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Research Paper

Effect of different cooking conditions on antioxidant properties of some cucurbit vegetables

■ N. KARMAKAR, B.B. ABUJ, S. OJHA AND S. TRIPATHI

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■ **ABSTRACT :** Effects of pressure cooker and microwave cooking methods on total antioxidant activity (AA), Vitamin C, phenols, flavonoids, anthocyanin and total carotenoids different types of gourd vegetables like cucumber, pumpkin, bottle gourd, bitter gourd, pointed gourd and spine gourd were collected from local market of Navsari. The time length was standardized for different length of time in pressure cooker and microwave. The methanolic extracts of different raw and cooked (7, 10 and 15 min) both in pressure and microwave cooked vegetables were tested. The result revealed higher percentage of loss of antioxidants under microwaving compared to pressure cooking.There four it is clear that bitter gourd is the vegetable which is containing the highest antioxidant activity. This experiment also clarified the fact that most of the vegetable, microwave heating for 7 minutes and pressure cooking for 10 minutes gives the best result as this food material contains possible higher amount of antioxidant activity with proper cooking standard.

■ **KEY WORDS:** Gourd, Pressure cooked, Microwave, Antioxidant, Cooking time

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See end of the paper for authors' affiliations

N. KARMAKAR
Department of Soil Science and Agricultural Chemistry, Navsari Agricultural University, NAVSARI (GUJARAT) INDIA
Email : nilimanau13@gmail.com

The Reactive Oxygen Species (ROS) is raised in our body due to oxidative stress is considered as a major factor of damaging of cells. As a result of which some chronic diseases like cancer, diabetes and some cardiovascular disease are occurred (Ames *et al.*, 1993 and Aruoma, 1994). It is well known that plant based diets like vegetables and fruits can reduce the risk of the level of these kind of chronic diseases as they are the potential source of antioxidants like vitamin C, carotenoids, polyphenols, vitamin E etc. and the deleterious effect of ROS is minimized by the activities of antioxidants (Huang *et al.*,1994 and Shahidi and Naczk, 1995). The non enzymatic antioxidant compounds like different vitamins and poly phenols can be acquired through the diet. Though different vegetables are rich in a diverse group of antioxidants, the form in which it is consumed has a great role in the availability of the antioxidants (Joshipura *et al.*, 1999). Different methods of processing, preservation and cooking have a great impact of the stability of antioxidants. Antioxidants like vitamin C is labile to high heat whereas anthocyanins alter their nature in higher pH (Sako *et al.*, 1996 and Howard *et al.*, 1999). Hence proper way of cooking can minimize the loss of antioxidants from the diet. Recently, microwave heating, which utilizes the interaction of an electromagnetic field with chemical

constituents of food, has been used for cooking. Microwave heating has wellknown advantages over boiling, the conventional heating process, because foods are heated directly and rapidly without contact with hot surfaces (Young and Jolly, 1990). Many experimentshave been carried out on the effect of processing and cooking on vitamin C content in vegetables (Erdman and Klein, 1982 and Kiribuchi and Kawashima, 1987).These cooking processeswould bring about a number of changes in physical characteristics and chemical composition of vegetables (Rehman *et al*., 2003 and Zhang and Hamauzu, 2004). Sahlin *et al.* (2004) showed that boiling and baking had a small effect on the ascorbic acid, total phenolic, lycopene and antioxidant activity of the tomatoes while frying significantly reduced the ascorbic, total phenolic and lycopene contents of tomatoes. Zhang and Hamauzu (2004) pointed out that cooking affected the antioxidant componentsand antioxidant activity of broccoli. As cucurbit vegetables are rich in different antioxidant source and has a greater potentiality of yield in South Gujarat, this experiment was conducted to investigate the effects of domestic cooking methods (pressure heating and microwaving) on the loss of nutritional quality. Different types of gourd vegetables were collected from local market of Navsari, Gujarat and the total antioxidant activity (AA), contents of vitamin C, phenols, flavonoids, anthocyanin and total carotenoids of raw vegetable sample as well as microwaved and boiled vegetables for different lengths of time were assessed with the intentions to find out the particular cucurbit vegetable/vegetables containing the highest source of antioxidants and to standardize the particular temperature and length of time for cooking the vegetable for minimum loss of antioxidants.

■ RESEARCH METHODS

The experiment was conducted at the Department of Soil Science and Agricultural Chemistry, N.M. College of Agriculture, Navsari Agricultural University, Gujarat in the year 2016. Six different types of gourd vegetables namely cucumber, pumpkin, bottle gourd, bitter gourd, pointed gourd and spine gourd were obtained from Navsari local market.

Mode of cooking and specifications:

For pressure cooking 5 lit of Hawkins model CL 50 was used under full flame on LPG stove. For microwaving Samsung model CE117ADV of was used under 900W power. Gas used for the cooking purpose in the pressure cooker was LPG cooking gas was used from cylinder (14.2kg), diameter of burner head was 85 mm, diameter of burner pore size was1.7mm and pressure of gas during cooking was 5.5kg/sqmt.

Seven treatments were considered for the study was namely: UC= uncooked raw vegetable, PC7= pressure cooked for 7 minutes (No whistle), PC10= pressure cooked for 10 minutes (1whistle), PC15= pressure cooked for 15 minutes (3 whistles), MW7=micro wave cooked for 7 minutes. MW10 = micro wave cooked for 10 minutes, MW15=micro wave cooked for 15 minutes. For each parameters data was recorded with four replications. Simple CRD design was adopted for the study and data was analyzed by using statistical software SAS 9.3

Sample materials :

The vegetables were cooked by adopting different modes such as pressure cooking and microwaving. 100 grams of peeled raw vegetable was cooked for 7, 10 and 15 min, with 200 ml of water each before performing extractions in pressure cooker with above specification in full flame mode. 100 grams of peeled raw vegetable was cooked for 7, 10 and 15 min, with 200 ml of water each before performing extractions in pressure cooker with above specification in 900 W in microwave.

Extraction :

Ten g (dry weight) of raw or cooked tissues were homogenized with 15 ml of 80% methanol.The homogenate were then centrifuged at 10,000 RPM for 20 min. Supernatants were collected and diluted with distilled water to various concentrations. Extracts were stored in a refrigerator at 3°C for no longer than 4 weeks.

Estimation of different antioxidant parameters:

The total flavonoid content of the obtained extracts was estimated using a colorimetric method described by Heimler *et al.* (2005) and was expressed as catechin equivalent. The phenolic content of the obtained extracts was estimated by a colorimetric assay based on procedures by Singleton and Rossi (1965) and results are expressed as the microgram of gallic acid equivalents/ 0.5 ml of extract (GAEs) through the calibration curve of gallic acid. Total carotene was analysed

spectrophotometrically using β-carotene as the standard (Singh and Bradbury, 1988) where the total carotene content was calculated by using a calibration curve against a high purity β-carotene standard of Sigma Company. Anthocyanin content of the obtained neat extracts was determined using a pH differential method described by Hosseinian *et al.* (2008) and total anthocyanin content (μg/0.5 ml) was expressed as Cy-3-glc equivalents. Vitamin C estimation was determined by the Folin–Ciocalteu reagent method by Jagota and Dani (1982),with modifications and the vitamin C content was estimated through the calibration curve of ascorbic acid. Total antioxidant activity Total antioxidant activity of fenugreek seeds exposed to PEG and $HgCl_2$ was estimated and compared with the control on the basis of scavenging activity of the 1,1-diphenyl-2-picrylhydrzyl (DPPH) following the study of Braca *et al.* (2001) and the IC_{50} value is the concentration of antioxidant, required for 50% scavenging of DPPH radical in the specified time period.

■ RESEARCH FINDINGS AND DISCUSSION

For treatment UC from the perusal of all the data (Table 1) indicate that flavonoid content shows significant difference in all the vegetable. The value ranges from 87.0297 mg/100gm in bitter gourd to 45.032mg/100g in pumpkin in the pooled data of two years. For all the treatments of pressure cooking and microwaving bitter gourd showed highest amount of flavonoid content (83.0110 to 65.8035 mg/100g) whereas pumpkin showed lowest amount of flavonoid (42.09 to 25.84 mg/100g) in different treatment. For total flavonoid content 15 min cooking in microwaving was proved to be highest loss. Delaviz *et al.* (2014) studied effects of cooking methods on antioxidant activity and flavonoid content in vegetables. Total flavonoids content was significantly increased in boiling (8%) and reduces in microvave (4%) methods. Although, a little decrease in total phenolics of pepper was also observed in boiling (7.4%) and Microwave (3.6%) cooking methods.

For treatment UC from the perusal of all the data (Table 2) indicate that phenol content shows significant difference in all the vegetable. The value ranges from 153.080 mg/100g in bottle gourd to 47.99mg/100g in cucumber in the pooled data of two years. For all the treatments of pressure cooking and microwaving bottle gourd showed highest amount of phenol content (148.17 to 73.02 mg/100g) whereas cucumber showed lowest amount of phenol content (43.17 to 32.77 mg/100g) in different treatment. For total phenol content 15 min cooking in microwaving was proved to be highest loss. Microwave cooking may affect the antioxidant status of all vegetables due to the destruction of more phenolic compounds and destruction or creation of redox-active metabolites these results are more or less similar with Jiangfeng *et al.* (2013). They were evaluated the effect of three different cooking methods on antioxidant content and radical scavenging activity of sweet corn. The results showed that there was a significant decrease in TP (1.2–1.9 times) and TC (1.1 to 1.8 times) content of fresh sweet corn after each cooking out of that microwave cooking losses are more compared to steaming.

For treatment UC from the perusal of all the data (Table 3) indicate that carotenoid content shows significant difference in all the vegetable. The value ranges from 953.26 mg/100g in bitter gourd to 46.053mg/

Table 1: Total flavonoid content (mg/100g) in different vegetables under different cooking condition

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	68.76	62.07	55.61	45.95	58.01	53.82	41.39	54.91
Pumpkin	45.03	42.09	36.17	32.84	37.02	33.04	25.84	36.00
Bottle gourd	72.97	68.92	62.90	56.96	65.14	57.90	52.10	62.41
Bitter gourd	87.02	83.01	76.00	73.02	79.50	73.10	65.80	76.78
Pointed gourd	63.06	58.06	52.98	45.90	55.03	49.02	43.03	52.44
Spine gourd	63.85	59.06	52.75	46.10	55.97	47.07	43.00	52.54
Treatment mean	66.67	62.20	56.07	50.13	58.44	52.24	45.19	
	Vegetables x treatment	Vegetables	Treatment					
S.E.±	0.1774	0.0664	0.0722					
C.D. (P=0.05)	0.4916	0.1841	0.2002					
CV%	0.90							

100gm in cucumber in the pooled data of two years. For all the treatments of pressure cooking and microwaving bitter gourd showed highest amount of carotenoid (948.25 to 929.68 mg/100g) whereas pointed gourd showed lowest amount of carotenoid content (42.83 to 26.16 mg/100g) in different treatment. For total carotenoid content 15 min cooking in microwaving was proved to be highest loss. Similar results were reported by previous researchers (Gayathri *et al.*, 2004), however, microwaving for 5 min resulted in significantly ($P < 0.05$) lower TC than that of 3 min microwaving. This may be due to the prolonged microwaving time that may result in a longer exposure of sweet corn to heat, oxygen and light.

For treatment UC from the perusal of all the data (Table 4) indicate that anthocyanin content shows significant difference in all the vegetable. The value ranges from 44.62mg/100g in pumpkin to 6.075mg/100g in cucumber in the pooled data of two years. For all the treatments of pressure cooking and microwaving pumpkin showed highest amount of anthocyanin (26.76 to 8.14 mg/100 g) whereas cucumber showed lowest amount of anthocyanin content (4.74 to 0.63 mg/100g) in different treatment. For total carotenoid content 15 min cooking in microwaving was proved to be highest loss. Scalzo *et al.* (2008) found similar results as like present findings anthocyanin composition of cauliflower (*Brassica oleracea* L. var. botrytis) and cabbage (*B. oleracea* L. *var.* capitata) analyzed in relation to thermal treatment samples were analysed for total anthocyanin content by using a spectrophotometric differential pH method. They found that microwave cooking drastically reduced total cauliflower anthocyanin content.

For treatment UC from the perusal of all the data (Table 5) indicate that ascorbic acid content shows significant difference in all the vegetable. The value

Table 2 : Total phenol content (mg/100g) in different vegetables under different cooking condition

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	47.99	43.17	38.88	35.98	42.88	36.02	32.77	39.67
Pumpkin	62.93	59.43	54.84	51.92	53.94	47.37	42.85	53.33
Bottle gourd	153.08	148.17	136.99	97.85	142.97	122.92	73.0	125.00
Bitter gourd	72.75	71.08	64.79	61.58	65.70	53.16	43.01	61.87
Pointed gourd	53.91	51.97	43.04	35.28	45.85	39.62	26.08	42.25
Spine gourd	65.90	61.51	54.19	47.79	58.14	53.04	37.02	53.94
Treatment Mean	76.09	72.56	65.62	55.07	68.25	58.69	42.46	
	Vegetables × treatment	Vegetables	Treatment					
S.E.±	0.2093	0.0808	0.0872					
C.D. (P=0.05)	0.580216	0.223970	0.241722					
CV%	0.97							

Table 3 : Total carotenoid content (mg/100gm) in different vegetables under different cooking condition

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	46.05	42.83	36.27	33.91	39.13	33.010	26.16	36.76
Pumpkin	474.14	452.09	442.06	436.03	445.80	437.20	429.32	445.24
Bottle gourd	188.95	180.05	172.89	166.13	172.23	166.05	153.10	171.34
Bitter gourd	953.26	948.25	942.09	936.25	946.56	938.02	929.68	942.02
Pointed gourd	53.13	47.69	42.24	38.78	43.09	37.14	28.87	41.56
Spine gourd	468.09	453.43	442.66	435.13	450.90	439.97	417.98	44.02
Treatment mean	363.94	354.06	346.37	341.04	349.62	341.90	330.85	
	Vegetables x Treatment	Vegetables	Treatment					
S.E.±	0.4412	0.1632	0.1785					
C.D. (P=0.05)	1.22282	0.4523078	0.494875					
CV%	0.36							

ranges from 72.93mg/100g in bitter gourd to 2.86mg/100g in cucumber in the pooled data of two years. For all the treatments of pressure cooking and microwaving bitter gourd showed highest amount of ascorbic acid (15.94 to 3.01 mg/100g) whereas cucumber showed lowest amount of ascorbic acid content (1.31 to 0.28 mg/100g) in different treatment. For ascorbic acid content 15 min cooking in microwaving was proved to be highest loss. Somsub *et al.* (2008) conventional pressure cocker method of cooking was an effective method to reduce the content of vitamin C and other antioxidants. They analyzed for vitamin C, tannin and total phytat vegetables commonly consumed in Thailand.

For treatment UC from the perusal of all the data (Table 6) indicate that total antioxidant activity shows significant difference among all the vegetables. Total antioxidant activity had been expressed as IC_{50} value of DPPH radical which means as the higher amount of extract is needed to to quench 50% of the DPPH radical has lower antioxidant activity and the lower amount of extract is needed to quench 50% of the DPPH radical has higher antioxidant activity. Highest antioxidant ranges from 7.20µg/ml in bitter gourd to 33.90µg/ml in pointed gourd. For all the treatments of pressure cooking and microwaving bitter gourd showed highest antioxidant activity as because lowest amount of extract is needed to quench 50% of the DPPH radical. Throughout all the different treatment the bitter gourd conserved comparatively higher and pointed gourd showed comparatively lower antioxidant activity. In case of each and every vegetable distinctly 15 min microwaving caused higher amount of loss of antioxidants so that to quench 50% DPPH radical higher amount of sample material is needed Turkmen *et al.* (2005) found more or less similarity with present findings. They reported that microwave cooking and significant reduces total antioxidant activity of pepper, green beans, broccoli and spinach. The IC_{50} of boiled pumpkin found in this study

Table 4 : Total anthocyanin content (mg/100g) in different vegetables under different cooking condition

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	6.07	4.74	2.45	0.84	4.10	2.13	0.63	2.98
Pumpkin	44.62	26.76	15.14	8.10	24.52	14.04	8.14	20.19
Bottle gourd	11.88	7.61	3.91	1.20	6.08	3.59	0.45	4.96
Bitter gourd	24.39	14.10	9.08	6.02	13.06	9.16	5.08	11.56
Pointed gourd	7.38	4.24	1.75	0.6	4.79	1.21	0.52	2.83
Spine gourd	15.94	11.89	9.00	3.88	10.88	7.81	4.09	9.07
Treatment mean	18.38	11.56	6.89	3.45	10.44	6.32	3.15	
	Vegetables x Treatment	Vegetables	Treatment					
S.E.±	0.1955	0.0734	0.0799					
C.D. (P=0.05)	0.541983	0.2033518	0.2215					
CV%	6.42							

Table 5 : Total ascorbic acid (Vitamin C) (mg/100g) in different vegetables under different cooking condition

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	2.86	1.31	0.84	0.45	1.21	0.062	0.28	1.08
Pumpkin	4.63	3.03	1.73	0.73	2.95	1.15	0.56	2.11
Bottle gourd	23.14	15.94	8.85	4.75	14.03	6.06	3.01	10.83
Bitter gourd	72.93	62.01	42.15	18.05	55.89	23.19	8.81	40.43
Pointed gourd	3.76	2.64	0.07	0.43	1.18	0.61	0.18	1.36
Spine gourd	5.98	4.66	2.87	0.76	4.09	1.80	0.67	2.98
Treatment Mean	18.88	14.93	9.52	4.20	13.23	5.57	2.25	
	Vegetables × Treatment	Vegetables	Treatment					
S.E.±	0.1653	0.0614	0.0672					
C.D. (P=0.05)	0.4583	0.1700605	0.1862					
CV%	4.72							

was higher than that reported by Mau *et al.* (2004), who found that the IC50 of *Antrodiacamphorata*mycelia was in the range of 1.70 to 2.06 mg ml^{-1} for white and red mycelia, respectively. Bushra *et al.* (2008) reported antioxidant activity of the vegetables examined was appreciably affected because of varying cooking treatments. The results of the present investigation showed that all the cooking methods affected the antioxidant properties of the vegetables; however, microwave treatment exhibited more deleterious effects when compared with those of other treatments.

To depict out which is the optimum temperature for proper cooking the cooked vegetables were tested by five women and frequency analysis were performed. From the frequency data analysis (Table 7) it is clear that, for over all the vegetables and all treatments MW7 for microwave cooking and PC10 for pressure cooking is widely identified as proper temperatures for cooking. Microwaving cooking caused greater antioxidant loss than did in boiling reported by Galor *et al.* (2008) they were analyzed cooked vegetables, antioxidant content was highest in steamed > boiled > microwaved, and decreased with longer cooking time, regardless of method. All steamed vegetables had lowers antioxidant contents than had matching raw vegetables. Effects were variable for boiling and microwaving. Pressure cooking may be the best cooking method of choice to release/ conserve antioxidants. The cooking water is a potentially rich source of dietary antioxidants.

Perusal of the above data clearly depicts the time of cooking where the maximum antioxidant property can be maintained as well as the vegetable which has lost the minimum antioxidant and showed the maximum antioxidant during different cooking procedure. From the result it is clear that bitter gourd is the vegetable which is containing the highest antioxidant activity. The above experiment also clarified the fact that experiment it is clear that for most of the vegetable, microwave heating for 7 minutes and pressure cooking for 10 minutes gives the best result as this food material contains possible higher amount of antioxidant activity with proper cooking standard.

Conclusion:

Results from the study showed that cooking affected both the bioactive compounds and their

Table 6 : Total antioxidant activity (µg/ml) in different vegetables under different cooking condition (expressed as 50% quenching of ROS=IC_{50}) (mg/100g)

Treatment / Vegetables	UC	PC7	PC10	PC15	MW7	MW10	MW15	Vegetable mean
Cucumber	23.84	37.37	55.48	65.65	42.13	63.55	78.01	52.29
Pumpkin	16.90	26.32	45.67	55.25	32.35	52.51	64.85	41.83
Bottle gourd	12.13	25.25	34.61	48.77	27.91	46.66	57.61	36.14
Bitter gourd	7.20	11.62	22.62	32.49	15.38	25.83	38.82	22.00
Pointed gourd	33.90	41.61	52.52	65.05	45.94	62.24	73.12	53.48
Spine gourd	15.08	24.06	36.56	47.03	33.83	43.05	56.70	36.62
Treatment Mean	18.04	27.70	41.25	52.37	32.92	48.98	61.48	
	Vegetables × treatment	Vegetables	Treatment					
S.E.±	0.3052	0.1159	0.1261					
C.D. (P=0.05)	0.8458	0.3212	0.3496					
CV%	2.17							

Table 7 : Frequency analysis of the treatments identified as cooked by the testers for different vegetables

Vegetable	Treatments identified as cooked with frequency in parentheses			Selected treatment on the basis of frequency
Cucumber	PC07(3)	MW07(4)		MW07
Pumpkin	PC10(4)	MW07(4)		both can be selected
Bottle gourd	PC07(5)	MW07(5)		both can be selected
Bitter gourd	PC10(5)	MW07(3)	MW10(3)	PC10
Pointed gourd	PC10(5)	MW10(5)		both can be selected
Spine gourd	PC10(5)	MW07(5)	MW10(4)	PC10

antioxidant activity. The evaluation of those bioactive compounds in pumpkin would provide information about the changes of phenolic compounds, carotenoids and their antioxidant activity during cooking.The above experiment also clarified the fact that experiment it is clear that for most of the vegetable, microwave heating for 7 minutes and pressure cooking for 10 minutes gives the best result as this food material contains possible higher amount of antioxidant activity with proper cooking standard.

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Authors' affiliations:

B.B. ABUJ AND S. TRIPATHI, Department of Soil Science and Agricultural Chemistry, Navsari Agricultural University, NAVSARI (GUJARAT) INDIA

S. OJHA, Department of Agricultural Statistics, Faculty of Agriculture, Uttar Banga Krishi Viswavidyalaya, Pundibari, COOCH BEHAR (W.B.) INDIA

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