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COMPARISON OF ANTIOXIDANT ACTIVITY AND PHENOLIC CONTENT OF GARLIC, LEEK AND ONION VEGETABLES IN DIFFERENT COOKING METHODS

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ABSTRACT

Epidemiological studies have shown consumption of vegetables and fruits were related with reduced risks of several age-related and degenerative human disease, cardiovascular and cancers. Among the widely consumed vegetables garlic (Allium satium L.), leek (Allium porrum .) and onions (Allium cepa L are important medicines to the ancient Iranian. **Material and Methods:** The vegetable samples (2.5 kg) were collected and five portions (500 g each) were prepared. One portion was kept raw as control stored at 4 ◦C in the fridge and others were subjected for four thermally treatments such as boiling, Pressure-cooking, Microwave cooking and frying. Raw and cooked vegetables were analyzed by different antioxidant activity such as diphenyl-2-picrylhydrazyl (DPPH) and trolox equivalent antioxidant capacity (TEAC) methods and total phenol contents. All data were expressed as means ± standard deviation .For statistics analysis samples one-way analysis of variance (ANOVA) was applied.**Results:** The total phenolics content of onion samples was insignificantly reduced after cooking procedures . However significant reductions in leek and garlic were reported. In total phenol procedure the highest losses were reported by leek in boiling method .Leek showed highest scavenging activity (32.7 µM TE/g) whereas onion had lowest activity with 21 µM TE/g by DPPH assay .According to result of the TEAC radical scavenging activity the highest losses were reported in garlic in boiling method. The boiling cooking method in all assays was reported with maximum of % losses. **Conclusion:** Among spice vegetables tested, garlic had the highest phenolic contents and antioxidant activity. All antioxidant activities decrease in the vegetables except leek in thermal treatments by different methods.

KEY WORDS: Garlic, Leek, Onion, Antioxidant Activity, cooking methods.

INTRODUCTION

Epidemiological studies have shown consumption of vegetables and fruits were related with reduced risks of several age-related and degenerative human disease, cardiovascular and cancers. Among the widely consumed vegetables garlic (Allium satiVum L.), leek (Allium porrum) and onions (Allium cepa L are important medicines to the ancient Iranian.According to literature data garlic was fed to the athletes in the earliest Olympics in Greece as a performance enhancing" agents. It was discovered from 2600-2100 B.C. Increasing attention and more focus has been paid in Asia and Europe to the medical use of garlic and onion in the past up to now [1].

The most of the vegetables are cooked by different technology methods such as boiling in water or microwaving before consumption. According to some finding, cooking practice may cause a number of changes in physical and chemical property of vegetables [2]. Vegetables contain nutritional antioxidants and a variety of phytochemical compounds such as total phenols, flavonoids, betalains, S-allyl cysteine, and S-methyl cysteine [3]. Quercetin, is one of the most significant flavonoids substances in vegetables with most biological activity which have several valuable effects on human health [4].

Domestic cooking procedures, including boiling, microwaving and frying, induce a partial loss of the flavonols substances [5].Antioxidant activities of vegetables in different cooking procedures such as pressure-cooking, microwaving, and frying were changed depend to some parameters such as the vegetable character , type of cooking, the bioavailability of phenolics temperature, cutting, chopping, stability of the structure to heat[6] .

Four reasons for the increase in antioxidant potential of some vegetables after cooking were suggested in literature: The release of high level of antioxidant substances in the thermal damage of cell walls,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 [7]. The reasons for the decrease of total phenols in some vegetables after cooking which present in literature as follow: Due to lixiviation phenomenon in boiling or pressure-cooking methods total phenol (49%) and carotenoids (64%) were loss.Formation of complex phenol proteins in cooking water.Exposed of phenolic acids to the water in the outer layers of some vegetables rich with phenolic acids such as pea, spinach, cauliflower, and cabbage[8].

However, due to break of supramolecular structures in vegetables phenolic compounds may increase and release of glicosidic bounds in phenol – sugar complex [9].In according to some literature in microwave heating the active components not changed in cooking processes ,Because microwave heating, does not stimulate the release of ascorbic acid or other antioxidants from cooked tissue[10]. In the frying process in presence of olive oil, the food content of α-tocopherol, polyphenols, and even terpenic acids from olive oil source increases however the food loses water content [11].

Antioxidant, antimicrobial and anti-inflammatory potential of garlic and onions was reported in literature. They used for prevent a wide range of diseases including ageing, cardiovascular, cancer and degenerative diseases [12, 13].

The organosulfur compounds, flavonoids such as quercetin, fructans and anthocyanin pigments also reported in garlic and onion. Garlic, leek bulb, and onions have posses the highest concentration of fructans in ranged 1.2 to 17.4 g/100 g of fresh weight (FW). According to suggestion of some study, heating interfere with the formation of the active allyl sulfur substances in garlic, which may be related in its anticancer potential. It was shown that the processing of garlic, onions, and other vegetables can noticeably effects in their effectiveness, changing the antioxidant property and the bioactive compounds [1]. Garlic, leek and onion 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 different cooking methods. Two antioxidant capacity tests, Trolox equivalent antioxidant activity (TEAC**)** and diphenyl-2-picrylhydrazyl (DPPH) were applied in this study.

MATERIALS AND METHODS

Sample preparation

Fresh garlic (Allium sativum, leek (Allium porrum and onion (Allium cepa, L.) used in this research were obtained from a market in Yasuj, Iran and immediately washed, cleaned by removed manually cut with a knife. All vegetables were carefully washed with water (in consumer conditions), dried air and were cut to halves for garlic and pieces for onions and leek) before heat treatment. The vegetable samples (2.5 kg) were collected and five portions (500 g each) were prepared. One portion was kept raw as control stored at 4 ◦C in the fridge in home as consumer conditions), others were subjected for four thermally treatments.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.

Table 1 .Different Cooking procedures with necessary times used to cook the vegetable

Cooking procedures				
	Boiling	**Pressure-cooking**	**Microwave cooking**	**Frying**
Vegetables	Times (min)			
Garlic	20	4	2.5	8
Leek	15	3	2	8
Onion	20	5	3.5	12

Boiling

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

Microwave cooking

the vegetable (500 g) was placed in a glass dish which placed in the oven is heated by microwaves from all directions, and cooked in a commercial – 1000 W microwave oven Cooking took 2 min for spinach and 2 min for, broccoli, pepper. Samples were drained off and cooled in room temperature for a few minutes.

Pressure-cooking: vegetables (500 g) were placed in a pressure cooker (stainless steel, 22 cm diameter, MagefesaR, Zaragoza, Spain), containing water (300 mL) and a pressure valve for high pressure-cooking. In this method the temperature of boiling water can be raised above 100 ^{0}c.

Frying

the vegetable sample (500 g) was placed in a heated metal or frying pan with hot refined olive oil (169 ◦C) (100 mL) without covering it , and stirred until the sample became crisp-tender.The times for cooking in all samples, treated according to the above-mentioned table (table 1).

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. 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 homogenized sample (as triplicate) was placed in a ceramic container dried in a oven at 70 ^{0}C for at least 2 days until reaching constant weight [6,2]. 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 samplet [14].

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 [14].

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 [15].

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.

RESULT

The fresh vegetables total phenol content ranged 616.4–822 mg GAE/100 g dry matter and the rankings were leek > garlic> onion >. After cooking procedures, the total phenolics content of onion samples was insignificantly reduced and reductions were 12.7, 8.8, 12.2 and 12 % in boiling, Pressure-cooking, Microwave cooking and frying cooking methods respectively. However significant reductions in leek were reported as follow: 52.5, 35.5, 35.2 and 34 % in boiling, Pressure-cooking, frying and microwave cooking methods respectively. There was reported a significant decrease in total phenolic content of garlic in all cooking methods compare to fresh cooking method (Figure 1). According to present finding in total phenol procedure the highest losses were reported by leek in boiling method (Figure 1 and (Table 1).Antioxidant activity of vegetables determined by the DPPH radical

scavenging method decreased inThe order: leek > garlic > onion (Figure 2). Leek showed highest scavenging activity with a inhibition of 32.7 µM TE/g whereas onion had lowest activity with 21 µM TE/g (Table 2). Total antioxidant potential of garlic and onion decreased during all cooking method compared to the fresh procedure. However, antioxidant activity by DPPH method in leek samples was increased during cooking procedures. The most losses were reported in boiling cooking by leek samples. However microwave cooking was the safest method (Figure 2). According to analysis of the DPPH radical scavenging activity the highest losses were reported in leek in boiling method (Figure 2 Table 2). Figure 3 shows TEAC radical scavenging capacity for raw and cooked vegetables that expressed by TEAC value. Antioxidant activity of fresh vegetables according to TEAC method decreased in the order: garlic > onion > leek. In TEAC antioxidant activity against to DPPH antioxidant assay all vegetables garlic, onion and leek decreased during all cooking procedures compared to the fresh procedure except in boiling method by leek sample. Onion in frying method in TEAC assay produced the lowest loses (2.7%) however; highest losses were reported by garlic (47%) in boiling cooking method (Table 3). In Pressure-cooking the lowest (16.6%) and highest losses (39.3%) was reported by onion and garlic respectively also. In microwaving, the lowest (11%) and highest losses (31.8%) were reported by onion and garlic respectively. Onion and garlic in frying cooking method same to Pressure-cooking and microwaving methods were reported with lowest (2.7%) and highest losses (38.5%) antioxidant activity respectively. According to result of the TEAC radical scavenging activity the highest losses were reported in garlic in boiling method (Figure 3).In summary, the boiling cooking method in all assays was reported with maximum of % losses.

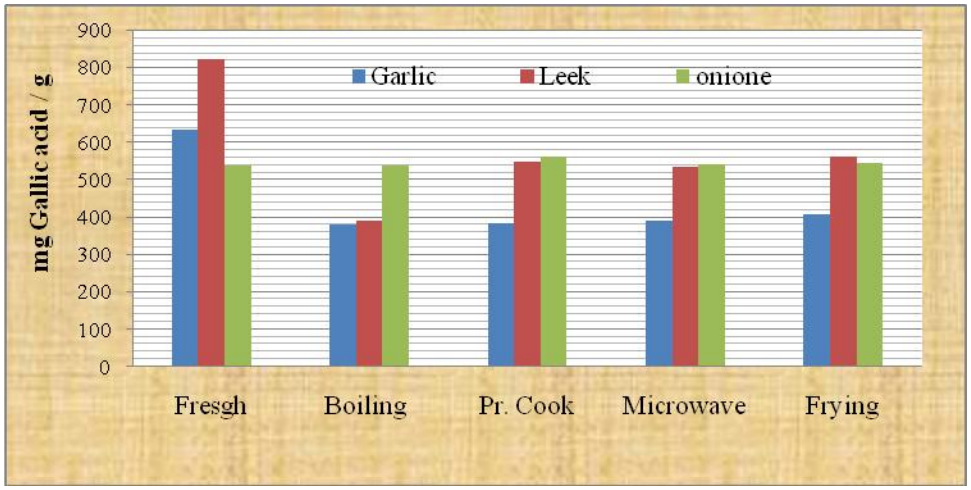

FIgure1.Effect of different cooking methods on total phenolic content of garlic, leek and onion vegetables

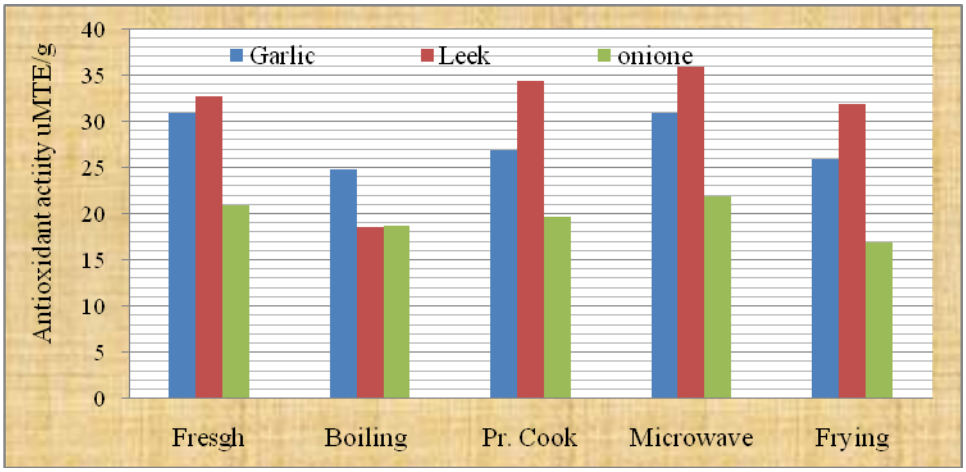

Figure 2; Effect of different cooking methods on antioxidant activity by DPPH method in garlic, leek and onion vegetables

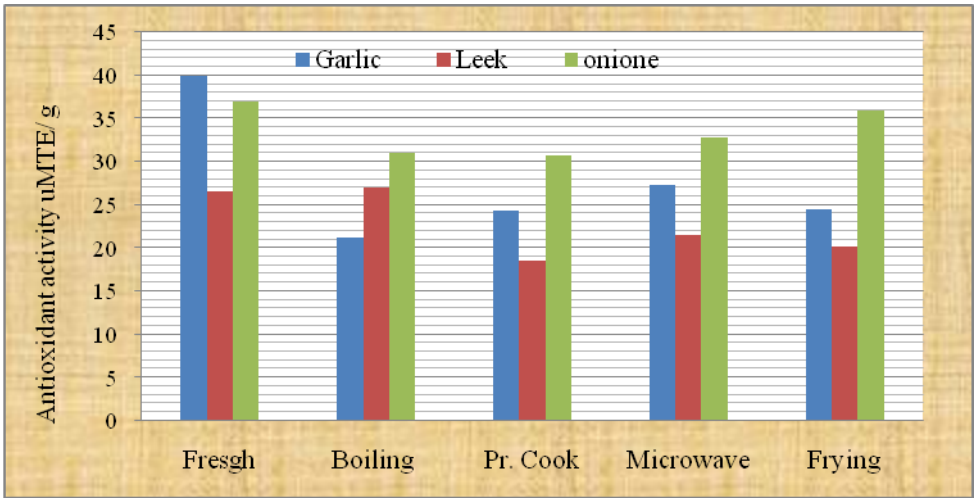

Figure 3: Effect of different cooking methods on antioxidant activity by TEAC in garlic, leek and onion vegetables

Table 1. Percentage of losses in total phenol by different cooking methods in garlic, leek and onion vegetables

% Losses				
Type of Cooking				
Vegetables	Boiling	Pressure-cooking	Microwave cooking	Frying
Garlic	40	39.4	38.3	35.5
Leek	52.5	33.5	35.2	34
Onion	12.7	5.8	12.2	12

Table 2 .Percentage of change in Antioxidant activity of DPPH by different cooking methods in Garlic, Leek and onion vegetables

% changes				
Type of Cooking				
Vegetables	Boiling	Pressure- ooking	Microwave ooking	Frying
Garlic	↓20.3	↓13	↓1.6	↓12.2
Leek	↓ 43.7	↑ 7.5	↑ 10.9	↑ 0.9
Onion	↓ 11	↓ 5.2	↑2.8	↓ 19

↓ = decrease, ↑= Increase, diphenyl-2-picrylhydrazyl (DPPH)

Table 3 . Change in Antioxidant activity of TEAC by different cooking methods in Garlic, Leek and onion vegetable Samples

% changes				
Type of Cooking				
Vegetables	Boiling	Pressure-cooking	Microwave cooking	Frying
Garlic	↓47	↓39.3	↓31.8	↓38.5
Leek	↑2.2	↓30	↓20	↓24
Onion	↓15.8	↓16.6	↓11	↓2.7

↓ = decrease, ↑= Increase, trolox equivalent antioxidant capacity (TEAC)

DISCUSSION

The expected cause for change of bioactive substances, antioxidant property, in garlic and onions following various cooking procedures can be explain by their different physical characters such as matrix softening, texture, color and increased extractability. It was determined in present study that all total phenols and their antioxidant potential have differently changed during, pressure cooking , boiling, frying, and microwaving which this is in agreement with others. Onion is a rich source of flavonoids as a bioactive compound that cooked in different ways during the world. According to literature a parallel to present study, variety of cooking methods do not significantly destroyed of quercetin compounds and total antioxidant activity .In Microwave cooking procedures in absence of water flavonoids and ascorbic acid are stable. In present study similar to literature onion with least of degradation 8.8-12% loss of total phenol content was reported [16]. In present study due to breakdown of phenolic compounds in cooking methods caused loss of phenolics in garlic , leek and onion respectively [2]. In present work against to Zhang and Hamauzu finding, there was significant decrease in antioxidant activity and antioxidant components in studied vegetables [17].In recent experimental study, antioxidant activity of leek in DPPH assay in pressure cooking and microwave and also in TEAC assay by boiling method was insignificantly

increased. This finding parallel to some study in literature due to inactivated of peroxidases at high temperatures [2]. This study demonstrated that cooking by different methods decreased antioxidant potential in all garlic and onion samples, and most of leek samples in DPPH and TEAC assays.

CONCLUSION

Among spice vegetables tested, garlic had the highest phenolic contents and antioxidant activity. All antioxidant activities decrease in the vegetables except leek in thermal treatments by different methods. Cooking had significant deleterious effect on total phenol content and loss in antioxidant activity by different methods. However leek in pressure and microwave cooking exhibited non 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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