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Effect of Blanching and Drying on Antioxidants and Antioxidant Activity of Selected Green Leafy Vegetables

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Abstract: ***Leafy vegetables contain a significant amount of non nutritive health promoting phytochemicals which act as antioxidants and impart health benefits to human beings. Blanching and dehydration by drying are processes commonly used in preservation of these vegetables. The present investigation was planned to study effect of blanching and drying on total phenols, flavonoids and antioxidant activity of selected commonly consumed leafy vegetables. Results revealed that maximum and minimum antioxidant activity in fresh samples were found in mint and spinach respectively. After blanching antioxidant activity retained maximum in carrot leaves and minimum in chenopodium. After drying antioxidant activity retained maximum in mustard leaves and minimum in fenugreek leaves. The antioxidant activity of selected leafy vegetables was found influenced by processing treatments (blanching and drying), drying has more influence on antioxidant activity than blanching.***

Keywords: Antioxidants, leafy vegetables, blanching, drying

1. Introduction

Leafy vegetables are rich source of vitamins such as ß carotene, ascorbic acid, vitamin E, folic acid, riboflavin, tocopherol and vitamin K as well as minerals like calcium, phosphorus, iron, potassium and sodium. Leafy vegetables also contain significant amount of health promoting phytochemicals such as polyphenols (Yadav *et al.* 2013)[1]. They have been reported to exhibit antioxidant activity which allows them to scavenge free radicals in the body (Krimmel *et al*. 2010)[2]. Flavonoids, a class of phenolic compounds has been shown to possess anti-inflammatory, antiviral, anti-carcinogenic, anti-thrombotic, anti-allergic and hepato-protective (Enayde *et al.* 2006)[3]. Recently special attention has been paid towards green leafy vegetables especially those that are rich in secondary metabolites (frequently called phyto-chemicals) and there is now increasing interest in antioxidant activity of such phyto-chemicals present in the diet and effect of processing on them. Thus present study was set up to determine the antioxidant activity and phytochemical contents of commonly consumed leafy vegetables and to determine the influence of blanching and drying treatments.

2. Materials and Methods

The present study was carried out on eight green leafy vegetables (Table 1). They were obtained from local market of Sanganer, Jaipur, Rajasthan in a single lot. Selection of sample was done on the basis of availability and consumption by the local population.

Table 1: Botanical and local / common names of vegetables used in this study

S. No.	Common Hindi/ English name	Botanical names
1.	Palak/ Spinach	*Spinacia oleracea*
2.	Methi/ Fenugreek leaves	*Trigonella foenum graecum*
3.	Bathua/ Chenopodium	*Chenopodium album*
4.	Pudina/Mint	*Mentha arvensis*
5.	Dhania/ Coriander leaves	*Coriandrum sativum*
6.	Piyaz ke patte /Onion stalks	*Allium ascalonicum*
7.	Gajar ke patte/Carrot leaves	*Daucus carota* subsp. *sativus*
8.	Sarson ke patte / Mustard leaves	*Brassica juncea*

All the samples of leafy vegetables collected (in triplicate) were washed thoroughly in running tap water to remove dust and dirt. The tender part of stems and seeds and foreign material and edible portion were separated. Each sample was divided into three portions, *i.e.* raw, blanched and dried to know the impact of processing (*i.e.* blanching and drying) on the antioxidant activity, total phenol and flavonoid content in the selected samples.

Blanching: All the selected green leafy vegetables were blanched by emersion in boiling water for 2 minutes. After blanching the extra water was drained and vegetables stored in airtight container and kept in deep freezer at -18° C ± 5° C till analysis is done.

Drying: The green leafy vegetables (100g each) were dried using a cabinet dryer at 60°C for 10-12 hours until samples became crisp and brittle to touch. After drying the samples were powdered (1.0 mm mesh) and stored in an airtight container and kept in a refrigerator for further analysis.

All the selected green leafy vegetables were also analyzed in raw and fresh form for which they were stored in airtight container and kept at -18°C ± 5°C till analysis was done.

Extraction of samples for analysis of total phenols, flavonoids and antioxidant activity: Ten g of crushed sample from each vegetable was taken with 100 ml of methanol in a conical flask, plugged with cotton wool and then kept on a rotary shaker at 120 rpm for 24 h. After 24 h, the extract was filtered through eight layers of muslin cloth; centrifuged at 5000 rpm for 10 min., supernatant was collected and the solvent was evaporated and the dry extract was stored at 4ºC in air tight bottles (Parekh and Chanda, 2007)[4].

Determination of total phenols, flavonoids and antioxidant activity in extracted samples

Total phenol content: Total phenol content in the sample extract was determined using UV spectrophotometer by folin-ciocalteu method (Olajire and Azeez, 2011)[5].

Flavonoid content: Flavonoid content in extracted samples was estimated by aluminum chloride ($AlCl_3$) method (Jagadish *et al.* 2009)[6] using UV spectrophotometer.

Antioxidant activity by Ferric reducing antioxidant power (FRAP) assay: antioxidant activity was analysed using FRAP method (Oyaizu, 1986)[7] in sample extract. UV spectrophotometer was used for reading the absorbance.

3. Results and Discussion

Total phenols, flavonoids and antioxidant activity in fresh and raw selected leafy vegetables: The results of the study are presented in table-3

Total phenols: The mean Total phenol content in raw samples was found to be significantly higher in mustard leaves (48.36mg/100g GAE) followed by chenopodium leaves (42.64 mg/100g) and coriander leaves 41.84mg/100g) than all other GLV's. Values observed in this study were comparable to those reported earlier by Yadav *et al.* (2013)[1]. They also reported variation in total phenolic content in their study on chenopodium, fenugreek leaves, spinach, and mustard leaves respectively.

Flavonoids: Flavonoids concentration ranged from 9.16mg/100g (mustard leaves) to 38.32mg/100g (mint).

Antioxidant activity: antioxidant activity estimated in selected leafy vegetables ranged from 18.3mg/100g AAE (spinach)) to 77.8mg/100g AAE (mint). Similarly Yadav *et al.* (2013)[1] studied antioxidant activity by FRAP method among different green leafy vegetables and reported that 15.20mg /100g ascorbic acid equivalent (AAE) in spinach 28.34mg /100g AAE in chenopodium leaves and 46.5mg/100g AAE in mustard leaves on fresh weight basis . Similarly the antioxidant activity as reported by Ali *et al.* (2011)[8] studied in mustard leaves 48.72 mg/100g trolox equivalent (TE).

Variation in the genetic composition of the plants, the environmental conditions under which the plants were grown, harvesting time and the season of the year, agronomic practices applied to the plants prior to harvest and the harvesting and handling practices prior to analysis (Mosha *et al.* 1997)[9].

Effect of blanching on total phenol, flavonoids and antioxidant activity in selected leafy vegetables
Results of the effect of blanching total phenolics, flavonoids and antioxidant activity are summarized in table 3.

Total Phenols: Blanching resulted in a slight decrease in the concentration of total phenols in all leafy vegetables. The total phenol content retained after blanching was 92.46%, 86.47%, 83.65%, 79.60%, 93.40%, 79.10%, 79.90% and 95.60% in spinach, fenugreek leaves, coriander leaves, mint, chenopodium leaves, onion leaves, carrot leaves and mustard leaves respectively. It was observed that the retention of phenol content was found lowest in onion leaves followed by mint and then carrot leaves. The retention of polyphenol content was highest in mustard leaves.

Flavonoids: In case of flavonoids blanching resulted in a significant ($p<0.05$) reduction in all leafy vegetables. Flavonoid retention after blanching was 90.80%, 90.10%, 67.60%, 73.20%, 82.30%, 71.20%, 65.30% and 83.60% for spinach, fenugreek leaves, coriander leaves, mint, chenopodium leaves, onion leaves, carrot leaves and mustard leaves, respectively.

Antioxidant Activity: Blanching caused decrease in antioxidant activity in all vegetables selected for study. The results of present study indicated that the retention of antioxidant activity in onion leaves (97.30%) , carrot leaves (95%), coriander leaves (91%), mint (90%), mustard leaves (86.46%) spinach (84.15%), fenugreek leaves (79.50%) and chenopodium leaves (69.30%) was in decreasing order. Approximate similar results have been reported earlier by Gacche *et al.* (2010)**[10].**

Effect of drying on total phenol, flavonoids and antioxidant activity in selected leafy vegetables
Drying of the leafy vegetables resulted in a significant ($p<0.05$) increase in concentration of total phenols, flavonoids and antioxidant activity in all leafy vegetables. (Table-3)

Total Phenols: The highest total phenols were found in chenopodium leaves (424.10mg/100g GAE) followed by coriander leaves (418.2mg/100g GAE) than all other leafy vegetables.

Flavonoids: The mean flavonoid content was 78.7 ±0.61, 121.5 ±0.31, 173.2 ±0.20, 165.2 ±0.46, 208.4 ±0.42, 82.5 ±0.20, 113.1 ±0.38, 103.6 ±0.57 mg QE/100g in carrot leaves, chenopodium leaves, coriander leaves, fenugreek leaves, mint, mustard leaves, onion leaves and spinach respectively. These values were much higher than those of fresh raw leafy vegetables.

Table 2: Weight retained after drying of leafy vegetables

S. No.	*Name of leafy vegetable*	*Weight retained after drying g/100g*
1	Carrot leaves	8.2 ±0.37
2	Chenopodium leaves	6.4 ±0.30
3	Coriander leaves	5.7 ±0.2
4	Fenugreek leaves	6.1 ±0.2
5	Mint	5.8 ±0.61
6	Mustard leaves	8.0 ±0.45
7	Onion leaves	4.3 ±0.41
8	Spinach	7.9±0.56

Antioxidant Activity: Antioxidant activity after drying increased in all the samples. This may be due to concentration effect of drying on nutrients. Antioxidant activity of selected leafy vegetables after drying ranged from 394.0 (spinach) minimum to 801.4 mg / 100g AAE (mint) maximum. The percent increase in antioxidant activity after drying on leafy vegetables was highest in fenugreek leaves (95.65%) followed by coriander leaves (94.71%), spinach (93.60%), mint (92.80%), carrot leaves (92.36%), chenopodium (92.32%), onion leaves (91.42%) and mustard leaves (90.79%). These results are in corroboration with the finding of Singh *et al.* (2007)[11]. Zoro *et al.* (2016)[12] studied the antioxidant properties of shade dried leafy vegetables and found increase in antioxidant activity which ranged from 34.44% to 52.03% after 15 days of shadow drying.

Table 3: Antioxidant contents and antioxidant activity present in raw, blanched and dried green leafy vegetables.

S. No.	Name of vegetable	Raw Green Leafy Vegetables*			Blanched Green Leafy Vegetables			Dried Green Leafy Vegetables*		
		Total phenols (mg/100g GAE)	Flavonoids (mg/100g Quercetin E)	Antioxidant activity (mg/100g AAE)	Total phenols (mg/100g GAE)	Flavonoids (mg/100g Quercetin E)	Antioxidant activity (mg/100g AAE)	Total phenols (mg/100g GAE)	Flavonoids (mg/100g Quercetin E)	Antioxidant activity (mg/100g AAE)
1	Carrot leaves	11.64 ± 0.15	10.45 ± 0.60	43.5 ± 3.18	9.2 ±1.30	6.83 ±0.71	41.3 ±2.05	95.34 ± 0.44	78.7 ±0.61	421.6 ±1.57
2	Chenopodium leaves	42.64 ± 0.51	12.83 ± 0.78	55.4 ± 1.21	39.86 ± 0.50	10.57 ± 0.47	38.4 ±1.45	424.12 ± 0.60	121.5 ± 0.31	645.2 ±1.31
3	Coriander leaves	41.84 ± 0.15	16.76 ± 0.55	69.3 ± 1.15	34.98 ± 0.45	11.32 ± 0.55	62.8 ±2.33	418.2 ±0.27	173.2 ± 0.20	727.34 ±1.09
4	Fenugreek leaves	36.23 ± 0.45	17.43 ± 0.31	48.3 ± 2.91	31.4 ± 0.85	15.76 ± 0.50	38.4 ±3.25	309.34 ±0.60	165.2 ± 0.46	474.0 ±2.46
5	Mint	38.32 ± 0.40	20.12 ± 0.76	77.8 ± 2.49	30.48 ± 1.30	14.72 ± 0.45	70.2 ±4.33	313.4 ±0.62	208.4 ± 0.42	801.4 ±1.48
6	Mustard leaves	48.38 ± 0.55	9.12 ±0.51	46.5 ± 3.34	46.22 ± 1.55	7.64 ±0.45	40.2 ±4.20	302.34 ± 0.71	82.5 ±0.20	461.5 ±2.50
7	Onion leaves	16.3 ± 0.45	11.7 ±1.15	53.9 ± 2.07	12.9 ± 0.20	8.34 ±0.87	47.2 ±2.88	164.4 ±0.25	113.1 ± 0.38	584.2 ±2.80
8	Spinach	22.56 ± 1.07	9.24 ±0.30	18.3 ± 0.76	20.86 ± 0.45	8.32 ±0.40	15.4 ±2.86	276.64 ± 1.02	103.6 ± 0.57	394.0 ±4.80
CD (5%)		0.930	1.162	4.038	1.644	0.999	5.309	1.061	1.547	4.362

*Raw and blanched green leafy vegetables were analysed on wet basis
*Dried green leafy vegetables were analysed on dry weight basis
± Standard deviation

4. Conclusion

Green leafy vegetables are rich source of polyphenols, flavonoids, and antioxidant activity. Blanching caused a decrease in the total phenols, flavonoids and antioxidant activity in leafy vegetables studied while drying caused increase in concentration of nutrients and also increase in phenol, flavonoid content and antioxidant activity. Thus, the dried leaves can be easily incorporated in different traditional recipes at acceptable levels. They can also be used as natural fortificants in our daily diet for enhancing the micronutrient content.

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