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Phenolic Compound and Trace Elements Contents of some Fresh and Processed Egyptian Vegetables

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ABSTRACT

The objective of this study was to evaluate the effect of some domestic processing on phenolic compounds and trace elements contents in certain vegetables, which commonly consumed in Upper Egypt. Total phenolic in some leafy and pulses vegetables were ranged from 6.31 to 37.63 mg/g as Galic acid, While the levels of trace elements were higher in leafy vegetables than in those of pulses vegetables. Blanching and cooking and processes of vegetables caused most significant reduction in total phenolic compounds content. Losses of phenolic compounds were slightly at the first months of storage for spinach, then was more gradually decreased during freezing storage process. Storage of leafy and pulses vegetables under refrigeration conditions for different periods led to a significant decrease of TPCs. Blanching process have the same trend as cooking on reducing some trace elements content of some vegetables samples under study, but at a lower rate than cooking. Effect of freezing process on trace elements contents of vegetables was investigated. Freezing process resulted in a decreasing in some elements; iron, manganese, copper and zinc for both of green beans and peas, where the loss in peas was higher than those of losing in green beans. Trace elements content was not affected by refrigerating process. It can be concluded that the excessive in the various domestic processing thermal treatment for vegetables caused a negatively effect on their content of phenolic compounds, trace elements and their nutritional value.

Keywords: leafy and pulses vegetables, phenolic compounds, trace elements, domestic processing

INTRODUCTION

Vegetables make up a major portion of the diet which play a significant role in human nutrition, especially as sources of phytonutriceuticals: vitamins, minerals, dietary fiber and phytochemicals (Kmiecik *et al.*, 2004). Some phytochemicals of vegetables are phenolic compounds with potent antioxidant activity, that is a substance that inhibit or delays oxidative damage to the cells of the organisms and are thought to reduce the risk of chronic disease by protecting against free-radical damage (Adebooye *et al.*, 2007; Yamagishi and Matsui, 2011).

The words “trace elements” are used for elements existing in natural and perturbed environments in small amounts, with excess bioavailability having a toxic effect on the living organism. Among these, iron is the most abundant in human serum, followed by zinc, copper and manganese. Are ultra-trace elements and are present in least amounts (at ppm order) (Arakawa, 2016). Minerals are necessary for the bone strengthening, the transmission of nerve impulses or the enzymatic structure. The existence of a significant variety of minerals in our organism is related to the different functions they have, although some play similar roles. Microminerals play an important role in the structural fraction of enzymes, in the formation of erythrocyte cells in the regulation of glucose levels of activation of antioxidant enzymes and may be involved in the various processes of the immune system (Gharibzahedi and Jafari, 2017). As a result of soil uptake at various stages of growth, plants are good sources of mineral elements like iron, calcium and magnesium (Bakhru, 2007).

Many fresh leafy vegetables have a shelf- life of only few days before they are unsafe or undesirable for consumption. In fact, Vegetables are highly perishable foods subject to rapid deterioration by microorganisms, enzymes, or oxidation reactions. Storage and processing technologies have been utilized for centuries to transform these perishable vegetables into safe, delicious and stable products (Rickman *et al.*, 2007). Use of postharvest preservation methods such as refrigeration and freezing might extend their shelf- life but may also affect the nutritional content of these crops (Chinma and Igyor, 2007).

All the vegetables had high total phenolic content ranging from 10.02 to 51.10 mg/g, the traditional leafy vegetables and high antioxidant activities and total phenolics (Chipurura *et al.*, 2013). Heating affects the content of some polyphenols, due to the extractability alteration by the rupture of the cell wall. In this way, polyphenols linked to the wall could be released more easily on cooking than from the raw material (Peleg *et al.* 1991). Cell breakages occurring during freezing and frozen storage can lead to the release of antioxidant compounds and their degradation due to chemical and enzymatic oxidation reactions, and thus, they could present a lower antioxidant activity compared to the corresponding fresh product (Neri *et al.*, 2020). These losses could be attributed to the respiration, transpiration, ethylene production and enzyme activity during refrigeration storage (Acho *et al.*, 2015).

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Most minerals are lost when vegetables cooked. The loss of minerals in the vegetables may be due to leaching effect during the cooking process (Bwembya *et al.,* 2018). Deterioration of the vegetable tissue and cells during the freezing storage period was noted, with a high loss of exuded liquid during defrosting being the cause of this decrease (Amaro-Lopez *et al.,* 1998). Concentrations of trace elemental were declined after 8 days of storage at 4ºC. These observed reductions may be due to the small losses of ashes by transpiration phenomena during refrigeration (Oulai *et al.,* 2015). The objective of this study was to evaluate the effect of domestic processes on phenolic compounds and some trace elements contents in certain leafy and pulses vegetables grown in Sohag Government.

MATERIALS AND METHODS

Materials:

Leafy vegetables:

Spinash (*Spinacia oleracea*), Jew's mallow (*Corchorus olitorius*) , Cabbage (*Brassica oleracea var. capitata*) , Dill (*Anethum graveolens*), Lettuce (*Lactuca sativa*), Chard (*Beta vulgaris var. cicla*), Parsely (*Petroselinum crispum*), Rocket salad (*Eruca vesicaria ssp. Sativa*) and coriander (*Coriander sativum*).

Pulses vegetables:

Green beans (*Phaseolus vulgaris* L.*)*, Peas (*Pisum sativum* L.) and *Tomato (Solanum lycopersicum* L.). All samples were obtained from the faculty of Agriculture, Sohag University and local markets in Sohag Governorate. Fresh vegetables were obtained during the season of 2019 and were representative of quality of those available at that season.

Chemicals and reagents:

Aqueous methanol, Folin-Ciocalteu and gallic acid. Some chemicals were obtained from Sigma (Germany). The other chemicals were of the highest quality was purchased from El-Gomhoria Company, Egypt.

Preparation of samples:

Fresh samples:

All vegetable samples were cleaned, trimmed and washed with distilled water; Fresh vegetable samples were cut into small pieces and quickly used for chemical analysis.

Refrigeration process:

Fresh vegetable samples used in this investigation were stored under refrigeration at 4ºC for several days until it's were considered inedible. Part of samples were cut into small pieces and quickly used for chemical analysis every two days.

Thermal treatment (cooking and blanching):

Samples were prepared for cooking as for normal consumption and cooked in boiling distilled water (1:2 w/v) for different times according to the type of sample. The process of cooking and blanching was carried out inside a piece of gauze, then samples were cooled and used quickly for chemical analysis.

- Leafy vegetables were cooked at 95ºC for 5 min and blanched for 1 min.
- Pulses vegetables were cooked at 95ºC for 10 min and blanched for 5 min.

Freezing process:

Blanched and cooled samples were placed in polyethylene bags and stored at a temp**e**rature of -18 to -20 degrees Celsius using a deep freezer for 6 months. Samples were used quickly for chemical analysis every month.

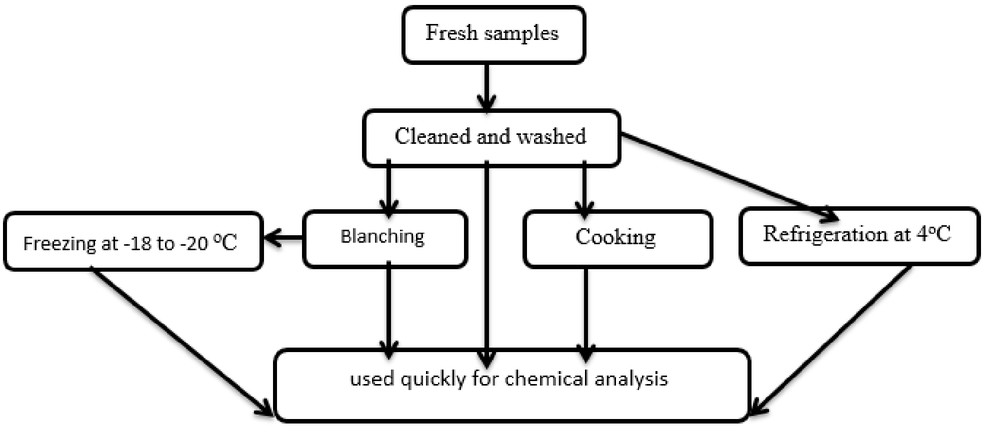

Fig. 1. Preparation of samples

Analytical methods:

Determination of total phenolic compounds (TPCs):

Phenolic compounds (TPC) in the crude extracts was determined by the Folin-Ciocalteu colorimetric method (Singleton and Rossi, 1965) using gallic acid as a standard phenolic compound.

Determination of trace elements (TE):

Iron, manganese, copper and zinc were determination using Atomic absorption spectrometer (SPECTRUM-SP- AA4000), as described in Jackson (1985) and AOAC. (2012). The analysis was performed in Soil and Water Department Labs, Faculty of Agric., Sohag University.

Statistical analysis:

Data were statistically analyzed by SAS statistical software (SAS ver. 9.2, SAS Institute, 2008). The LSD at 5% significant level was calculated according to Petersen (1985), for comparing mean values of studied traits.

RESULTS AND DISCUSSION

Total phenolic compounds (TPCs):

Total phenolic compounds content of some fresh vegetables:

Results shown in Fig. (2) demonstrate the total phenolic compounds content in some fresh leafy and pulses vegetables. Total phenolic in some leafy vegetables were ranged from 6.31 to 37.63 mg/g as Galic acid. While total phenolic compounds in pulses vegetables ranged from 6.31 to 17.38 mg/g as Galic acid of peas and tomato, respectively. Results are in the line with those reported by (Chipurura *et al.*, 2013; Alam *et al.*, 2020).

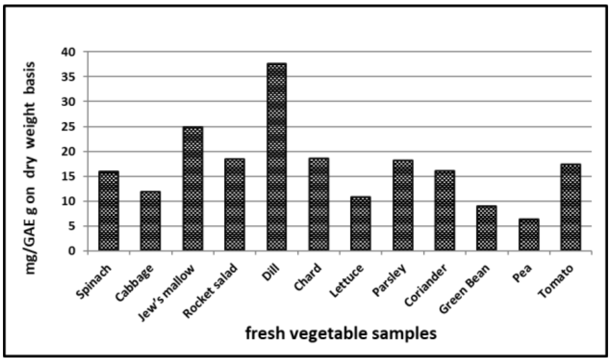

Fig. 2. Total phenolic compounds content in some fresh vegetables (mg GAE/g on dry weight basis).

Effect of cooking process on total phenolic compounds content of some leafy and pulses vegetables:

The results in Fig. (3) show the effect of cooking process on total phenolic compounds in some leafy and pulses vegetables. Cooking process of leafy vegetables caused most significant reduction in total phenolic compound content were 52.1, 54.1 and 58.38% reductions in total phenolic of spinach, cabbage and jew's mallow, respectively. Cooking process of pulses vegetables caused a loss of 46.94 and 42% of total phenolic in green beans and peas, respectively. Similar results finding was reported by Şengül *et al.* (2014); Vasconcellos *et al.* (2016).

These results indicated that phenolic compounds were very sensitive to thermal treatment. Losses during cooking process may indicate the destruction of phenolic compound as affected with cooking heat. This may be explained by Ahmed and Ali (2013), they found that, the phenolic compounds are highly soluble in water also in the boiling process; it may be lost by leaching. However, heat treatment may soften the vegetal tissues and facilitate the extraction from the cellular matrix (Blessington *et al.*, 2010).

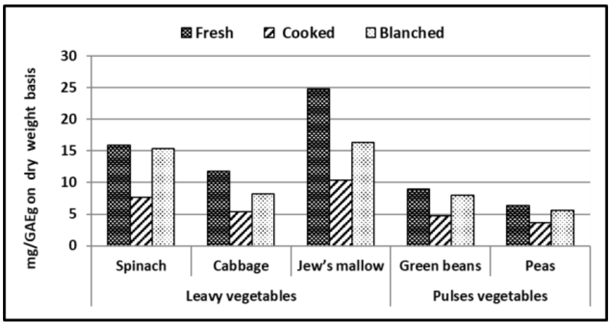

Fig. 3. Effect of cooking and blanching on total phenolic compounds content of some leafy and pulses vegetables (on dry weight basis)

Effect of blanching process on total phenolic compounds content of some leafy and pulses vegetables:

The results in Fig. (3) illustrate the effect of blanching before freezing process on total phenolic compounds in leafy and pulses vegetables. In blanching process vegetables there were 3.94, 30.1, 34.17, 10.87 and 11.88% reductions in total phenolic compounds of spinach, cabbage, jew's mallow, green beans and peas, respectively. Similar results occurred by Volden *et al.* (2009); Şengül *et al.* (2014). This may be due to leaching of total phenolic in blanching water, but the decrease in boiling process was less than in the case of cooking, this may be due to the effect of increasing the boiling time (Korus and Lisiewska, 2011).

Effect of frozen storage on total phenolic compounds content (TPC):

The results in Figs. (4 and 5) illustrate the effect of frozen storage for six months on TPC in blanched leafy and pulses vegetables. Freezing of blanched leafy and pulses vegetables for six months caused variable losses in total phenolic compounds. The losses of phenolic compound were slightly at the first months of spinach storage, and then it was increase gradually during further freezing storage. For frozen cabbage and jew's mallow, the losses of TPC were slightly increase during storage under freezing for 6 months.

Blanched pulses vegetables freezing stored for 6 months resulted losses of total phenolic content. The loss of phenolic compounds was decreased gradually during freezing stored for 180 days. At the end storage period the loss of total phenolic reached 25.53 and 32.01% of the initial value in blanched green beans and peas, respectively. These results are in accorded with that obtained by Korus and Lisiewska (2011); Bonwick and Birch (2014)

This decrease may be due to the decomposition of phenolic compounds. Neri *et al.* (2020) noticed that, cell breakages occurring during freezing and frozen storage can lead to the release of antioxidant compounds and their degradation due to chemical and enzymatic oxidation reactions, and thus, they could present a lower antioxidant activity compared to the corresponding fresh product.

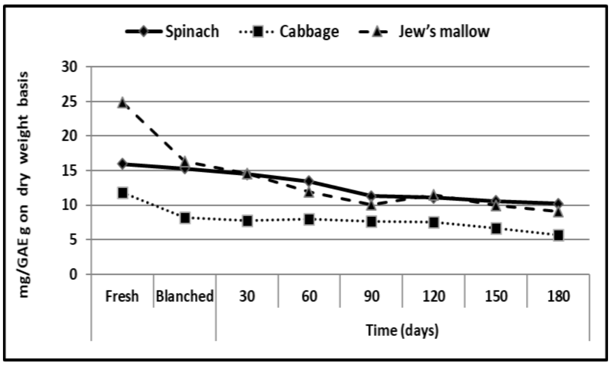

Fig. 4. Effect of freezing storage on total phenolic compounds content of some leafy vegetables (on dry weight basis).

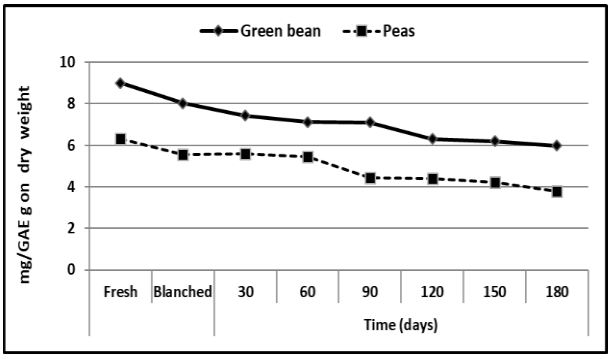

Fig. 5. Effect of freezing storage on total phenolic compounds content of some pulses vegetables (on dry weight basis).

Effect of refrigeration storage on total phenolic compounds content of some leafy and pulses vegetables:

Data in illustrated in Figs. (6 and 7) demonstrate the effect of refrigeration on total phenolic compounds of some leafy and pulses vegetables. Storage of leafy and pulses vegetables under refrigeration led to significantly decrease of TPCs. Storage periods at refrigeration for spinach and jew's mallow was 6 days while cabbage storage stretched to 12 days. Refrigeration process at 4°C of cabbage for 12 days caused significantly decrease of TPCs.

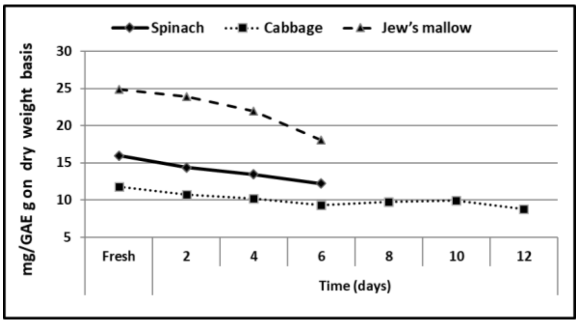

Fig. 6. Effect of refrigeration on TPCs content of some leafy vegetables (on dry weight basis).

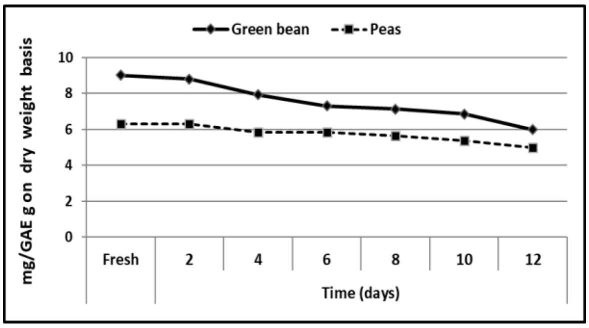

Fig. 7. Effect of refrigeration on TPCs content of some pulses vegetables (on dry weight basis).

The pulses vegetables stored at 4°C refrigeration for 12 days and the loss in phenolic compounds was greater in green beans compared with peas. Data revealed that, the losses in total phenolic compounds were significantly increased from 2.3 to 33.51% and from 0.15 to 20.91% in green beans and peas, respectively. These results are in accord with results obtained by Mudau *et al.* (2015); Galani *et al.* (2017). This decrease in total phenolic may be due to the destruction of phenolic compounds with oxidizied enzymes during storage under refrigeration condition. These losses could be attributed to the respiration, transpiration, ethylene production and enzyme activity during storage Acho *et al.* (2015).

Trace elements content (TE):

Trace elements content in some fresh vegetables:

Results given in Table (1) illustrate the trace elements content in the studied fresh leafy and pulses vegetables. Iron levels in all studied leafy vegetables were found to be much higher than any of the other trace metals; spinach contained the highest value (163.23mg/kg), followed by coriander, parsley, and jew's mallow which contained 142.10, 128.18 and 118.69 mg iron/kg, respectively. Similar results were obtained by Elbagermi *et al.* (2012); Delbar and Kulkarni (2013).

Data in Table (1) showed that the amount of manganese was higher in cabbage (67.18mg/kg) followed by lettuce (22.08mg/kg) in leafy vegetables. On the other hand, chard and Spinach had the highest mean values of copper 130.00 and 113.54 mg/kg. Whereas, cabbage, lettuce, and jew's mallow had the lowest mean copper values were 2.48, 7.92 and 8.76 mg/kg, respectively. Also data represented in Table (18) showed that, zinc values are higher in spinach followed by chard and dill, and the value were; 66.49, 57.56 and 55.17 mg/kg, respectively.

Data in Table (1) indicated that, the content of elements were higher in leafy vegetables than those of pulses vegetables. Values of iron, manganese, and zinc are somewhat similar in green beans and peas it were 34.38 - 38.67, 8.94 - 9.45 and 40.12 - 49.76 mg/kg for iron, manganese and zinc, respectively. On the other hand, copper content of pulses ranged between 12.65 in peas and 19.42 in green beans mg/kg. These results are general agreement with those reported by Amos-Tautua and Onigbinde, (2014); Bahiru and Teju (2019).

Table 1. Trace elements content in some fresh vegetables (mg/kg on dry weight basis).

Samples		Ash %	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Leafy vegetables	Spinach	22.64^{e} ±0.1	163.23^{a} ±4.9	1.58^{f} ±0.1	113.54^{b} ±0.8	66.49^{a} ±2.2
	Cabbage	8.50^{j} ±0.1	11.53^{i} ±0.95	67.18^{a} ±3.27	2.48^{i} ±0.28	43.62^{d} ±2.48
	Jew's mallow	11.49^{h} ±0.1	118.69^{d} ±5	15.56^{c} ±1.5	8.76^{h} ±0.1	24.33^{f} ±1.1
	Rocket salad	16.77^{c} ±0.06	41.73^{f} ±3.83	13.70^{c} ±1.66	35.53^{e} ±3.8	42.46^{d} ±1.88
	Dill	13.40^{e} ±0.1	34.93^{g} ±0.81	10.23^{d} ±0.94	14.81^{g} ±0.43	55.17^{b} ±0.51
	Chard	19.11^{b} ±0.1	112.61^{e} ±1.7	10.26^{d} ±0.4	130.00^{a} ±5.5	57.56^{b} ±4.4
	Lettuce	11.76^{g} ±0.1	34.33^{g} ±1.1	22.08^{b} ±1.1	7.92^{h} ±0.1	22.45^{f} ±0.8
	Parsley	13.11^{f} ±0.1	128.18^{c} ±3.1	2.58^{f} ±0.2	99.85^{c} ±0.5	38.84^{ed} ±1.4
	Coriander	14.19^{d} ±0.1	142.10^{b} ±7.6	1.83^{f} ±0.2	47.18^{d} ±2.9	50.03^{c} ±0.5
Pulses vegetables	Green beans	8.11^{k} ±0.1	34.38^{g} ±1.2	8.94^{ed} ±0.4	19.42^{f} ±2.2	40.12^{ed} ±1.6
	Peas	3.50^{l} ±0.1	38.67^{fg} ±2.47	9.45^{ed} ±1.18	12.65^{g} ±0.41	49.76^{c} ±3.45
	Tomato	9.69^{i} ±0.1	19.69^{h} ±2.6	7.46^{e} ±0.4	12.68^{g} ±0.4	14.23^{g} ±1.3
$LSD_{0.05}$		0.155	5.97	2.15	3.74	3.58

Means ± standard deviation (SD) on dry weight basis.

$^{a-i}$ Values with different superscript letters represent significant differences between results 5% level

Effect of some technological processes on trace elements content of some leafy vegetables:

A) Cooking process:

The results given in Table (2) demonstrated that cooking process decreased trace elements levels of leafy vegetables. Manganese recorded the highest lost during cooking in all studied leafy vegetables it was 64.56, 74.27 and 74.36% for spinach, cabbage and jew's mallow, respectively. However, this decrease was probably due to the leaching out of the metals into the liquid. These results are in good agreement with those obtained by Ilelaboye *et al.* (2013) ;Tumwet *et al.* (2013). The loss of minerals in the vegetables may be due to leaching effect during the cooking process Bwembya *et al.,* (2018).

B) Blanching and freezing process:

The results represented in Table (2) showed that the blanching process had the same effect as cooking on reducing some trace elements content of some leafy vegetables, but in a lower rate than those of cooking process. The same observations were reported by Kmiecik *et al.* (2007)

Also the results illustrate the effect of freezing processes on some trace elements content of some leafy vegetables. It can be seen that the loss in iron content of blanched spinach, cabbage and jew's mallow after six months of frozen storage was 25.9, 13.82 and 39.19%, respectively. While the loss of manganese was 20.73, 22.37 and 23.96%, respectively. The highest loss of copper in cabbage was 49.61%. This decrease was probably due to deterioration of the vegetable tissue and cells during the freezing storage period, with a high loss of exuded liquid during defrosting being the cause of this decrease (Moses *et al.,* 2013).

C) Refrigerating process:

From Table (2) it can be seen that the trace elements content were not affected by refrigerating process in compared with that of fresh leafy vegetables. Obtained results were fluctuated between a slight increase and decrease in spinach, jew's mallow cabbage. The content of iron, manganese and zinc were decreased in spinach, cabbage and jew's mallow. On the other hand the refrigeration process led to an increase in the copper content in spinach and cabbage. Similar finding was reported by Mudau *et al.* (2015); Oulai *et al.* (2015). These losses could be attributed to the respiration, transpiration phenomena during refrigeration, ethylene production and enzyme activity during storage Acho *et al.* (2015).

Table 2. Effect of some processes on trace elements content of some leafy vegetables (mg/kg on dry weight basis).

Vegetable Samples	Treatment	Ash %	Fe	Loss %	Mn	Loss %	Cu	Loss %	Zn	Loss %
Spinach	Fresh	22.64^{a}±0.1	163.23^{a}±4.9		1.58^{a}±0.1		113.54^{b}±0.8		66.49^{a}±2.2	
	Cooked	13.41^{e}±0.1	60.96^{d}±2.2	62.65	0.56^{e}±0.0	64.56	59.06^{d}±1.4	47.98	26.90^{d}±1.4	59.54
	Blanched	18.70^{c}±0.1	144.94^{b}±3.5	11.21	0.82^{c}±0.0	48.10	90.60^{c}±3.1	20.20	41.58^{b}±2.3	37.46
	Frozen	17.96^{d}±0.1	107.39^{c}±3.5	25.9	0.65^{d}±0.1	20.73	63.19^{d}±2.1	30.25	34.45^{c}±2.2	17.14
	Refrigerated	19.51^{b}±0.1	155.58^{a}±7.09	4.69	1.03^{b}±0.03	34.81	140.25^{a}±3.75	-23.52	62.58^{a}±5.93	5.88
	$LSD_{0.05}$	0.15	8.27		0.08		4.48		5.86	
Cabbage	Fresh	8.50^{b}±0.1	11.53^{a}±1		67.17^{a}±3.3		2.48^{a}±0.3		43.62^{a}±2.5	
	Cooked	4.50^{e}±0.1	5.47^{d}±0.3	52.56	17.28^{e}±0.8	74.27	0.57^{c}±0.1	77.02	29.08^{c}±0.7	33.33
	Blanched	5.71^{d}±0.1	9.40^{b}±0.2	18.47	54.92^{c}±1	18.24	1.29^{b}±0.2	47.98	38.21^{b}±2.3	12.40
	Frozen	6.39^{c}±0.1	8.10^{c}±0.2	13.82	42.63^{d}±1.3	22.37	0.65^{c}±0.0	49.61	36.28^{b}±2.9	5.05
	Refrigerated	8.89^{a}±0.1	9.37^{b}±0.9	18.73	60.77^{b}±2.4	9.53	2.73^{a}±0.3	-10.08	36.45^{b}±4.6	16.44
	$LSD_{0.05}$	0.18	1.14		3.60		0.38		5.25	
Jew's mallow	Fresh	11.49^{b}±0.1	118.69^{a}±5		15.56^{a}±1.5		8.76^{a}±0.1		24.33^{a}±1.1	
	Cooked	9.18^{d}±0.1	45.22^{c}±1	61.90	3.99^{e}±0.2	74.36	2.72^{d}±0.1	68.95	11.94^{d}±1.3	50.92
	Blanched	9.03^{d}±0.1	88.40^{b}±1.9	25.52	8.47^{c}±1.1	45.57	6.20^{b}±1	29.22	21.68^{b}±1.3	10.89
	Frozen	10.81^{c}±0.1	53.75^{c}±2.18	39.19	6.44^{d}±0.24	23.96	5.01^{c}±0.24	19.19	15.98^{c}±1.1	26.29
	Refrigerated	12.03^{a}±0.06	111.80^{a}±9.48	5.81	13.47^{b}±1.25	13.43	9.45^{a}±0.94	-7.3	23.22^{a}±0.31	4.56
	$LSD_{0.05}$	0.16	9.06		1.83		1.16		1.97	

Means ± standard deviation (SD) on dry weight basis.

$^{a-e}$ Values with different superscript letters represent significant differences between results at 5% level.

Effect of some technological processes on trace elements content of some pulses vegetables:

Cooking process:

The results presented in Table (3) show the effect of cooking process on the some trace elements content of fresh pulses vegetables. The loss of minerals varied among these vegetables under investigated. Iron content of all fresh pulses vegetables decreased after cooking from 34.38 to 26.25mg/kg and from 38.67 to 19.52mg/kg for green beans and peas, respectively. The data also indicated that the levels of manganese, copper and zinc decreased after cooking of green beans and peas. These results are in same trend with those reported by Lopez and Williams (2006). The loss of minerals in the vegetables may be due to leaching effect during the cooking process, culinary techniques can lead to the loss of micronutrients and toxic species by leaching mechanisms (Santos *et al.,* 2018).

Blanching and freezing process:

The result demonstrated in Table (3) showed that blanching lowered the trace elements content of all samples of pulses vegetables. The decrease in trace elements content varied among pulses vegetables under investigation. This decrease in some trace elements after blanching may be due the element being extracted into the liquid or blanching water (Lopez and Williams, 2006; Mepba *et al,.* 2007)

The results in Table (3) show that, the effect of freezing processes on some trace elements content of some pulses vegetables. Freezing resulted in a decreasing in iron, manganese, copper and zinc for both green beans and peas, where the loss in peas was higher than the loss in green beans. These results are in same trend with those reported with Amaro-Lopez *et al.* (1998); Polo *et al.* (1992). A deterioration of the vegetable tissue and cells during the freezing storage period was noted, with a high loss of exuded liquid during defrosting being the cause of this decrease.

Refrigeration process:

From the data in Table (3), Refrigeration process led to a decrease in the iron, copper and zinc content and a slight increase in the manganese content of the green beans, whilethe refrigeration process led to a decrease in the iron, manganese and zinc content and an increase in the copper content of the peas.

Table 3. Effect of processes on some trace elements content of some pulses vegetables (mg/kg on dry weight basis)

Sample	Treatment	Ash%	Fe	Loss %	Mn	Loss %	Cu	Loss %	Zn	Loss %
Green beans	Fresh	8.11^{a} ±0.1	34.38^{a} ±1.2		8.94^{a} ±0.4		19.41^{a} ±2.2		40.12^{a} ±1.6	
	Cooked	6.23^{d} ±0.1	26.25^{c} ±1.2	23.65	2.60^{d} ±0.2	70.92	10.39^{c} ±2.1	46.47	17.37^{c} ±0.6	56.70
	Blanched	6.53^{c} ±0.1	31.70^{b} ±1.5	7.80	5.80^{b} ±0.2	35.12	16.92^{ab} ±0.5	12.83	19.43^{c} ±1.2	51.57
	Frozen	6.79^{b} ±0.1	27.24^{c} ±1.1	14.06	3.68^{c} ±0.3	36.55	16.03^{b} ±0.7	5.26	18.52^{c} ±1.3	4.68
	Refrigerated	8.04^{a} ±0.05	33.77^{ab} ±1.06	1.77	9.02^{a} ±0.84	-0.89	18.61^{ab} ±0.82	4.12	40.04^{b} ±2.22	0.19
	$LSD_{0.05}$	0.141	2.22		0.81		2.64		2.71	
Peas	Fresh	3.50^{a} ±0.1	38.67^{b} ±2.47		9.45^{a} ±1.18		12.65^{a} ±0.41		49.76^{a} ±3.45	
	Cooked	3.10^{b} ±0.1	19.52^{d} ±0.5	49.52	1.46^{c} ±0.6	84.55	5.39^{c} ±0.4	57.39	16.80^{c} ±0.9	66.24
	Blanched	3.43^{a} ±0.06	32.53^{c} ±0.87	15.88	6.89^{b} ±0.75	27.09	8.60^{b} ±0.7	32.02	25.79^{b} ±1.7	48.17
	Frozen	3.43^{a} ±0.1	20.73^{d} ±1.8	36.27	2.52^{c} ±0.3	63.42	6.48^{c} ±1.1	24.65	19.09^{c} ±1.9	25.97
	Refrigerated	3.57^{a} ±0.06	37.58^{a} ±1.06	2.81	8.33^{a} ±0.78	11.85	13.76^{a} ±1.16	-8.77	49.28^{b} ±3.62	0.96
	$LSD_{0.05}$	0.14	2.74		1.40		1.49		4.62	

Means ± standard deviation (SD) on dry weight basis.

[a-d] Values with different superscript letters represent significant differences between results at 5% level

CONCLUSION

It could be concluded that changes in phenolic compounds and trace elements contents in certain vegetable crops have been affected by different domestic processing. Phenolic compounds were very sensitive to thermal treatment**,** which decrease significantly as affected by blanching and cooking processes of leafy and pulses vegetables. Moreover phenolic compound were slightly decrease at the first months of frozen storage, then it decreased gradually prolonged storage period. Blanching process had the same effect as cooking process on reducing the some trace elements content of some vegetables. Freezing also resulted in a decreasing in trace elements for both of leafy and pulses vegetables. In general, it was recommended that storing vegetables at a temperature of -18 to -22 °C for aperiod not exceeding 3 months to prevent the losing in bio active compounds (phenolic compound), trace elements and nutritional value.

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محتوي المركبات الفينولية والعناصر النادرة في بعض الخضروات المصرية الطازجة والمعامله

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الهدف من هذه الدراسة هو دراسة تقييم تأثير بعض المعاملات المنزلية على محتوي المركبات الفينولية و العناصر النادرة في بعض الخضروات التي تستهلك عادة في صعيد مصر.حيث تراوح إجمالي الفينولات الكلية في بعض الخضروات الورقية والجافة من ٦,٣١ إلى ٣٧,٦٣ مجم / جم مقدرة كحمض الجاليك. بينما كانت مستويات العناصر النادرة أعلى في الخضر الورقية منها في الخضر الجافة. ادت عمليات طهي الخضروات وسلقها في الماء إلي حدوث انخفاض في المحتوى الكلي للمركبات الفينوليه. كان الفقد في المركبات الفينولية طفيفًا في الأشهر الأولى من تخزين السبانخ ، ثم انخفض بشكل تدريجي أثناء التخزين بالتجميد لفترات طويلة اضافية. كما أدى تخزين الخضر الورقية والجافة تحت ظروف التبريد لفترات مختلفة إلى انخفاض كبير في محتوي TPCs. أيضا كان لعملية السلق نفس تاثير عملية الطهي في تقليل محتوى بعض العناصر النادرة لبعض عينات الخضروات قيد الدراسة ، ولكن بمعدل أقل من عملية الطهي. تمت دراسة تأثير عملية التجميد على محتويات العناصر لبعض الخضروات المختارة. أدت عملية التجميد إلى انخفاض في محتوي الحديد والمنجنيز والنحاس والزنك لكل من الفاصوليا الخضراء والبازلاء ، حيث كان الفقد في البازلاء أعلى من الفاصوليا الخضراء. لم يتأثر محتوى العناصر النادرة بعملية التبريد عند مقارنة النتائج بمثيلتها بالخضروات الورقية الطازجة. يمكن أن نستنتج من ذلك أن الإفراط في المعاملات المنزلية المختلفة للخضروات يمكن أن يؤدي إلى تأثير سلبي على محتواها من المركبات الفينولية والعناصر النادرة وقيمتها الغذائية.