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Effect of Boiling Cooking on Antioxidant Activities and Phenolic Content of Selected Iranian Vegetables.

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ABSTRACT

The present research was carried out for evaluation effects of antioxidant capacity and total phenolic of the Iranian vegetables by boiling cooking method compare to fresh. Eleven kg of eleven Iranian vegetables samples was collected. For each sample two portions (500 g each) were prepared, one portion was kept raw as control and stored at 4 ◦C in the fridge as consumer conditions, other was subjected for boiling thermally treatment. In boiling practice 500 g of each vegetable was added to 750 ml of water in a stainless steel pan that had just reached at 100 C and cooked for 13-20 min. The samples were drained off and cooled in room temperature for a few minutes. After cooking, the cooked vegetables were cooled for a few minutes at room temperature and then all vegetables were homogenized in a blender for 2 min, and stored in at −20 ◦C until analyses. Total phenol (TP) content in fresh and boiling methods ranged 413–1306 and 238-1256 mg GAE/ g dry matter respectively. Antioxidant activity by Diphenyl pycrylhydrazyl (DPPH) in the fresh and boiling methods ranged 13–87.7 and 15-89.9 mg mM trolex / g dry matter respectively. Antioxidant activity by the Trolox equivalent antioxidant capacity (TEAC**)** in the fresh and boiling cooking methods varied 6-140.6 and 5.36-107 mM trolex / g dry matter respectively. Amongst all vegetables tested, spinach had the highest TEAC and TP whereas garlic had the lowest TP content and antioxidant activities in fresh and boiling procedures.

Keywords: Vegetables, Antioxidant Activity, cooking methods, boiling.

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INTRODUCTION

Fruit and vegetables are regularly consumed for foods by most of individuals in all of world .They contain vital chemical compounds as a phytochemicals with antioxidant property. Phytochemicals are mostly phenolic compounds and flavonoids as a natural substances with vast of biological activity such as taste, odor and physic- chemical properties. According to epidemiological researches consumption of vegetables and fruits were associated with reduced degenerative human disease, cardiovascular and cancers.

The vegetables usually are cooked by different technology procedures such as boiling in water before use. I attention to some results, cooking practice may cause a number of changes in physical and chemical property of vegetables [2].Vegetables comprise nutritional antioxidants and a lot of phytochemical substances including total phenols, flavonoids, betalains, S-allyl cysteine, and S-methyl cysteine [3].

Quercetin, is one of the most important flavonoids materials in vegetables with greatest biological potential with useful on human health [4].According to some findings, flavonols substances was a partial loss during different cooking such as boiling, microwaving and frying, [5].Based on the vegetable character, type of cooking, cutting, chopping, stability of the structure to heat antioxidant activities of vegetables in different cooking were changed compare to fresh samples [6].

References to some study, antioxidant potential and total phenol of some vegetables were increased after cooking compare to fresh samples.Broccoli, carrot, celery, eggplant, leek, green been, onion, pepper, spinach, zucchini, Garlic are common vegetables consumed as raw and cooked. However, a little information is available in the Iran about the antioxidant potential and total phenolics of these vegetables. Therefore, the present research was carried out for evaluation effects of antioxidant capacity and total phenolics of the vegetables by bioling cooking method compare to fresh. Two antioxidant capacity tests, Trolox equivalent antioxidant activity (TEAC) and diphenyl-2-picrylhydrazyl (DPPH) were applied in this study.

MATERIALS AND METHODS

Vegetables were obtained from a market in Yasuj, Iran and immediately washed with water (in consumer conditions), cleaned by removed manually and dried air and were cut to halves for garlic and pieces for onions, zucchini, green been, carrot, eggplant and leek before heat treatment. The vegetable samples (11 kg) were collected and two portions (500 g each) were prepared for each sample. One portion was kept raw as control stored at 4 ◦C in the fridge as consumer conditions; other was subjected for boiling thermally treatment.

Table 1: Different English, Latin names and necessary cooking times of Iranian Yasuj vegetable

English name	Latin name	Boiling time (min)
Broccoli	*Brassica oleracea, L*	16
Carrot	*(Daucus carota var. sativa)*	23
Celery	*Apium graveolens var. dulce*	20
Eggplant	*Solanum melongena*	16
leek	*Allium porrum*	15
Green been	*Canavalia ensiformis, C*	21
Onion	*Allium cepa, L*	20
Pepper	*Capsium annuum, L*	20
Spinach	*Spinacia oleracea,L*	13
Zucchini	*Cucurbita pepo L*	20
Garlic	*Allium sativum*	20

The best cooking times were determined according to common cooking techniques which conducted by trained researchers. Cooking conditions for each vegetable were examined, with a preliminary experiment in our laboratory [2,6].

Boiling

In cooking method for each vegetable (500 g) was added to 750 ml of water in a stainless steel pan that had just reached at 100 C and cooked for 13-20 min. The samples were drained off and cooled in room temperature for a few minutes. After cooking, the cooked vegetables were cooled for a few minutes at room temperature and then all vegetables were homogenized in a blender (Moulinex – France) for 2 min, and stored in at −20 ◦C until analyses[2,6].

All parameter were determined on dry matter basis due to various water content of sample. For prepared of the dry matter, 3–4 g of raw or cooked homogenised sample (as triplicate) was placed in a ceramic container dried in an oven at 70 _C for at least 2 days until reaching constant weight[2,6].Raw and cooked vegetables were analyzed by different antioxidant activity methods and total phenol contents.

Determination of total phenol

The total phenolic contents of fruit extracts were estimated using the Folin-Ciocalteau reagent technique with slight change. Total phenol was expressed as Gallic acid equivalent (GAE) /g dry matter [7].

Antioxidant Activity of Diphenyl picrylhydrazyl (DPPH)

Antioxidant capacity of fruit extracts determined with some modification. Percent of inhibition was estimated as follow: Inhibition % = [(A0 - A1)/A0] ×100. A0 is the absorbance of control and A1 is the absorbance of the sample [7].

Trolox equivalent antioxidant capacity (TEAC)

The antioxidant activity was measured using TEAC based on Arnao method with some modification. Percent of inhibition same DPPH method was calculated [8].

Statistical Analysis

All data were expressed as means ± standard deviation of (n=3) measurements. For detect of significant differences in vegetable samples one-way analysis of variance (ANOVA) was applied which followed by post hoc tests. P-values less than 0.05 were considered significant.

RESULTS

In this study, 11 different vegetables from Iran were screened for their total phenol and their antioxidant potential. The fruit samples are arranged from the highest to lowest total phenols concentration.Total phenol content in the fresh and boiling cooking methods ranged 413–1306 and 238-1256 mg GAE/ g dry matter respectively (Figure 1).The ranking of phenol content in boiling cooking method were in: spinach > celery > zucchini> carrot > broccoli> pepper > onion> eggplant> green been> leek>garlic.

After cooking procedure the total phenolic content of garlic, leek, eggplant and pepper samples were significantly reduced (p<.01) however, zucchini sample was significantly increased(P<.001).There was reported a significant decrease in total phenolic content of garlic and pepper compare to fresh cooking method (Figure 1). Amongst the vegetables the maximum order of antioxidant activitty in DPPH were reported in broccoli> spinach > zucchini> celery> onion> carrot > leek> pepper > green been> eggplant> garlic (Figure 2).

Antioxidant activitity in DPPH in the fresh and boiling cooking methods ranged 13–87.7 and 15-89.9 mg mM trolex /g fresh and cooked samples respectively. Antioxidant activity by the TEAC radical scavenging method in the fresh and boiling cooking methods of samples varied 6-140.6 and 5.36-107 mM trolex /g fresh and cooked samples respectively(Figure 2,3). Antioxidant activity of vegetables in TEAC radical scavenging method presented in the order: spinach > celery> zucchini> carrot > broccoli> pepper > onion> eggplant> green been> leek> garlic (Figure 3).

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Amongst all vegetables tested, spinach had the highest TEAC and TP level, whereas garlic had the lowest content in fresh and boiling procedures .However, broccoli and garlic in DPPH radical scavenging method was reported with the highest and the lowest level respectively.

In antioxidant potential of TEAC, garlic, spinach, onion and pepper were decreased during boiling cooking method compared to the fresh procedure. However, in antioxidant activity by DPPH method garlic and pepper samples were decreased during cooking procedure. In all tests, in boiling method zucchini was significantly increased (P<.001). In boiling method in DPPH and TEAC teats onion and green bean were significantly increased respectively (Figure 1-3). According to analysis of the TEAC radical scavenging activity the highest losses were reported in garlic.

Table 2: Percentage of change in total phenol, Antioxidant activity of DPPH and TEAC by boiling cooking method compare to fresh in 11 Iranian vegetables

	% loss in boiling					
	TP		ABTS		DPPH	
Names	↓	↑	↓	↑	↓	↑
Broccoli						
Carrot						
Celery						
Eggplant	↓*					
leek	↓*					
Green been				↑***		
Onion			↓**			↑*
Pepper	↓**		↓***		↓**	
Spinach			↓*			
Zucchini		↑**		↑***		↑***
Garlic	↓**		↓**		↓*	

↓ = Decrease ; ↑= Increase; * = P<0.05 ; **=P<0.01 ; ***= P<0.001
TP= Total phenol; DPPH = Diphenyl pycrylhydrazyl ; TEAC Trolox equivalent antioxidant capacity

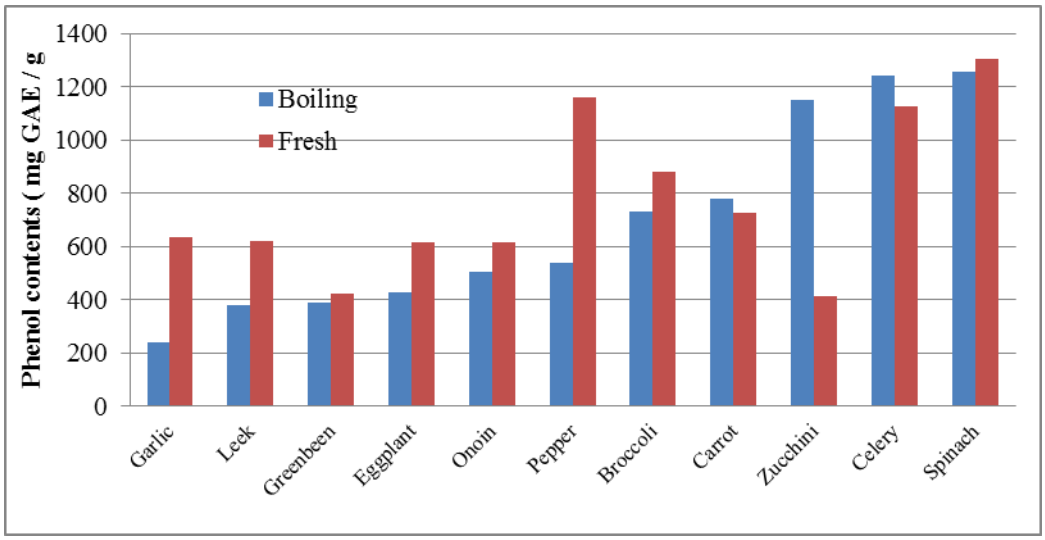

Figure 1: Rank order for mean total phenol in eleven Iranian vegetables expressed as mg Gallic acid (GAE) equivalents /g dry matter

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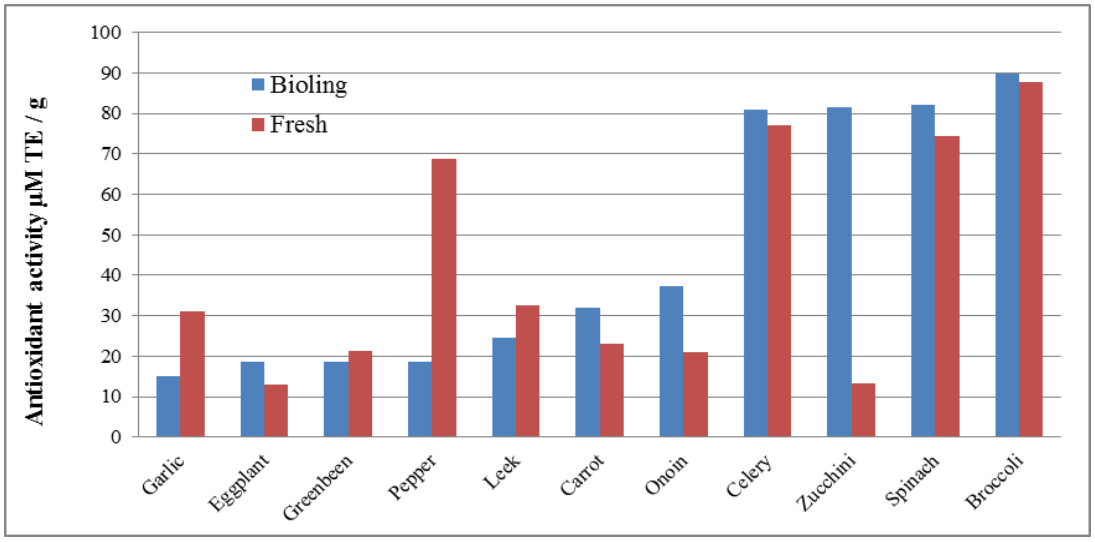

Figure 2: Rank order for mean antioxidant potential of eleven Iranian vegetables base on the DPPH value expressed as mM of Trolox equivalent / g dry matter

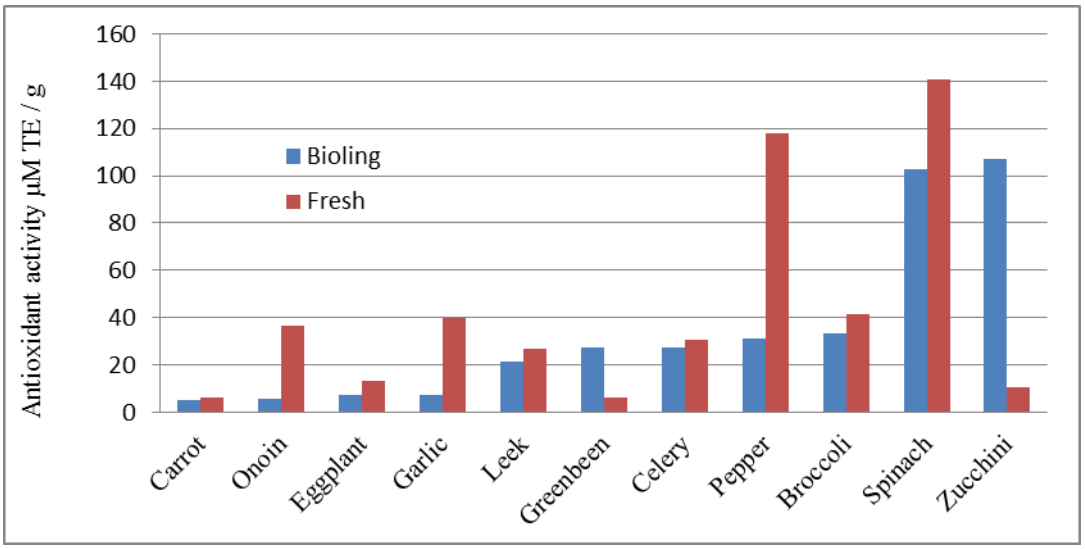

Figure 3: Rank order for mean antioxidant potential of eleven Iranian vegetables bases on the TEAC value expressed as mM of Trolox equivalent / g dry matter

DISCUSSION

Vegetables are a main source of antioxidants and it is required to defend against the free radicals. Consequently, it is essential to evaluate the antioxidant potetial and total phenol level of vegetables by different methods. Boiling is the common method of cooking in vegetables but in most cases breaks up delicate vegetables and destroys nutrients. Boiling vegetables in water leads a considerable loss of water-soluble vitamins and chemical composition of vegetables.

In present study in boiling total phenolic content of zucchini and celery significantly increased and, but TP in garlic, pepper, leek and eggplant significantly reduced.The reasons for the decrease of total phenols in garlic, pepper, leek and eggplant vegetables after cooking may due to lixiviation phenomenon in boiling cooking, complex phenol proteins formation, exposed of phenolic acids to the water in the outer layers [9].

Increase of total phenol content by zucchini and celery vegetables probably due to break supra-molecular structures in vegetables phenolic compounds and may result in increase and release of glicosidic bounds in phenol – sugar complex [10].

High level of antioxidant substances in the zucchini, onion, and green been in present study may be due to thermal damage of cell walls and result in release of antioxidant activities , formation of stronger antioxidants, or new substances with antioxidant potential in thermal chemical reaction state and inhibition of the oxidative enzymes in thermal chemical reaction condition [11].

According to suggestion of some study, heating and processing of garlic, onions, and other vegetables can noticeably changes in their effectiveness, the antioxidant property and the bioactive compounds [1].

Result of this study suggested that the total phenol and antioxidant activities by DPPH and TEAC in garlic and pepper were decreased by boiling method compare to the fresh procedure.

As previously reported same present study, there were no significant differences in the antioxidant activity of the some vegetables by boiling cooking compare to fresh state [12]. However, this result also suggested that the bioactive compound in some vegetables probably degraded during boiling water that leads to decrease of the active element [13].

CONCLUSION

Among spice vegetables tested, spinach had the highest phenolic contents and antioxidant activity by TEAC test in cooking method compare to fresh states. Boiling cooking had significant deleterious effect on total phenol content and loss in antioxidant activity on some vegetables. However zucchini, celery and green bean in boiling cooking exhibited significant increases in its antioxidant activities. According to present finding, it is better to consume most vegetables in their raw forms.

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