This may be due to the final exposure to heating by hot water, while, steaming has a softer effect on the structure of the food matrix than exposure to heating by boiling (Palermo *et al*., 2013 and Preti *et al*., 2017).

Finally, it could be concluded that ,the levels of bioactive compounds in both organic or conventional green beans were slightly affected by steam blanching than boiling blanching and remained unchanged during storage at – 18 °C for 4 months and then gradually reduced.

REFERENCES

Abed EL-Hakim, H. I.(2017). Improvement of shelf life and physicochemical quality of fresh–cut green bean pods (*phaseolus vulgaris l. Cv. Polista*) using edible coatings. Journal of Food Sciences, 4 (1): 1-10.

Abu-Zahra, T. R. (2016). Quality and Nutrient Contents of Fruits Produced Under Organic Conditions. Organic Farming - A Promising Way of Food Production. Chap.16, https://doi.org/10.5772/61245

A.O.A.C. (2012). Official Methods of Analysis of the Association of Official Analytical Chemists. 19 th ED. Gaithersburg, Maryland, U.S.A.

Bamidele, O. P.; Fasogbon, M. B.; Adebowale, O. J. and Adeyemi A. Adeyanju. (2017). Effect of blanching time on total phenolic, antioxidant activities and mineral content of selected green leafy vegetables . Current Journal of Applied Science and Technology, 24(4): 1-8.

Brand-Williams, W.; Cuvelier, M. and Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. Lebensm. Wiss. Tech., 28: 25-30.

Chuah, A.M.; Lee Y-C.; Yamaguchi, T.; Takamura, H.; Yin, J. and Matoba T.(2008).Effect of cooking on the antioxidant properties of coloured peppers. Food Chem. 111:20-28.

Dangour, A.D. ; Lock, K. ; Hayter, A. ; Aikenhead, A. ; Allen, E. and Uauy, R. (2010).Nutrition-related health effects of organic foods: a systematic review. American Journal of Clinical Nutrition, 92: 203–210.

Dapkevicius, A.; Venskutonis, R.; Van Beek, T. and Linssen, P. (1998). Antioxidant activity of extracts obtained by different isolation procedures from some aromatic herbs grown in Lithuania. J. Sci. Food Agric., 77:140–145.

Davey, M. W.; Van Montagu, M., Inze, D., Sanmartin, M., Kanellis, A., Smirnoff, N.,*et al*. (2000). Plant L-ascorbic acid: chemistry, function, metabolism, bioavailability and effects of processing. Journal of the Science of Food and Agriculture,80: 825-860.

Derbyshire, E. (2011). The nutritional value of whole pulses and pulse fractions. Pulse Foods: Processing Quality, 363-383.

EAS-MALR, Volumes (2018-2019). Economic Affairs Sector- Ministry of Agriculture and Land Reclamation. Bulletin of Important indicators of the Agricultural Statistics.

Faller; A.L.K. and Fialho, E. (2010). Polyphenol content and antioxidant capacity in organic and conventional plant foods. Journal of Food Composition and Analysis, 23(6), 561–568.

FAO, (2020). FAO Stat. Database. Available from http://faostat.fao.org.

Ferreira, D.; Guyot, S.; Marnet, N.; Delgadillo, I.; Renard, C.M. and Coimbra, M.A.,(2002). Composition of phenolic compounds in a portugese pear (*Pyrus communis L.Var. S. Bartolomeu*) and changes after sun drying. J. Agric. and Food Chem., 50: 4537–4544.

Filiz,B.E.; Korkmaz,N.; Budak,N.H.; Seydim,A.C. ana Seydim, Z. B. G. (2017). Antioxidant activity and phenolic acid content of selected vegetable broths. Czech Journal of Food Sciences, 35(6): 469–475.

Goupy, P.; Hugues, M.; Biovin, P. and Amiot, M.J. (1999). Antioxidant composition and activity of barley (*Hordeum vulgare*) and malt extracts and isolated phenolic compounds. J. Sci. Food Agric., 79: 1625-1634.

Hallmann, E. (2012).The influence of organic and conventional cultivation systems on the nutritional value and content of bioactive compounds in selected tomato types. J. Sci. Food Agric., 92, 2840−2848.

Holm, G. (1954). Chlorophyll mutations in barley. Acta. Agr. Scand., 4: 457-471.

Jakopic, J.; Slatnar, A.; Mikulic-Petkovsek, M.; Veberic, R.; Stampar, F.; Bavec, F. and .; Bavec, M. (2013). Effect of Different Production Systems on Chemical Profiles of Dwarf French Bean (*Phaseolus vulgaris* L. cv. Top Crop) Pods. Journal of Agricultural and Food Chemistry, 61(10), 2392–2399.

Jia, Z.; Tang, M.and Wu, J. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem., 64: 555–559.

Lima, G.P.P and Vianello ,F. (2011). Review on the main differences between organic and conventional plant-based foods. International Journal of Food Science and Technology.46:1–13.

Loon, Y.; Wong, J.; Yap, S. and Yuen, K.(2005). Determination of flavonoids from Orthosiphon stamineus in plasma using a simple HPLC method with ultraviolet detection. J. Chromatogr. B., 816: 161– 166.

Magkos, F.; Arvaniti, F. and Zampelas, A. (2003). Organic food: Nutritious food or food for thought? A review of the evidence. International Journal of Food Sciences and Nutrition, 54(5) : 357–371.

Mastura, H.Y., Hasnah, H. and Dang, T. N .(2017). Total phenolic content and antioxidant capacity of beans organic vs inorganic. International Food Research Journal, 24(2): 510-517.

Matt, D.; Rembialkowska, E.; Luik, A.; Peetsmann, E. and Pehme, S. (2011). Quality of organic vs. conventional food and effects on health – report. Estonian University of Life Sciences.

Maurya, S. and Singh, D. (2010). Quantitative analysis of total phenolic content in Adhatoda vasica nees extracts. Int J. Pharm. Tech. Res., 2(4): 2403-2406.

Mazzoni, L.; Di Vittori, L.; Balducci, F.; Forbes-Hern´andez, T. Y.; Giampieri, F.; Battino, M. and *et al*. (2020). Sensorial and nutritional quality of inter and intra—Specific strawberry genotypes selected in resilient conditions. Scientia Horticulturae, 261, 108945.

Oruňa-Concha, M.J.; M.J. González-Castro, M. J.; Lopes-Hernández, J. and Simal-Lozano, J. (1997). Effects of freezing on the pigment content in green beans and padrón peppers. Z Lebensm Unters Forsch (205): 148-152.

Palermo, M.; Pellegrini, N. and Fogliano, V. (2013). The effect of cooking on the phytochemical content of vegetables. Journal of the Science of Food and Agriculture, 94(6), 1057–1070.

Preti, R.; Rapa, M.; Vinci, G. (2017). Effect of steaming and boiling on the antioxidant properties and biogenic amines content in green bean (*phaseolus vulgaris*) varieties of different colours. Journal of Food Quality, 1–8.

Ranganna, S. (1977). Fruit and Vegetable Analysis. Manual of analysis of fruit and vegetable products. Tata. Mc. Graw-Hill, Pub. Co. Ltd, New Delhi.

Rossetto MRM, Vianello F, Saeki MJ, Lima GPP. (2015). Polyamines in conventional and organic vegetables exposed to exogenous ethylene. Food Chem., 188:218–224.

Shalaby, M.A. ; Ibrahim, S.K. ; Zaki, E.M. ; Abou-Sedera, F.A. and Abdallah, A.S. (2016). Effect of sowing dates and plant cultivar on growth, development and pod production of snap bean (*Phaseolus vulgaris* L.) during summer season.International Journal of Pharm.Tech. Research, 9: 231–242.

Soleiman,S.A and Abd-Elhamed Nuran,I.A (2018). Reality and prospects of organic farming in the world level and its role in agricultural development with a focus on egypt. 8th International Conference of Agricultural Development, Fac. of Agric.,Fayoum Univ.,Fayoum, Egypt, March 5-7.

Steel, R.; Torrie, J. and Dickey, D. (1997). Principles and procedures of Statistics: A Biometrical Approach, 3rd ed., McGraw-Hill, New York, NY.

Talhaoui, N.; Taamalli, A.; Gómez-Caravaca, A. M.; Fernández-Gutiérrez, A.; and Segura- Carretero, A. (2015). Phenolic compounds in olive leaves: Analytical determination, biotic and abiotic influence, and health benefits. Food Research International, 77:92–108.

Turkmen, N.; Sari, F. and Y. Velioglu, S . (2005). The effect of cooking methods on total phenolics and antioxidant activity of selected green vegetables. Food Chemistry, 93 :713–718.

Turkmen, N.; Poyrazoglu, E.S.; Sari, F. and Velioglu, Y. S . (2006). Effects of cooking methods on chlorophylls, pheophytins and colour of selected green vegetables. International Journal of Food Science and Technology . 41:281–288.

Wettstein, D. (1957). Chlorophyll – letale und der submikroskopische ormwechsel der Plastiden. Experimental Cell Research, 12: 427–487.

Willer, H. and Lernoud,J. (2019). The World of Organic Agriculture: Statistics and Emerging Trends, 20 ed, Research Institute of Organic Agriculture (FiBL) and the International Federation of Organic Agriculture Movements (IFOAM).

Winter, C.K. and Davis, S.F.(2006) . Organic foods. Journal of Food Science 71: R117-R124.

Worthington, V. (2001). Nutritional quality of organic versus conventional fruits, vegetables and grains. Journal of Alternative and Complementary Medicine, 7:161–173.

Xu, D. ; Li, Y. ; Meng, X. ; Zhou, T. ; Zhou, Y. ; Zheng, J. ; Zhang, J. and Li, H. (2017). Natural antioxidants in foods and medicinal plants:Extraction, assessment and resources. International Journal of Molecular Sciences, 18 (1), 96.

تأثير عملية السلق والتخزين بالتجميد على المركبات الحيوية الفعالة وبعض عوامل الجودة فى الفاصوليا الخضراء العضوية والغير عضوية

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الملخص

هناك اهتمام عالمي كبير بالزراعة العضوية ليس فقط لقدرتها على تحسين الإتاحة للمغذيات ولكن لانها تقلل أيضًا من الإعتماد على المدخلات الخارجية فهى قريبة من الطبيعة. وحديثا" زاد الإقبال على الأغذية العضوية ومنتجاتها زيادة سريعة نظرًا لأن المستهلك غالبًا ما يعتقد ان الأغذية العضوية أفضل من الناحية الصحية والغذائية عن مثيلاتها الغير عضوية. لذلك تم إجراء هذه الدراسة لتقييم المركبات الكيميائية والحيوية النشطة فى الفاصوليا الخضراء سواء المنتجة عضويا أو من الزراعة التقليدية، بالإضافة إلى دراسة تأثير العمليات التكنولوجية المختلفة كالسلق بالماء اوالسلق بالبخار والتخزين بالتجميد على درجة حرارة 18 ^{o}C- لمدة ستة أشهر على محتوى كلا" من المركبات الكيميائية والحيوية النشطة فى الفاصوليا الخضراء الناتجة .واظهرت النتائج احتواء الفاصوليا الخضراء المنزرعة عضوياً على نسبة عالية من السكريات الكلية والعناصر المعدنية وجميع المركبات النشطة بيولوجيًا وقيم النشاط المضاد للأكسدة عن الفاصوليا الغير عضويه. ووجد ان البيروجالول هو المركب الفينولى السائد فى كلا" من الفاصوليا الخضراء العضوية والغير عضوية على السواء (٧،٥٨ و ٦،٧١ مليجرم/ ١٠٠جرام ، على التوالي) ، يليه أحماض الكلوروجينك والإلاجيك، وكان هناك اختلافات في محتوى الفلافونويدات المفردة بين الفاصوليا الخضراء العضوية والغير عضويه، حيث سجلت الفاصوليا الخضراء العضوية أعلى محتوى (٦،٠٦ مليجرم/ ١٠٠جرام) مقارنة بالفاصوليا الخضراء الغير عضويه (٤،٦٧ مليجرم / ١٠٠ جرام).وعامة فقد اظهرت عينات الفاصوليا الخضراء العضوية المجمدة درجة ثبات عالية لكافة العناصر الغذائيه مقارنة بالعينات الغير عضوية المجمدة خلال فترة التخزين على -١٨ درجة مئوية. علاوة على ذلك ، فإن التغير كان بشكل طفيف فى محتوى المركبات النشطة بيولوجيًا في كلا من عينات الفاصوليا الخضراء العضوية والغير عضوية والمعاملة بالسلق بالبخار مقارنه بالسلق بالغليان فى الماء وظل التغير طفيفا" طوال فترة التخزين على -١٨ درجة مئوية ولمدة ٤ أشهر بعدها زاد الإنخفاض تدريجيًا.