Effect of different cooking methods on some quality attributes of green pea and spinach

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ABSTRACT

Effect of cooking methods (boiling, microwave oven, steaming and pressuring) on some quality attributes including firmness, chlorophyll *a*, *b*, gross chemical composition, mineral contents, ascorbic acid, total phenolics, carotenoids and organoleptic properties of green peas and spinach leaves were estimated. Cooking methods change the content of vegetables according to the type of process which effect on material quality. However, the firmness period of pressure processing was the lowest one (5 min.) in tested samples compared with other processes. Chlorophyll *a* and *b* were higher after steam processing (13.31 and 2.99 mg/100g, respectively) for peas, while they were higher for spinach treated by microwave oven (76.37 and 24.83 mg/100g), respectively. Chlorophyll contents of pressure samples were the lowest one of other tested methods. Microwave oven treatment had the lowest decrement on ascorbic acid, phenolic compounds and carotenoids, which consider a natural antioxidant. In case of boiling, the loss of tested antioxidants were the highest. The loss in gross chemical composition was highest in case of pressure processing, while the gross chemical composition of treated vegetables with steaming process had the lowest decrement compared with other cooking methods. All samples were rich in Ca/P and K/Na ratio that suitable for bone formation and decreasing the blood pressured. Steaming method had the highest amount of minerals and the lowest were found in treated samples with pressure method. Also, copper was not found after cooking in all peas samples while, it was found (in trace amount) after cooking of spinach samples. The overall acceptability of steamed green peas and spinach leaves were found to be the best and more suitable as cooking method compared with other tested processes. The study recommended that, use of cooking methods in case of peas were as follow: microwave oven > steaming > boiling or pressuring. In case of spinach they were: microwave oven or steaming > boiling > pressuring. Mostly, the loss in nutritional values are high when use of pressuring method that could be, indicated that, the commercial sterilization will cause a high decrement on nutritional quality. However, types of cooking method cause different effects on cooked vegetables according to the kind of vegetables and it's content of nutrients.

Keywords: cooking methods, peas, spinach, chlorophyll, antioxidants

INTRODUCTION

There is substantial evidence for the role of diets in the prevention of many diseases (Link and Potter, 2004). Fruits and vegetables are considered particularly protective to their contents of phytochemicals. These naturally occurring compounds (such as minerals, carotenoids, polyphenols and vitamins, etc..) have attracted great attention from the scientific community for their antioxidants properties and their implication in a variety of biological mechanism at the base of degenerative processes (Kaur and Kapoor, 2001).

Most vegetables are commonly cooked before being consumed. It is known that cooking induces significant changes in chemical composition, influencing the concentration and bioavailability of bioactive compounds in vegetables. However, both positive and negative effects have been reported depending upon differences in process conditions, morphological and nutritional characteristics of vegetable species (Miglio *et al*, 2008). Physical properties of vegetables are also greatly affected by cooking methods (Turkmen *et al*, 2006). Texture and color are considered very important parameters in the cooking quality of vegetables, and they may strongly influence consumer purchases of these food items.

Green peas (*Pisum sativum L.*) have a nutritionally favorable composition with respect to macronutrients. They have a low fat content and high fiber and protein contents (Anon, 2002). Spinach (*Spinacia oleracea L.*) was studied by Kuti and Kuti., (1999), they found that, crude protein, ash, fat and crude fiber of raw spinach were 3.2, 1.9, 0.4 and 0.9% (as wet weight), respectively. Horvate, (1985) indicated that, moisture, crude protein, fat, crude fiber and carbohydrate contents of spinach were 94, 2.90, 0.4, 0.512 and 2.7% (as wet weight), respectively.

Cooking methods and other ways of processes improve nutritional value of legumes. Mineral contents of legume seeds is distinctive when compared to other food plant origin (Varo, *et al.*, 1980). On the other hand, the minerals analysis of spinach indicated a high concentration of iron, calcium, magnesium, sodium and potassium compared with lettuce (*lactuca sativa*) (Ruben *et al.*, 2006).

Chlorophyll *a* and *b* have been shown to be the main compounds responsible for the green color of vegetables (Schwartz and Von Elbe, 1983). Furthermore, the properties of chlorophyll in green tissues may depend on the nature of its association with lipoprotein of the chloroplast. Disruption of the chlorophyll structure can not take place until the membrane array of chlorophyll has been disorganized (Haisman and Clarke, 1975). Chlorophyll degradation in dehydrated foods is likely to occur at high water activity (a_w, water available for chemical reactions) or

low a_w (mechanism linked to nonenzymic browning or to lipid oxidation) (Lajollo and Lanfer-Marquez, 1982).

Increased intake of vegetables are generally associated with a reduce risk of cancer and cardiovascular diseases (Kris-Etherton *et al.*, 2002). This association is based on the present of different phytochemicals in vegetables with either potential or proven beneficial effects on human health, like carotenoids and phenolic acids (Mattila and Kumpulainen, 2002). Processing and preparation, especially thermal treatments, which are applied prior to consumption, may affect these phytochemicals. Andrea, *et al.*, (2008) found that, total phenolic contents in the fresh spinach were 2088 mg/kg (as dry weight) and after boiling to 10 min. it was 1067.4 mg/kg. Also, he reported that, carotenoid contents were decreased from 223 to 243.6 mg/kg after thermal treatments of spinach samples.

Thermal processing techniques emphasize the achievement of commercial sterility while minimizing changes in nutritional values and eating quality. However, no matter how minimal the heating source is, thermal processing can promote reactions that could affect overall quality of foods. Quality loss involves both subject factors like taste that cannot be readily quantified and quantifiable factors such as nutrient degradation. (Awuah, *et al.*, 2007). It is a common practice that most of the vegetables are cooked by a simple boiling processes before use. However, pressure and microwave oven are also being used for this purpose. Cooking bring about a number of changes in physical characteristics and chemical composition of vegetables and other food materials. (Rehman, *et al.*, 2003).

This study was undertaken to investigate the effect of cooking methods such as boiling, microwave oven, steaming and pressuring on the quality attributes of green peas (*Pisum sativum L.*) and spinach (*Spinacia oleracea*) as a popular vegetables in Egypt.

MATERIALS AND METHODS

Materials:

Fresh vegetables (Peas and Spinach) were purchased from the local market at Kafr El-Sheikh City, Egypt.

Methods:

Cooking of vegetables:

Edible part of vegetables were properly chopped with the help of a sharp knife and then cooked by different processing in triplicate, as follows: Ordinary cooking (Boiled at 100 °C); Microwave oven (Electra EM-230, 220-240 volt, 800 W.) at 100 °C; steaming (at 121°C) and autoclave pressuring at 15 lbs/inch^2 (at 121°C). The chopped vegetables

were put in flat bottom beakers, tap water (1g : 4 ml) was added, beakers top were covered with aluminum foil except steaming then the samples were cooked. Processed vegetables were ground in a sieve to pass the through a 40-mesh sieve before chemical analysis. All laboratory treatments were done in central laboratory of Kafrelsheikh University.

1. Vegetables firmness:

Vegetables firmness (kg/mm^2): was determined thrice at raw and after cooking processes of samples by Maguns pressure tester. (A.O.A.C, 1990).

2. Chemical analysis:

2.1. Gross chemical compositions:

Moisture, ash, ether extract, crude protein, crude fiber and non protein nitrogen were determined according to the methods of A.O.A.C.(1990). Carbohydrate were determined by differences 100 - (ash + ether extract + crude protein + crude fiber).

2.2 Mineral contents:

Total soluble salts, was determined in water extract according to Page, (1982). 0.5 g of samples were digested in 10 ml of H_2SO_4 and 1 ml perchloric acid in a conical flasks (A.O.A.C, 1990). Phosphorus was determined according to Carter, (1993). Calcium, sodium and potassium were determined by Sherwood, flame photometer,410 according to Black, (1983). Total Fe, Zn, Pb, Mn and Cu were determined using atomic absorption spectrophotometer technique using unit GBC (mode Avanta) as given by Chapman and Pratt (1961).

2.3. Total phenolic compounds:

Total phenolic compounds were extracted from 5g samples according to the method described by Rodringuezde Sotillo *et. al.*, (1994) using methanol 95% under cooling at 4°C and added 0.5 ml of Folin-Denis regent.

Total phenolic compounds were determined calorimetrically according to the method outlined by Swain and Hillis, (1959) using (spectrophotometer JENWAY 6100) at 725 nm. Calibration required for evaluation was carried out using standard tannic acid solution having concentration between 10 to 100 µg.

2.4. Ascorbic acid content:

Ascorbic acid content (as mg/100g fresh weight) was determined by titration using 2,6 dichlorophenolindophenol (2,6 D) blue dye, as given by (Cox and Peasons, 1962).

2.5. Photosynthetic pigments:

Leaf pigments, chlorophyll *a, b* and carotenoids of samples were determined as described by Wettestein, (1957) using spectrophotometer (UNICO 1200). Concentration of chlorophyll *a, b* and carotenoids, respectively in samples were calculated as follows:

$$\text{Chl. a} = 9.784 \times E_{662} - 0.99 \times E_{644} \quad \text{mg/gm}$$

$$\text{Chl. b} = 21.426 \times E_{644} - 4.65 \times E_{662} \quad \text{mg/gm}$$

$$\text{Carot.} = 4.695 \times E_{440.5} - 0.268 (\text{Chl. a} + \text{Chl. b}) \quad \text{mg/gm}$$

Chl. a, Chl. b and carot. = concentration of chlorophyll a, b and carotenoids, respectively. E = optical density at the wave length indicated.

3. Organoleptic qualities evaluation:

Color, odor, texture, taste and appearance of peas and spinach samples after cooking by different methods were evaluated by ten panelist. It was used a 10 point scale for grading the quality of cooked samples, according to the following numerical system: excellent (10 – 8.5); very good (8.49 – 7.5), good (7.49 – 6.5); average (6.49 – 5); bad (less than 5 - 4.49) and very bad less than 4.5. Scoring of these qualities was carried out according to Dutche and Wirschaflich, (1973).

4. Statistical analysis:

The data were statistically analyzed using the analysis of variance and the means were further tested using the least significant difference test as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Effect of cooking methods and periods on firmness of green peas and spinach leaves:

Effect of cooking methods on shear force which indicated to texture, of green peas and spinach leaves are shown in Table (1). The degree of firmness was induced after processing for all cooking methods as referred to the raw vegetables. Shear force of green peas take a longer time to be less than 100 (kg/mm^2) than that of spinach leaves. Furthermore, the times which need to make the share force less than 100 (kg/mm^2) were different according to the type of treatments and the kind of vegetables. However, pressured cooking treatment take the lowest time (5 min.) to be the samples firmness less than 100 (kg/mm^2), followed by steamed (15 min. in green peas and 10 min. in spinach leaves), at last, the boiled green peas (20 min.) and the spinach leaves (15 min.). Krokida and Maroulis, (2001) indicated that texture is one of the important characteristic indicating product quality and its properties are usually

related to mechanical test, which examine the viscoelastic behavior of the material. Miglio *et al.*, (2008) noticed that boiled vegetables by all the cooking methods which they used (Boiling, steaming and frying) were lower shear force (higher degree of softness > 96%). On the other hand, the same table indicates that the weight of tested vegetables were increased after processes. The lowest increment was found after steamed method follow by microwave oven then pressuring and boiling of both green peas and spinach leaves, respectively. Moreover, observation vision clear that, cooking methods that induce the firmness of tested vegetables and increased the samples weight and led to mechanical tissues damage as affected by types of cooking methods processing.

Table (1): Effect of different cooking methods period on firmness and weight changing of green peas and spinach leaves.

Vegetables	*Green peas*				*Spinach leaves*			
Treatments / *Periods (min.)*	*Boiled*	*Microwave oven*	*Steamed*	*Pressured*	*Boiled*	*Microwave oven*	*Steamed*	*Pressured*
	Firmness (kg/mm²)				*Firmness (kg/mm²)*			
Zero time	200	200	200	200	165	165	165	165
5	150^{d}	140^{c}	130^{b}	*	140^{c}	120^{b}	120^{b}	*
10	130^{c}	110^{a}	120^{b}	*	120^{b}	*	*	*
15	120^{b}	*	*	*	*	*	*	*
20	*	*	*	*	*	*	*	*
Weight changes g/100g	$+4.62^{d}$	$+2.01^{b}$	$+1.31^{a}$	$+3.34^{c}$	$+4.89^{d}$	$+2.01^{b}$	$+1.29^{a}$	$+2.28^{c}$

** = less than 100 (Kg/mm²)*

Each value was an average of three determinations

Values followed by the same letter in row are not significantly different at < 0.05

2. Effect of cooking methods on gross chemical composition of green peas and spinach leaves:

Table (2) tabulates the gross chemical composition of raw and cooked green peas and spinach leaves. It could be observed that, moisture, ether extract and ash contents were higher in spinach leaves compared to those of green peas. Souci *et al.*, (2000) found that, gross chemical composition of raw peas were 75.2, 6.55, 1.05, 0.48, 4.25 and 12.3 % for moisture, crude protein, total nitrogen, fat, total dietary fiber and available carbohydrates, respectively. Also, they found that, the same contents of raw spinach were 91.5, 2.65, 0.42, 0.30, 2.58 and 0.61%, respectively. However, cooking methods affected the chemical composition of samples as follows: moisture was increased as affected by wet processed methods, crude protein including protein nitrogen and non protein nitrogen, ash and crude fiber were reduced. The lowest decrement

on protein and ash contents were found in steamed vegetables followed by heated samples with microwave oven and the highest loss in protein and ash contents were after boiling processing.

Chemical degradation of cellulose into glucose and hemicellulose into arabinose, xylose and galactose might account for the reduction of the dietary fiber components of the vegetables on cooking (Robinson and lowler, 1986). Kuti and Kuti (1999), reported that, proximate compositions of spinach (*Spinicia oleraceae*) was decreased by cooking (boiling) as followed: protein from 3.2 to 3, fat from 0.4 to 0.3, ash 0.9 from 1.9 to 0 and fiber from 0.9 to 0.8% (as wet weight). Rehman *et al.*, (2003) found that, dietary fiber components from peas and spinach were reduced to various extents, depending on the type of cooking methods and pressure cooking showed a more pronounced effect on the reduction of dietary fiber components than ordinary and microwave cooking. Lin and Brewer, (2005) stated that, microwave reduce the amount of nutrients lost to leaching in comparison with boiling water.

Table (2): Effect of cooking methods on gross chemical composition percentages of green peas and spinach leaves (on dry weight basses).

Vegetables	*Green peas*					*Spinach leaves*				
Treatments / *Contents (%)*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*
Moisture	75.18^{a}	76.44^{bc}	76.61^{d}	76.32^{b}	82.22^{e}	89.54^{a}	93.44^{d}	93.74^{d}	90.15^{b}	92.50^{e}
Total solids	24.82^{d}	23.56^{b}	23.91^{c}	23.68^{b}	17.78^{a}	10.46^{a}	6.56^{ab}	6.26^{a}	9.85^{a}	7.50^{a}
Crude protein	6.02^{a}	1.47^{a}	4.59^{a}	5.54^{d}	3.86^{b}	3.22^{c}	2.02^{a}	2.57^{b}	2.58^{b}	2.50^{b}
[1]N.P. N.	1.29^{a}	0.95^{c}	0.60^{b}	1.09^{cd}	0.32^{a}	0.26^{a}	0.45^{b}	0.60^{c}	0.57^{c}	0.61^{c}
[2]P. N.	4.73^{c}	0.52^{a}	3.99^{b}	4.45^{c}	3.54^{b}	2.96^{d}	1.57^{a}	1.97^{a}	2.01^{c}	1.89^{b}
Ether extract	1.92^{c}	1.26^{b}	1.30^{b}	1.06^{a}	1.90^{c}	5.60^{c}	5.19^{a}	5.50^{b}	5.59^{b}	5.52^{b}
Ash	2.98^{c}	2.49^{b}	2.51^{b}	2.52^{b}	2.09^{a}	15.79^{e}	9.13^{b}	10.01^{c}	14.70^{d}	7.26^{a}
Crude fiber	59.30^{e}	54.10^{c}	52.10^{b}	55.00^{d}	49.50^{a}	30.30^{d}	25.70^{b}	26.20^{c}	26.10^{c}	23.20^{a}
[3]T. Char.	29.78^{a}	40.68^{d}	39.50^{c}	35.88^{b}	42.65^{e}	45.09^{a}	57.96^{d}	55.72^{c}	51.03^{b}	61.52^{e}

[1]N.P. N: Non Protein Nitrogen *[2]P. N.* : Protein nitrogen = crude protein – *N.P.N.*

[3]T. Char. : Total Carbohydrate = 100 – (Crude protein+Ether extract+Ash +Crude fiber)

Each value was an average of three determinations

Values followed by the same letter in row are not significantly different at < 0.05

It can be concluded that, cooking methods affect the gross chemical composition of green peas and spinach leaves and the effect was depended upon the type of process. The differences between peas and spinach could be attributed to the period of processing and contents of their nutrients composition. Moreover, minimum losses in the gross chemical composition of tested samples were found after steaming followed by microwave compared with the other processes. Also, the maximum losses were found in pressured vegetables.

3. Effect of cooking methods on mineral contents of green peas and spinach leaves:

Effect of cooking methods on mineral contents of green peas and spinach leaves were listed in Table (3). The results reveal that, spinach leaves had more contents of iron, copper, calcium, sodium, potassium and phosphorus compared to that showed in green peas. However, the contents of all determined minerals were changed after cooking methods. The greatest decrements of mineral contents of vegetables were noticed after pressure process followed by boiled then, microwave oven treatment and the lowest reducing was found in steamed vegetables.

Moreover, the study reported that, after cooking methods all samples contain moderate amount of sodium, which is a macronutrient and constitutes 2 percent of the total minerals contents of the body, it is vital in maintaining the body fluid volume, osmotic equilibrium and acid-base balance (Ishida *et al.*, 2000). Furthermore, the highest amounts of sodium in processed vegetables were noticed after steaming.

Table (3): Effect of cooking methods on minerals contents (mg/100g) of green peas and spinach leaves (on wet weight basses).

Vegetables	*Green peas*					*Spinach leaves*				
Treatments / *Minerals (mg/100g)*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*
**T.S.S*	797.92	307.2	288	723	128	1497.6	313.6	300.8	1420.68	262.4
Fe	14.62	2.24	3.88	12.08	1.34	17.52	11.46	14.62	10.24	5.66
Mn	0.52	0.04	0.16	0.40	0.12	0.32	0.20	0.22	0.24	0.16
Zn	0.94	0.26	0.36	0.32	0.12	0.20	0.10	0.12	0.16	0.16
Cu	0.12	0	0	0	0	0.16	0.08	0.10	0.16	0.10
Na	5.98	4.26	5.68	5.68	5.68	38.34	17.04	19.88	26.98	18.46
Ca	46.00	24.00	40.00	44.00	16.00	106.00	58.00	60.00	96.00	44.00
K	43.50	27.00	39.00	43.46	16.50	91.50	37.50	42.00	75.00	27.00
P	24.60	11.27	11.65	14.55	8.05	30.68	17.18	25.21	38.96	14.35
Ca/P ratio	1.87	2.13	3.43	3.24	1.99	3.46	3.38	2.38	2.46	3.07
K/Na ratio	7.27	6.34	6.87	7.65	2.90	2.38	2.20	2.11	2.78	1.46

**T.S.S : Total soluble salts.*

Shills and Young (1988) brought the concept of Ca/P ratio, because modern diets which are rich in animal proteins and phosphorus tend to promote the loss of calcium in urine. If Ca/P ratio is lower than 0.5, high amounts of calcium may be loss in urine, resulting a decrease in the calcium levels of bones. In this relation, Ca/P ratio of tested vegetables is more than one which is a good source of minerals required for bone formation, the highest ratio were found after thermal treating samples by steam processing.

Iron is an essential trace element for hemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). It was recommended that one mg/day of iron is suitable for adults to maintain the daily balance of intake and excretion (Ishida *et al.*, 2000). The results in Table (3) indicated that raw samples contain high levels of iron. Moreover, the lowest amounts of iron were found after processing.

Whereas high levels of potassium in diets are beneficial for those suffering from hypertension and those who suffer excessive excretion of potassium through the body fluids (Siddhuraju *et al.*, 2001), thus steamed process are beneficial for good health. A K/Na ratio in diet is an important factor in prevention of hypertension and arteriosclerosis, since K depresses and Na enhances blood pressure (Yoshimura *et al.*, 1991). From Table (3), it could be noticed that, the calculated K/Na ratios were higher after steaming process compared with other processing thus, it is recommended for making products that lowering blood pressure levels.

On the other hand, after cooking methods, copper element was not found in green peas and it was small amounts in spinach. Also magnesium and zinc were higher in peas than that found in spinach. However, copper, magnesium and zinc are vital for human metabolism as given by (Ishida *et al.*, 2000).

Total soluble salts used as indicator to the loss of soluble salts in water during processing. In steamed samples the loss of total soluble salts were higher compared with other processes that could be attributed to the effect of conduction with the blanching water. Thus, in case of steaming was not direct connection, while the connect of other tested samples with water were direct connections. So, the steamed samples show more loss in soluble salts.

4. Effect of cooking methods on ascorbic acid and total phynolic compounds of green peas and spinach leaves:

Data in Table (4) show the effect of cooking methods on ascorbic acid and total phynolic compounds contents of green peas and spinach leaves. The results indicated that the greatest losses were found in boiled vegetables and the lowest losses were observed in microwave oven samples followed by steamed processing. Moreover, spinach leaves had more values of ascorbic acid and total phynolics. Ascorbic acid, one of the most labile nutrients in vegetable, is water soluble and sensitive to pH, light and heat as well as affected by the naturally occurring ascorbic acid oxidase (Brewer and Begum, 2003). They reported also that preservation of ascorbic acid in vegetables, particularly those that are good source, is important in preserving food quality. Lane *et al.*, (1985) studied the ascorbic acid content of four vegetables blanched by microwave and conventional methods (boiling water and steaming). They

found that, with the exception of steam-blanched purple hull peas, ascorbic acid retention was not affected by the blanching method. Bune *et al.*, (2008) found that, the total phenolic contents in the fresh spinach and after boiling it were 2088 and 1911.6 mg/kg, respectively.

Table (4): Effect of cooking methods on ascorbic acid and total phenolics (on dry weight bases) calculated as mg/kg.

Vegetables	*Green peas*					*Spinach leaves*				
Treatments / *Contents*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*	*Raw*	*boiled*	*Microwave oven*	*steamed*	*Pressured*
Ascorbic acid mg/kg	722.38^{e}	166.34^{a}	281.21^{d}	214.42^{c}	209.68^{b}	902.49^{e}	408.93^{a}	890.26^{d}	810.98^{c}	785.33^{b}
Total phenolics compound mg/kg	480.59^{e}	113.00^{a}	370.20^{d}	331.00^{c}	300.76^{b}	2195.79^{e}	1489.47^{a}	2164.83^{d}	2142.94^{c}	1732.93^{b}

Each value was an average of three determinations
Values followed by the same letter in row are not significantly different at < 0.05

5. Effect of cooking methods on chlorophyll contents of green peas and spinach leaves:

The obtained data in Table (5) indicate that, raw spinach leaves had the highest values of chlorophyll *a, b* and total chlorophyll (81.61; 63.32 and 144.93 mg/100 g, respectively).

Chlorophyll *a, b* and total chlorophyll of raw green peas were 20.40; 10.91 and 31.13 mg/100 g, respectively. The contents of chlorophyll *a, b*, total chlorophyll and carotenoids of green peas and spinach leaves (on wet weight basis) were affected by cooking methods. The highest effect on chlorophyll *a, b* and total chlorophyll were found after pressured cook, while the lowest ones were found after microwave oven or steamed treatments compared with the raw samples.. Schwartz and Lorenzo, (1991) stated that, several factors, such as temperature and duration of the heat treatment, which are required to achieve commercial sterility, will influence the quantity of chlorophyll retained during processing. Furthermore, Beatriz, *et al.*,.(1998) noticed that, chlorophyll *a* and *b* were lost 99.9% after canning as a consequence of the heating used in industrial processing.

On the other hand, carotenoids content were decreased after processes and the lowest decrement were noticed after microwave oven treatment (16.97 and 31.46 mg/100g of peas and spinach, respectively)

and the highest loss were found in pressured and boiling samples in case of peas (13.50 mg/100g) and in spinach case, it was after boiling (11.94 mg/100g) followed by pressured process (17.83 mg/100g).

In general, cooking methods decreased the values of chlorophyll *a*, *b*, total chlorophyll and carotenoids content. Moreover, pressure and boiling processes help to make more degradation of chlorophyll to pheophytines. While, the degradation action was more slowly when the samples treated with microwave oven, such case, could be cause to use lower temperature (100°C) in microwave oven compared to that used with pressure method (121°C and pressure of 15 lbs/inch^2).

Table (5): Effect of cooking methods on the content of chlorophyll *a*, *b*, total chlorophyll and carotenoids of green peas and spinach leaves (mg/100 gm). (on wet weight basses)

Vegetables	*Green peas*					*Spinach leaves*				
Treatments / *Types of Chlorophyll*	*Raw*	*Boiled*	*Microwave oven*	*Steamed*	*pressured*	*Raw*	*Boiled*	*Microwave oven*	*Steamed*	*pressured*
**Chl. a*	20.40^{e}	11.33^{b}	14.55^{d}	13.31^{cd}	9.48^{a}	81.61^{e}	35.90^{b}	76.37^{d}	43.37^{c}	27.68^{a}
**Chl. b*	10.91^{d}	1.95^{ab}	1.61^{a}	2.99^{c}	0.00	63.32^{d}	16.85^{b}	24.71^{c}	24.83^{c}	7.73^{a}
*Total *Chl.*	31.13^{d}	13.28^{b}	16.16^{c}	16.30^{c}	9.48^{a}	144.93^{e}	52.75^{b}	101.08^{d}	68.20^{c}	35.41^{a}
Carotenoids	31.64^{d}	13.50^{a}	16.97^{c}	15.32^{b}	13.50^{a}	36.87^{e}	11.94^{a}	31.46^{d}	20.57^{c}	17.83^{b}

Each value was an average of three determinations
Values followed by the same letter in row are not significantly different at < 0.05

6. Effect of cooking methods on organoleptic properties of green peas and spinach leaves:

The average values for investigated each character (color, taste, odor, texture and appearance) of green peas and spinach leaves are shown in Table (6). Steamed samples were higher in color, taste, texture, appearance and its overall acceptability (very good) compared with other methods, followed by microwave oven vegetables. Pressured treatments had the lowest scour of all characters and its overall acceptability was the lowest (standard grade). However, this results are in agreement with the data presented in Tables (1 and 5) which, indicated to loss of firmness (texture) and chlorophyll (color) after cooking methods. Also, it can noticed that, the pressured (15 lbs/inch^2) and the temperatures (121°C) of cooking methods had the lowest score of panelists which, decreased the overall acceptability of samples compared with other processes. This results are in agreements with those reported by Lin *et al.*, (1998) and Miglio *et al.*, (2008).

Table (6): Organoleptic evaluation of green peas and spinach leaves treated with different types of cooking methods.

Vegetables	*Green peas*				*Spinach leaves*			
Treatments / *Organoleptic properties*	*boiled*	*Microwave oven*	*steamed*	*Pressured*	*boiled*	*Microwave oven*	*steamed*	*Pressured*
Color	7.33^{b}	7.87^{b}	8.11^{c}	6.63^{a}	7.00^{b}	7.13^{c}	7.63^{d}	6.43^{a}
Taste	7.67^{b}	7.89^{c}	7.89^{c}	6.63^{a}	7.00^{b}	7.13^{c}	7.63^{d}	6.43^{a}
Odor	7.44^{b}	7.56^{b}	7.44^{b}	7.13^{a}	6.38^{a}	6.63^{b}	7.50^{c}	5.57^{c}
Texture	7.89^{b}	7.44^{b}	8.33^{c}	6.63^{a}	7.13^{a}	7.13^{a}	7.75^{c}	6.43^{b}
Appearance	7.77^{b}	7.89^{b}	8.00^{c}	6.75^{a}	7.25^{c}	7.00^{b}	8.00^{a}	6.14^{a}
**Overall acceptability*	7.62^{b}	7.73^{c}	7.95^{d}	6.75^{a}	6.95^{b}	7.00^{b}	7.70^{c}	6.20^{a}

**Overall acceptability: the following grade system was used for the total score:*
1.Fancy grade : least 90% of score *2.Very good : least 80% of score*
3.Medium grade : least 70% of score *4.Standared grade : least 60% of score*
5.Substandared grade : least 50% grade.
Each value was an average of 10 determinations
Values followed by the same letter in row are not significantly different at < 0.05

CONCLUSION

In this study the behavior of gross chemical compositions, mineral contents, firmness, phytochemical pigments, ascorbic acid, total phenolic compounds, carotenoids and overall acceptability of cooked green peas and spinach leaves, as affected by different cooking methods, were evaluated. Generally, it could concluded that, the previous testing parameters s (Table 7) which conclude the effect of cooking methods according to the losses in contents as follows: every type of cooking methods (boiling, microwave oven, steaming and pressuring) were arranged from one degree (the highest loss) till four degree (the lowest loss) then, calculation the sum of the tested parameters degrees . Thus, it can noticed from data presented in Table (7) that, the highest total tested parameter in green peas was found after cooking with microwave oven and the lowest were observed after boiling and pressured processes peas. In spinach leaves the highest total tested parameters were noticed after microwave oven treatment and steaming process, while the lowest ones were found after boiling process.

Finally, from these results obtained in this study, it can be recommended that cooking with microwave oven had to more quality attributes followed by steaming and ended with pressure process or boiling processes in case of peas. In spinach it will begin with microwave oven or steaming process and ended with boiling.

Table (7): Concluded the effect of different cooking methods total tested parameter of green peas and spinach leaves.

Vegetables	Green peas				Spinach leaves			
Treatments / Parameters	boiled	Microwave oven	steamed	Pressured	boiled	Microwave oven	steamed	Pressured
Firmness period	1	2	2	3	1	2	2	3
Total chlorophyll	2	3	4	1	2	4	3	1
Total solid	2	3	4	1	2	1	4	3
Total tested minerals	2	3	4	1	2	3	4	1
Ascorbic acid	1	4	3	2	1	4	3	2
Total phenolics	1	4	3	2	1	4	3	2
Carotenoids	2	4	3	2	1	4	2	3
Overall acceptability	2	3	4	1	2	3	4	1
Total	13	26	23	13	12	25	25	16

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الملخص العربي

تأثير عمليات الطبخ المختلفة على بعض خواص جودة البسلة والسبانخ

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تم دراسة تأثير عمليات الطبخ المختلفة (الطبخ بالغليان وباستخدام الميكروويف و بالبخار وبالضغط على١٥ رطل/مال^{2}) وذلك على خواص الجودة (الصلابة والمحتوى من كلوروفيل أ ، ب والكاروتينات وحامض الأسكوربيك والمركبات الفينولية والتركيب الكيماوي والعناصر المعدنية والخواص العضوية الحسية) لكلا من البسلة والسبانخ ، وأوضحت النتائج أن عمليات الطبخ قد أحدثت تأثيرات مختلفة على العينات المختبرة وكانت هذه التغيرات حسب طريقة الطبخ المستخدمة والتي أثرت بالتالي على خواص جودة الخضروات المطبوخة .

حيث أظهرت النتائج أن الصلابة تقل بعد عمليات الطهي المختلفة والتي بالتالي تؤثر على قوام المنتجات كما تختلف مدة الطهي حسب طريقة الطهي المستخدمة ولوحظ أن الطهي بالضغط استغرق أقل زمن (٥ دقائق) بالمقارنة بطرق الطهي الأخرى . كما حدث فقد في المحتوى الكلي للكلوروفيل أ ، ب وكان الطهي بالمايكروويف أقل فقدا حيث كانت ١٣,٣١ و ٢,٩٩ ملجم/١٠٠ جم على الترتيب في حالة البسلة أما في حالة السبانخ كانت نتائج الكلوروفيل أ ، ب كما يلي ٧٦,٣٧ و ٢٤,٨٣ ملجم/١٠٠جم على الترتيب . وكانت العينات المطبوخة بالضغط أعلى فقدا في جميع العينات المختبرة ، من جهة أخرى وجد أن العينات المطبوخة في فرن المايكروويف كان محتواها عاليا في حامض الأسكوربيك والمركبات الفينولية والمحتوى من الكاروتينات والتي تعتبر من مضادات الأكسدة الطبيعية بالمقارنة بطرق الطهي الأخرى بينما سجلت النتائج أن الطهي بالغليان كان أعلى فقدا في مضادات الأكسدة ، كما تأثر التركيب الكيماوي للخضروات المختبرة حيث لوحظ أن العينات المعاملة بالبخار كانت أقل فقدا في التركيب الكيماوي في حين انه بمعاملة العينات بطريقة الطهي تحت ضغط كان الفقد الحادث في التركيب الكيماوي عاليا بالمقارنة بالطرق الأخرى المستخدمة . جميع العينات المختبرة كانت تحتوي على نسب عالية من الكالسيوم/الفسفور وهو هام في تكوين العظام ، كما احتوت العينات أيضا على نسب عالية من البوتاسيوم/الصوديوم والتي لها دور في ضبط نسبة ضغط الدم عند الإنسان وبصفة عامة يمكن القول أن المحتوي الكلي للعناصر المعدنية كان أعلى في حالة استخدام طريقة الطهي بالبخار وكان أقلهم في حالة الطهي تحت ضغط . وقد لوحظ اختفاء عنصر النحاس في جميع عينات البسلة المطبوخة بينما لوحظ تواجده ولكن بنسب منخفضة في عينات السبانخ المطبوخة .. وقد فضل المحكمون في الاختبارات العضوية الحسية العينات المعاملة بطريقة الطهي بالبخار عن غيرها من العينات المعاملة بطرق الطهي الأخرى.

وتوصي الدراسة باستخدام طرق الطهي بالترتيب التالي في حلة طهي البسلة: فرن المايكروويف > البخار > الغليان أو الضغط بالأوتوكلاف وفي حالة السبانخ يكون ترتيب طرق الطهي كالتالي : فرن المايكروويف أو البخار > الضغط بالأوتوكلاف > الغليان.

وبصفة عامة يكون الفقد في جودة الخضروات عاليا في حالة المعاملة بالأتوكلاف مما يشير أيضا إلى أن التعقيم التجاري قد يسبب فقد كبير في جودة الأغذية . كما أوضحت الدراسة أن طرق الطهي والزمن اللازم لإتمام الطهي يختلف على حسب نوع الخضروات من حيث كونها صلبة أو ورقية فيؤثر على محتواها من العناصر المغذية وبالتالي يؤثر على جودة المنتج .