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# EFFECT OF BLANCHING PROCESSES OF SOME VEGETABLES ON ASCORBIC ACID, CAROTENOIDS, AND IRON.

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## ABSTRACT

Nine fresh vegetables i.e., broccoli, fennel, cabbage, carrots, peas, green broad beans, potatoes, sweet potatoes, and spinach were used to estimate the effect of blanching processes on their content of ascorbic acid, total carotenoids (provitamin A) and iron contents. Ascorbic acid, carotenoids and iron content differ according to studied vegetable type and ranged from 19.3 - 118.2 , 3.05 – 13.78 and 1.36 – 4.06 mg/100g, respectively. Blanching techniques significantly decreased ascorbic acid, carotenoids and iron content for all the tested vegetables. Among the blanching methods, microwave recorded the highest ascorbic acid retention followed by steam – blanching, whereas boiling recorded the lowest values. The ascorbic acid retention in blanched vegetables ranged between 33.03 and 87.02%. Steam blanching was the most suitable method for carotenoids retention followed by pressure–steaming for all tested vegetables except for green broad beans and peas which retained more carotenoids with microwave blanching. Among the tested vegetables, peas and green broad beans had the highest carotenoids retention compared to the other vegetables. The retention of iron in blanched tested vegetables ranged from 58.62 to 86.98% of the original values. Microwave blanching resulted as the highest iron retention compared to the other methods followed in descending order by steaming, then pressure steaming, while boiling retained the lowest iron retention. The yield of blanched vegetables ranged between 81.6 and 110.3% and seemed to be influenced by the kind of vegetable rather than the blanching method.

## INTRODUCTION

Animal foods such as eggs, milk and liver, which are good sources of preformed vitamin A, are expensive. The poorer segments of the population are therefore depending upon plant foods, which provide β -carotene to meet their requirements of vitamin A. Vegetables are an indispensable component of a nutritionally adequate diet, as they generally contain low levels of fat and are good and rich sources of several vitamins, minerals and fibers. Most vegetables are inexpensive. Green leafy vegetables are major sources of vitamin A (as the precursor β -carotene), ascorbic acid, folic acid, calcium and iron. The vegetables are grown abundantly in most countries being easily and quickly cookable (**USDA, 1984** and **Gopalan *et al* 1999**).

β -Carotene accounts for more than 90% of total carotenoids in vegetables. In human beings β -Carotene not only serves as valuable source of vitamin A but also serves as a potent antioxidant, scavenging free radicals and quenching single oxygen. By this latter property β -carotene is understood to reduce the risk of development of certain types of cancer, cardiovascular and other diseases. Similar evidence also exists with regard to vitamin C. (**Bafidu, *et al* 1995**). As for iron, it is

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well known that iron deficiency anemia is a global nutritional problem, affecting nearly 1.78 billion people of which 358 million are from the developing world (**WHO, 1998).**

Iron deficiency has a massive economic cost, adding to the burden on the health system, affecting conjective performance of children and reducing adult productivity. Also, **Allen** and **Sablel (2001)** reported that, despite implementation of large scale nutritional intervention prophylaxis programmes, iron deficiency anemia still continues to be a public health problem in most developing countries.

It would be beneficial for population in which vitamin A, C and iron are public health problems to prepare their foods including vegetables, so that retention of these nutrients in the food is maximized. Cooking methods may affect the nutrient content of foods including vegetables. Generally vegetables are prepared in the home on the basis of convenience and taste preference rather than nutrient losses. Boiling in water is the most common cooking method for vegetables (**Lewis *et al* 1994).** Vitamins especially ascorbic acid, thiamin and folic acid are highly sensitive to thermal processing (**Reddy and Love, 1999**). Blanching results in leaching losses of nutrient such as vitamins especially ascorbic acid as well as iron **(Chun *et al* 2004 ;Koplik *et al* 2004).**

Several reports have documented the losses of β -carotene from vegetables during cooking procedures such as boiling, stewing, frying, blanching and pressure cooking, etc **Ogulensi** and **Lee, 1979; Bafidu *et al* 1995; Yadav** and **Sehgal, 1995& 1997).** Researchers have reported that, 5 to 78% of β-Carotene **(Gayathri *et al* 2004)** and from 9 to 67% of vitamin C. (**McErlain *et al* 2001** and **Kumari *et al* 2004**) were lost when various vegetables were prepared using different cooking techniques.

The present study aimed to estimate the true retention of some important nutrient i.e, β-carotene, ascorbic acid and iron as well as the yield value of some widely consumed vegetables blanched with different methods.

## MATERIALS AND METHODS

### Materials

### Vegetables collections

Nine cultivars of vegetables namely broccoli (*Brassica oleracea* var. italica), fennel (*Foeniculum vulgare* var. dules), cabbage (*Brassica oleracea* var. capitata), carrots (*Daucus carota* var. Sative), peas *(Pisum sativum),* faba beans (*Vicia faba),* potatoes (*solanum tuberosum*), sweet potatoes (*Ipomoea batatas)* and spinach (*Spinacia oleracea* var. inermis) were used in this study. These vegetables were purchased fresh from two different grocery at Giza through seasons of 2005 and 2006. Each vegetable item was visually checked for quality, sorted for similar appearance and washed gently. Random samples of each vegetable item were packed in polyethylene bags and stored over night at 4-5°C.

### Chemicals

All chemicals used in this study were of analytical grade and obtained from Sigma Chemical Co.

### Methods

### Vegetables preparation

Inedible portions were removed from each vegetable item, and the remained edible portions were cut into small pieces approximately equal size. From each vegetable sample, (300g) was randomly taken for each blanching process. Vegetable samples were analyzed for ascorbic acid, total carotenoids and iron (Fe) before and after blanching process as well as the yield of blanched vegetables.

### Blanching time

Vegetable samples were blanched by different methods namely boiling in water, steaming at 96-98°C, pressure steaming at 121°C, 1.5 bar and microwave for different periods (1-10 min). The optimal blanching time of vegetable items for different blanching method was estimated according to the achievement of overall acceptability being judged by ten panelists. The optimal blanching time based upon achieving the highest overall acceptability for each vegetable cultivar with any blanching method **(Table 1)** was used as a suitable condition for vegetable blanching process.

### Blanching processes

#### * Boiling blanching

300 g of each prepared vegetable were boiled in nine hundred ml of water in aluminum covered saucepan and the vegetables were blanched for the suitable time **(Table 1)**.

Table 1. Optimal blanching time (min.) for different vegetables based on the desirable overall acceptability

| | Optimal blanching time (min.) | | | |
|---|---|---|---|---|
| Vegetables | Boiling 100°C | Steaming | Pressure steaming | Microwave |
| Broccoli | 4 | 6 | 3 | 3 |
| Fennel | 4 | 6 | 3 | 3 |
| Cabbage | 4 | 6 | 3 | 3 |
| Carrots | 4 | 6 | 3 | 3 |
| Peas | 4 | 6 | 3 | 3 |
| Grain broad beans | 4 | 6 | 3 | 3 |
| Potatoes | 4 | 6 | 3 | 3 |
| Sweet potatoes | 4 | 6 | 3 | 3 |
| Spinach | 3 | 4 | 2 | 2 |

*** Steam blanching**

A suitable amount of water was boiled in a pan (to generate steam), then each prepared vegetable item (300g) was loaded in a suitable strainer and put over the pan and covered during heating. The steam passed through the chopped vegetables and the temperature was raised to 96-98°C for the suitable time **(Table 1)** to achieve the desirable overall acceptability.

*** Pressure – steam blanching**

A 300 g of each prepared vegetable were transferred to a suitable strainer and placed inside the blanching basket and subjected to the steam by autoclave at 121°C for suitable time **(Table 1)**.

*** Microwave blanching**

Each prepared vegetable (300 g) was transferred to a pan containing 900 ml water and placed in a microwave then blanched for the optimal time **(Table 1)** to get the desirable overall acceptability. Microwave used in this study was a household microwave oven (LG microwave, model MS-191 MC, 1000 W, 2450 MHZ).

Immediately after blanching processes, the blanched vegetables were put in colander for 10 min. to drain, then allowed to cool at room temperature for 5 min, weighed and stored at 5°C in polyethylene bags for one hour, then stored frozen until used for chemical analysis. Raw samples were treated similarly.

**Analytical methods**

Ascorbic acid was determined using 2.6 dichlorophenol-indophenol according to the method described by **Pearson (1976).**

Total carotenoids, iron (Fe) and moisture content were determined according to **AOAC (1995).** Yield of cooked vegetables was calculated from the weight of fresh and blanched samples.

From raw and blanched values, the true retention of these nutrients in the vegetables samples were calculated **(USDA, 1984).**

**Statistical analysis**

Data were statistically analyzed using analysis of variance and least significant differences (L.S.D) according to **Snedecor** and **Cochran, (1980).**

## RESULTS AND DISCUSSION

Moisture content, ascorbic acid, total carotenoids and iron (Fe) values of fresh tested vegetables are presented in **Table (2)**. The data show that, moisture content of the fresh studied vegetables are nearly similar ranged between 90.77 and 93.92% except potatoes and sweet potatoes which recorded the lowest value of about 86%,. On the other hand ascorbic acid values are widely differed among the tested vegetables according to the types and ranged from 19.3 to 118.2mg/100 g sample (w. basis), carrots recorded the lowest value, while

broccoli contained the highest one. As for the total carotenoids, the results of the current study herein have demonstrated that, potatoes contained the lowest value being 3.05 mg/100g, while carrots recorded the highest value being 13.78 mg/100 g (d.w. basis) , followed in a descending order by sweet potatoes (9.97 mg/100 g) and spinach (8.26 mg/100 g). The differences in carotenoids concentration are a result of different kind of tested vegetables. Results tabulated in **Table (2)** reveal that, iron content of the tested vegetables ranged from 1.36 mg/100 g (dry basis) for green board beans to 4.06 mg / 100 g in fennel, while iron concentration of other vegetables lies in between.

**Effect of blanching process on yield of vegetables**

The yield values of blanched vegetables are presented in **Table (3)**. The data show that, the yield of tested vegetables seems to be influenced by the kind of vegetable rather than the blanched method. The yield of blanched vegetables ranged from 81.6 to 110.3%. As can be seen, potatoes recorded the highest yield after blanching by any method ranged between 104.8 and 110.3% followed by sweet potatoes 102.97 – 107.1% while, broccoli, fennel and cabbage recorded lower yield 81.6 – 84.2%. The decreasing of yield of blanched vegetables except for potatoes and sweet potato would be attributed to leaching out of soluble solids into blanching solution. However, the increasing of potatoes and sweet potatoes yield may be justified by the high ability of starch for water absorption, since they contain a high amount of starch. Results of the current study are in accordance with **Lane *et al* (1986)** who found that the yield of blanched broccoli and sweet potatoes by boiling were 101% while it was 91% for spinach. Also, **Masrizal *et al* (1997)** stated that the yield of microwave – steam blanched green beans and spinach were 88.0 and 84.8% in succession while it was 97.0 and 89.4% for boiling blanching, respectively.

Results presented in **Table (3)** ascertain that, no significant differences in yieldwere detected between microwave and steam blanching for any tested vegetables. Also, it could be observed that the yield of broccoli was not affect significantly by the method of blanching. No significant differences were detected in the yield of fennel blanched by boiling, steaming and pressure – steaming or when blanched by steaming, pressure – steaming and microwave. Moreover, blanching of vegetables in the following categories either by boiling or pressure – steaming didn't show any significant differences, (broccoli, fennel, cabbage); (carrots, peas, green broad beans); (potatoes and sweet potatoes).

**Effect of blanching on ascorbic acid content of tested vegetables**

The retention values of ascorbic acid for the tested vegetables blanched by different methods were determined and the data are presented in **Table (4)**. The data reveal that, blanching methods caused a highly significant reduction in ascorbic acid for all tested vegetables Among the blanched methods, microwave recorded the highest ascorbic acid retention followed by steam blanching, whereas boiling blanching recorded the lowest retention. The retention of ascorbic acid in the tested blanched vegetables ranged between 33.03% for boiled spinach and 87.0% for microwave blanched potatoes, while other blanched vegetables lies in between. These results are in agreement with those reported by **Chun *et al* (2004)** and **Koplik *et al* (2004)** who stated that, blanching of vegetables caused blanching losses of nutrients such as vitamins especially vitamin C. Also, **Reddy and Love (1999)** stated that, the main mechanisms of vitamin C losses appeared to be due to water solubility and mass transfer, heat sensitivity and enzymatic oxidation.

Also, it could be seen that, the ascorbic acid retention for each kind of vegetable differed significantly according to the blanching methods except for spinach blanched by microwave or steaming. It could be observed that, the retention values of ascorbic acid differed significantly between vegetables blanched by the same methods except those included in the following categories, (broccoli, cabbage and carrots), (peas and sweet potatoes) with boiling blanching; (broccoli, fennel, cabbage and carrots) with pressure – steaming; (broccoli and fennel), (fennel, cabbage and carrots), (peas and green broad beans) with steam blanching, while in case of microwave blanching being (fennel, cabbage and carrots), and (broccoli, fennel and cabbage).

The present results are in agreement with the those obtained by **Mc Eralin *et al* (2001)** and **Kumari *et al* (2004)** who found that the loss of vitamin C from vegetables caused by different blanching method ranged from 9 to 67%. Also, **Quenzer and Burns (1981)** stated that, microwave blanching for spinach was superior in retention of ascorbic acid then steam or boiling water method. **Mathooko** and **Imungi (1994)**, reported

Table 2. Some chemical constituents of fresh tested vegetables

| Constituent / Vegetable | Moisture content % | Ascorbic acid mg/100 g* | Total carotenoids mg/100g** | Iron (Fe) mg/100 g** |
|---|---|---|---|---|
| Broccoli | 93.18 | 118.2 | 5.74 | 2.45 |
| Fennel | 93.55 | 44.27 | 6.13 | 4.06 |
| Cabbage | 93.92 | 54.5 | 5.02 | 3.27 |
| Carrots | 92.00 | 19.3 | 13.78 | 1.79 |
| Peas | 93.83 | 46.7 | 3.66 | 2.88 |
| Green broad beans | 90.77 | 39.1 | 4.37 | 1.36 |
| Potatoes | 86.30 | 26.14 | 3.05 | 2.19 |
| Sweet potatoes | 86.11 | 38.61 | 9.97 | 3.62 |
| Spinach | 93.03 | 57.6 | 8.86 | 2.91 |

*: on wet basis **: on dry basis

Table 3. The yield of blanched vegetables using different blanching method

| Blanching method / vegetables | Boiling water | Pressure steaming | Steaming | Microwave | L.S.D. 5% |
|---|---|---|---|---|---|
| Broccoli | 82.90 $^{Da}$ | 83.00 $^{Ea}$ | 82.80 $^{Ea}$ | 83.00 $^{Ga}$ | 1.595 |
| Fennel | 83.10 $^{Da}$ | 82.50 $^{Eab}$ | 81.90 $^{Eab}$ | 81.60 $^{Hb}$ | 1.325 |
| Cabbage | 84.17 $^{Da}$ | 83.50 $^{Ea}$ | 82.00 $^{Eb}$ | 81.83 $^{Hb}$ | 1.159 |
| Carrots | 100.30 $^{BCa}$ | 98.20 $^{Bb}$ | 97.80 $^{Bb}$ | 97.73 $^{Cb}$ | 1.507 |
| Peas | 95.00 $^{BCa}$ | 94.33 $^{Cab}$ | 93.47 $^{Cb}$ | 93.20 $^{Db}$ | 1.279 |
| Green broad beans | 96.00 $^{BCa}$ | 95.10 $^{Cab}$ | 93.60 $^{Cbc}$ | 92.00 $^{Ec}$ | 1.622 |
| Potatoes | 102.97 $^{ABa}$ | 107.10 $^{Aa}$ | 105.30 $^{Aa}$ | 103.10 $^{Ba}$ | 12.304 |
| Sweet potatoes | 110.30 $^{Aa}$ | 108.00 $^{Ab}$ | 106.00 $^{Ac}$ | 104.80 $^{Ac}$ | 1.412 |
| Spinach | 93.33 $^{Ca}$ | 92.00 $^{Db}$ | 91.00 $^{Dbc}$ | 90.00 $^{Fc}$ | 1.143 |
| L.S.D. 5% | 7.612 | 1.211 | 0.974 | 1.098 | |

Mean separation by Duncan's multiple range, $P \leq 0.05$.
Capital letters for vertical comparison (cultivars), while small letters for horizontal comparison (treatments)
Means within rows or column having different superscript are significantly different

Table 4. Effect of blanching methods on the retention of ascorbic acid of some vegetables

| Blanching method / vegetables | Boiling | Pressure steaming | Steaming | Microwave | L.S.D. 5% |
|---|---|---|---|---|---|
| Broccoli | 38.63 $^{Dd}$ | 43.26 $^{Ec}$ | 63.31 $^{Db}$ | 67.20 $^{Ea}$ | 1.571 |
| Fennel | 36.20 $^{Ed}$ | 44.06 $^{Ec}$ | 64.00 $^{CDb}$ | 67.91 $^{DEa}$ | 1.661 |
| Cabbage | 39.82 $^{Dd}$ | 44.92 $^{Ec}$ | 64.92 $^{Cb}$ | 68.00 $^{DEa}$ | 1.921 |
| Carrots | 40.09 $^{Dd}$ | 45.06 $^{Ec}$ | 65.23 $^{Cb}$ | 69.12 Da | 0.922 |
| Peas | 52.34 $^{Bd}$ | 60.01 $^{Cc}$ | 70.34 $^{Bb}$ | 79.80 $^{Ba}$ | 2.187 |
| Green broad beans | 49 52 $^{Cd}$ | 58.09 $^{Dc}$ | 69.10 $^{Bb}$ | 78.00 $^{Ca}$ | 1.624 |
| Potatoes | 55.65 $^{Ad}$ | 65.01 $^{Ac}$ | 78.98 $^{Ab}$ | 87.02 $^{Aa}$ | 1.702 |
| Sweet potatoes | 53.00 $^{Bd}$ | 62.01 $^{Bc}$ | 78.00 $^{Ab}$ | 86.23 $^{Aa}$ | 1.698 |
| Spinach | 33.03 $^{Fc}$ | 40.68 $^{Fb}$ | 60.63 $^{Ea}$ | 62.63 $^{Fa}$ | 2.450 |
| L.S.D. 5% | 1.711 | 1.776 | 1.516 | 1.535 | |

Mean separation by Duncan's multiple range, $P \leq 0.05$.
Capital letters for vertical comparison (cultivars), While small letters for horizontal comparison (treatments).
Means within rows or column having different superscript are significantly different.

that, boiling green leafy vegetables in water for 20 min. led to vitamin C loss of 75-89%.

**Effect of blanching of vegetables on carotenoids**

The data presented in **Table (5)** show that all blanching techniques used in this study caused highly significant reduction in carotenoids in the tested vegetables. Also, it could be observed that boiling blanching recorded the highest loss in carotenoids ( the lowest retention) compared to other blanching methods for all studied vegetables. Meanwhile, steam blanching recorded the highest carotenoids retention for all tested vegetables, but no significant differences was detected in carotenoids retention of peas or green broad beans when blanched with steam or microwave. The carotenoids retention of blanched vegetables ranged between 52.39 and 77.34% for all blanching methods. The results reported herein are confirmed by those obtained by several investigators, **Yadav** and **Sehgal (1995)** observed a greater reduction in β -Carotene in dried, blanched and cooked spinach and amaranth leaves. Also, **Mosha *et al* (1997)** stated that, conventional blanching and cooking resulted in significant ($P < 0.05$) decrease in the concentration of α, β -Carotene and total provitamin A in amaranth leaves. **Speek *et al* (1988)** found that, the retention of β -Carotene in swamp cabbage and vine spinach were 50%and 89% after boiling blanching, respectively. Also, **Bafidu *et al* (1995)** found that, β - carotene (mg/100g) in fresh pumpkin was 98.8, wherease after blanching being reduced to 86.3% for steam-blanching and 83.8% for water blanching. **Kidmose** and **Martens (1999)** mentioned that, a significant higher carotene content was obtained by microwave blanching of carrots than boiling or steam – blanching. Recently, **Gayathri *et al* (2004)** reported that, the high sensitivity of β -carotene to light and heat is well recognized and its loss is therefore expected during heat processing. They found higher losses of β -carotene occurred during open pan boiling of leafy vegetables – amaranth and drum stick leaves (50-60%) than on pressure – cooking (27-32%). This could be attributed to the higher oxidative destruction of β -carotene in the open heating system. Thus pressure – cooking is preferable for processing to boiling with regard to β -carotene retention in green leafy vegetables.

Regarding the vegetable variety, it could be observed that, peas and green broad beans recorded the highest carotenoids retention with any of blanching methods compared to the other tested vegetables. Also, it could be noticed that, the carotenoids retention values differed significantly for each kind of vegetables according to the blanching method except for those included in the following groups, fennel blanched with microwave or boiling; carrots blanched by microwave or pressure

Table 5. Effect of blanching with different methods on retention of carotenoids of some vegetables

| Blanching methods / Vegetables | Boiling water | Pressure steaming | Steaming | Microwave | L.S.D. 5% |
|---|---|---|---|---|---|
| Broccoli | 52.93 $^{Dc}$ | 61.00 $^{Db}$ | 66.95 $^{Ca}$ | 54.52 $^{Dc}$ | 1.857 |
| Fennel | 52.39 $^{Dc}$ | 60.95 $^{Db}$ | 67.01 $^{Ca}$ | 54.01 $^{Bc}$ | 1.801 |
| Cabbage | 53.21 $^{Dd}$ | 61.05 $^{Db}$ | 67.31 $^{Ca}$ | 54.92 $^{Dc}$ | 1.648 |
| Carrots | 56.34 $^{BCc}$ | 62.34 $^{CDb}$ | 71.92 $^{Ba}$ | 63.75 $^{Bb}$ | 1.540 |
| Peas | 57.69 $^{Bc}$ | 73.05 $^{Ab}$ | 75.63 $^{Aa}$ | 77.09 $^{Aa}$ | 1.474 |
| Green broad beans | 60.12 Ac | 73.63 $^{Ab}$ | 76.12 $^{Aa}$ | 77.34 $^{Aa}$ | 1.769 |
| Potatoes | 56.91 $^{BCd}$ | 64.31 $^{Bb}$ | 71.01 $^{Ba}$ | 60.34 $^{Cc}$ | 1.657 |
| Sweet potatoes | 55.34 $^{Cc}$ | 63.21 $^{BCb}$ | 73.34 $^{Ba}$ | 64.32 $^{Bb}$ | 1.587 |
| Spinach | 57.62 $^{Bd}$ | 63.93 $^{BCb}$ | 71.34 $^{Ba}$ | 61.00 $^{Cc}$ | 1.834 |
| L.S.D. 5% | 1.597 | 1.538 | 1.579 | 1.440 | |

Mean separation by Duncan's multiple range, $P \leq 0.05$.
Capital letters for vertical comparison (cultivars), whiles small letters for horizontal comparison (treatments).
Means within rows or column having different superscript are significantly different.

steam; peas blanched with microwave or steam; green broad beans blanched with microwave or stream and sweet potatoes blanched with microwave and pressure – steam. No significant differences in carotenoids retention were detected between vegetables in the following categories when blanched by, boiling, (broccoli, fennel, cabbage), (carrots, peas sweet potatoes and spinach), (carrots, Potatoes and sweet potatoes), (Peas and green broad beans), (potatoes sweet potatoes and spinach), (carrots, sweet potatoes and spinach); steam-blanching (broccoli, fennel and cabbage) (peas and green broad beans) and microwave blanching, (broccoli, fennel, cabbage) (carrots and sweet potatoes), (potatoes and spinach) and (Peas and green broad beans).

It could be observed that, the carotenoids retention of broccoli, cabbage and fennel was affected mainly by the blanching method rather than the kind of vegetables.

**Effect of blanching of vegetables on the retention of iron**

Results of the current study as shown in **Table (6)** demonstrate that all the used blanching techniques caused a distinct reduction in iron concentrations of the tested vegetables. The retention of iron ranged between 58.62 and 86.98% of the original content. The decrement of iron in blanched vegetables may be due to leaching out into the blanching water as stated by **Masrizal *et al* (1997), Kidmose** and **Martens (1999)** and **Koplik *et al* (2004)** who demonstrated that, great losses of minerals from vegetables were possible by leaching into blanching water especially in chopped ones (more surface area was contact with water).

The data tabulated in **Table (6)** reveal that, microwave blanching was the most effective blanching techniques for iron retention in all vegetables compared to the other methods followed in a descending order by steaming, then pressure – steaming, while boiling in water retained the lowest iron values. The present results are in the same trend with the data obtained by **Kimura** and **Itokawa (1990)** who reported mean cooking losses of iron of 48.2 and85.9% for spinach which was quick heat – mircowaved and 2 min. boiled, respectively. Also, **Esmat** and **Azza (2005)** who recorded lower iron retention values for leafy blanched vegetables being 46.8, 47.7 and 71.7% for boiling, steam pressure and microwave blanching, respectively. Also, our results are confirmed by the results obtained by **Mina** and **Myung (1996)** who mentioned that boiling of leafy vegetables greatly reduced their mineral contents. They added that, mineral retention was highest when the leafy vegetables were cooked by steaming or microwave method. Moreover, the present results are

Table 6. Effect of different blanching methods on iron retention of some vegetables

| Blanching method / Vegetables | Boiling | Pressure steaming | Steaming | Microwave | L.S.D. 5% |
|---|---|---|---|---|---|
| Broccoli | 62.82 $^{Ad}$ | 69.62 $^{Bc}$ | 74.93 $^{Bb}$ | 81.01 $^{Ca}$ | 1.671 |
| Fennel | 62.34 $^{Ad}$ | 69.34 $^{Bc}$ | 74.82 $^{Bb}$ | 80.95 $^{Ca}$ | 1.690 |
| Cabbage | 63.09 $^{Ad}$ | 70.21 $^{Bc}$ | 75.34 $^{Bb}$ | 81.06 $^{Ca}$ | 1.833 |
| Carrots | 62.00 $^{Ad}$ | 69.01 $^{Bc}$ | 74.71 $^{Bb}$ | 81.02 $^{Ca}$ | 1.471 |
| Peas | 62.93 $^{Ad}$ | 76.00 $^{Ac}$ | 80.01 $^{Ab}$ | 86.98 $^{Aa}$ | 1.846 |
| Green broad beans | 63.12 $^{Ad}$ | 76.53 $^{Ac}$ | 80.23 $^{Ab}$ | 86.93 $^{Aa}$ | 1.876 |
| Potatoes | 62.91 $^{Ad}$ | 75.09 $^{Ac}$ | 79.73 $^{Ab}$ | 85.01 $^{Ba}$ | 1.752 |
| Sweet potatoes | 63.00 $^{Ad}$ | 75.93 $^{Ac}$ | 79.92 $^{Ab}$ | 85.34 $^{Ba}$ | 2.134 |
| Spinach | 58.62 $^{Bd}$ | 62.34 $^{Cc}$ | 66.09 $^{Cb}$ | 73.02 $^{Ba}$ | 1.250 |
| L.S.D. 5% | 1.349 | 1.842 | 1.646 | 1.463 | |

Mean separation by Duncan's multiple range, $P \leq 0.05$.
Capital letters for vertical comparison (cultivars),while small letters for horizontal comparison (treatments).
Means within rows or column having different superscript are significantly different.

in a good agreement with those obtained by **Masrizal *et al* (1997)** who found that, the iron retention of some blanched vegetables ranged from 57.4 to 81.9 %when blanched with different methods. The different blanching techniques for the tested vegetables caused a significant differences in iron retention of these vegetables. Also, it could be noticed that, among the studied blanched vegetables, spinach had the lowest iron retention which differed significantly with the other blanched vegetables. Meanwhile, no significant differences in iron retention were detected between vegetables blanched by boiling water. Moreover, steaming or pressure – steaming blanching resulted no signifi cant differences in iron retention between vegetables included in followed categories (broccoli, fennel, cabbage and carrots), (peas, grain broad beans, potatoes and sweet potatoes) and the latter group was significantly higher in iron retention than the former group. As for the microwave blanching, the data show that grain broad beans and peas significantly retained more iron compared to the other microwave blanched vegetables, followed by potatoes and sweet potatoes then broccoli, fennel, cabbage and carrots, while no significant difference was detected in iron retention between vegetables in each above mentioned categories.

From the results in the present study, it could be recommended that blanching vegetables by microwave was the most suitable method followed by steam blanching for maximizing the retention of the important nutrients such as ascorbic acid, carotenoids and iron. Also this investigation ascertained that boiling blanching was not suitable in this respect.

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حوليات العلوم الزراعية
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# تأثير عمليات السلق لبعض الخضروات على حمض الأسكوربيك ، الكاروتينات والحديد

## [٢٨]

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تم دراسة تأثير عملية السلق بعدة طرق على ٩ أنواع من الخضروات، وهى البروكلى، الشمر، الكرنب ، الجزر ، البسلة ، الفول الأخضر ، البطاطس، البطاطا والسبانخ على محتواها من حمض الأسكوربيك والكاروتينات الكلية (مولد فيتامين A) والحديد.

وقد اختلف تركيز حمض الأسكوربيك والكاروتينات الكلية والحديد فى العينات الطازجة تبعا لنوع الخضر وتراوح بين (١٩,٣ - ١١٨,٢) ، (٣,٠٥ - ١٣,٧٨) ، (١,٣٦ - ٤,٠٦) ملجم/١٠٠ جم عينة على الترتيب.وقد أدت عمليات السلق جميعها إلى خفض معنوى كبير فى كل المكونات سابقة الذكر لكل أنواع الخضر محل الدراسة.وكانت طريقة السلق بالميكروويف هى أكثر الطرق المستخدمة محافظة على حمض الأسكوربيك تلتها السلق بالبخار فى حين كانت طريقة السلق بالغليان هى اكثر الطرق فقدا للفيتامين. هذا وتراوحت نسبة المتبقى من حمض الأسكوربيك للخضروات المستخدمة محل الدراسة بين ٣٣,٠٣ - ٨٧,٠٢%. وكانت طريقة السلق بالبخار أكثرالطرق مناسبة فى الحفاظ على الكاروتينات تلتها السلق بالبخار والبخار تحت ضغط لكل الخضروات فيما عدا الفول الأخضر والبسلة حيث تفوقت معهم طريقة السلق بالميكروويف. ومن بين كل الخضروات موضوع الدراسة كانت البسلة والفول الأخضرهى أكثر الخضر محافظة على الكاروتينات مع كل طريقة من طرق السلق - تراوحت نسبة المتبقى من الحديد فى الخضروات المدروسة بعد السلق بين ٥٨,٦٢ - ٨٦,٩٨% من الكمية الأصلية. وكانت أكثر طرق السلق محافظة على الحديد هى الميكروويف تلتها بترتيب تنازلى السلق بالبخار ثم البخار تحت ضغط فى حين كانت طريقة السلق بالغليان هى أقل الطرق فى الحفاظ على الحديد. كذلك تراوحت نسبة الناتج من الخضر بعد السلق بين ٨١,٦ - ١١٠,٦% ويبدو أن نسبة الناتج تأثرت بنوع الخضر اكثر منها بطريقة السلق نفسها.

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