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Research Paper

Effect of different blanching treatments on ascorbic acid retention in green leafy vegetables

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Abstract

Blanching is a prerequisite for preservation of green leafy vegetables. However, it may cause partial destruction of some nutrients like ascorbic acid which is highly oxidizable with time in the post harvest period on atmospheric exposure. The objective of the present study is to identify a suitable blanching treatment and conditions (temperature, time and media) for commonly consumed green leafy vegetables that ensures enzyme inactivation and maximum ascorbic acid retention. Ten commonly consumed leafy vegetables, viz. Amaranth (***Amaranthus gangeticus* Linn.**), *Ambat chuka* (***Rumex vesicarius* Linn.**), *Bathua* (***Chenopodium album* Linn.**), *Brahmi* [***Centella asiatica* (Linn.) Urban**], Drumstick (***Moringa oleifera* Linn.**), Fenugreek (***Trigonella foenum-graecum* Linn.**), *Keerae* (***Amaranthus* sp.**), *Kilkeerae* (***Amaranthus tricolor* Linn.**), *Shepu* (***Anethum graveolens* Linn.** syn. *Peucedanum graveolens* Linn.), and Spinach (***Spinacia oleracea* Linn.**) were blanched for 1, 2 and 4 min at 80, 90 and 98°C in water and chemical media, steamed for 5 and 10 min with and without chemical treatment and microwaved for 1 and 1.5 min, unblanched greens served as control. Retention of ascorbic acid was reduced as the blanching time and temperature increased in all greens. It was comparatively higher in chemically treated samples both in conventional and steam blanched samples. Steam blanched samples (5 min) had a higher level of ascorbic acid than conventional blanched samples irrespective of blanching media. Ascorbic acid content of microwave-blanched samples was better in some greens compared to conventionally blanched greens. Blanching at 80°C for 1 min, steaming for 5 min and microwaving for 1 min was sufficient to inactivate peroxidase in all except two green leafy vegetables irrespective of the blanching media. From the nutrition point of view, chemical blanching proved to be advantageous both in steam and conventional blanching for short period and it also ensured enzyme inactivation.

Keywords: Leafy vegetables, Ascorbic acid, Steam blanching, Chemical blanching, Microwave blanching, Peroxidase inactivation.

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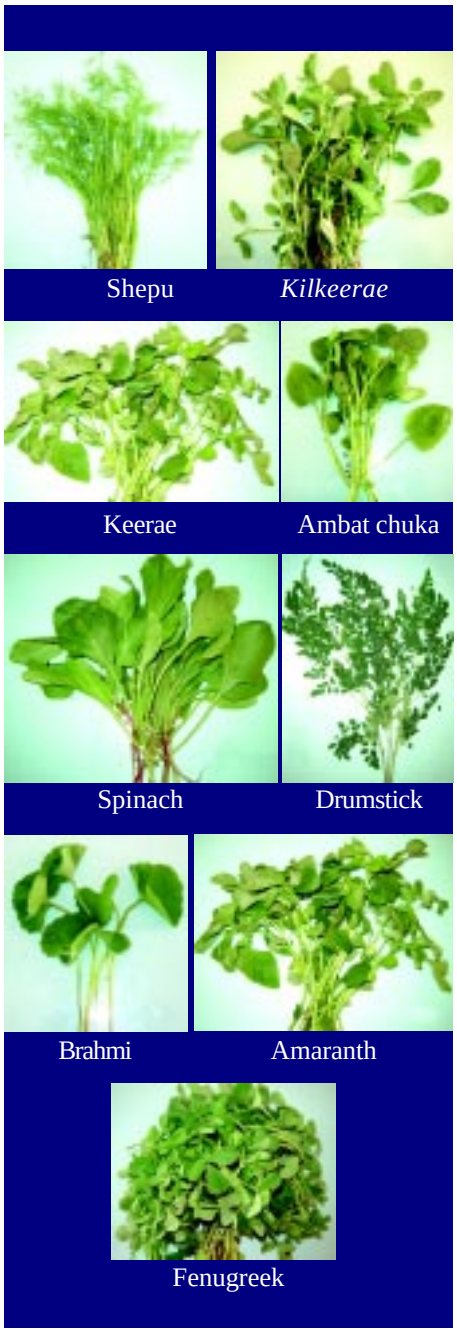

Introduction

Green leafy vegetables (GLVs) are a store house of vitamins such as beta carotene, ascorbic acid, folic acid and riboflavin as well as minerals such as iron, calcium and phosphorous. They also contain an immense variety of bioactive non-nutritive health promoting factors as antioxidants, phyto-chemicals, essential fatty acids and dietary fibre. Their high moisture content renders them perishable and seasonal availability limits their utilization all round the year. Hence, there is a need to preserve this nature's store house of nutrients through proper processing techniques for safe storage with efficient nutrient retention. Dehydration and freeze drying technologies are the commonly used techniques for preserving them. Research has shown that even in

normal storage conditions (-18°C) vegetables undergo changes in organoleptic and nutritional profile (vitamin A and C losses) which is attributed to enzymatic activity[1].

Peroxidases are the enzymes present in plant tissues that cause oxidation of many compounds in the presence of oxygen on storage[2]. When peroxidases react with hydrogen peroxide they form phototoxic free radicals which in turn cause loss of vitamins and develop cold damage symptoms[3, 4]. One common technique employed to arrest enzyme activity and associated changes before processing is blanching[4, 5].

Blanching consists of mild heat treatment of the vegetables in different heating system (steam, hot water and microwave) to varying time periods. It is influenced by various factors such as blanching media, temperature, time, physical and physiological characteristics of the vegetables, average size of the pieces and uniformity of heat distribution and penetration[6, 7]. These factors are highly specific for different leafy vegetables as the surface area exposed per unit mass varies from one to another[1].

Ascorbic acid, the antioxidant vitamin, is heat labile and sensitive to light, oxygen and oxidizing agents. Though blanching is a prerequisite to inactivate enzymes, it is deleterious to the vegetables causing vitamin losses by thermal degradation, diffusion and leaching[8]. The extent of loss, however, will depend on the extent and duration of exposure to these factors[9]. Ascorbic acid is the most difficult of the vitamins to preserve during blanching and dehydration. Chemical blanching is known to have a protective effect on ascorbic acid. The protective effect of sodium metabisulphite has been demonstrated by Chaudhary and Rao[10] and Badifu[11] which is supported by Mulay *et al*[12] who reported that the use of potassium metabisulphite (KMS) for pretreatment of the green leafy vegetables can reduce the extent of loss of ascorbic acid. A combination of chemicals (0.5% potassium metabisulphite + 0.1% magnesium oxide + 0.1% sodium bicarbonate) used for blanching is known to have better retention of ascorbic acid when compared to individual chemicals used for blanching[13].

As blanching is a prerequisite for preserving green leafy vegetables, it is very much essential to establish the conditions of blanching to enhance the utility of this nutritious economical source. The investigation was undertaken to identify the blanching treatment and conditions (temperature, time and media) for the commonly consumed green leafy vegetables that ensures enzyme inactivation and maximum ascorbic acid retention.

Materials and Methods

Ten commonly consumed green leafy vegetables namely: Amaranth (***Amaranthus gangeticus* Linn.**), *Ambat chuka* (***Rumex vesicarius* Linn.**), *Bathua* (***Chenopodium album* Linn.**), *Brahmi* [***Centella asiatica* (Linn.) Urban**], Drumstick (***Moringa oleifera* Linn.**), Fenugreek (***Trigonella foenum-graecum* Linn.**), *Keerae* (***Amaranthus* sp.**), *Kilkeerae* (***Amaranthus tricolor* Linn.**), *Shepu* (***Anethum graveolens* Linn.** syn. *Peucedanum graveolens* Linn.) and Spinach (***Spinacia oleracea* Linn.**) were procured from a single lot from a local market of Mysore city.

Processing

The selected green leafy vegetables were derooted, washed in tap water to remove the adhering mud particles, drained well and rinsed in glass distilled water. The greens were thoroughly drained, weighed, chopped into 1 cm pieces and blanched with 3 parts of water/ solution by the following methods: (i) Blanched at 80 ± 1°C, 90 ± 1°C, and 98 ± 1°C for 4 min in glass distilled water, (ii) Blanched at 80 ± 1°C for 1, 2 and 4 min in water and in a chemical solution containing 0.5% potassium metabisulphite+0.1% magnesium oxide+0.1% sodium bicarbonate, (iii) Steam blanched for 5 and 10 min in a pressure cooker with and without chemical treatment, and (iv) Microwave blanched for 60 and 90 sec at high power in distilled water (model no. BMO-700T, BPL microwave cooking system).

Chemical analysis

The above blanched samples were analyzed for ascorbic acid by visual titration method[14] and tested for peroxidase inactivation by Guaiacol peroxide method[7].

Statistical analysis

Analysis of Variance was applied to test the differences in the retention of ascorbic acid blanched under different conditions. Analysis was done using the statistical package MINITAB, probability level was fixed at 5 per cent.

Results and Discussion

Effect of blanching temperature on retention of ascorbic acid

Ascorbic acid content of all greens blanched at 80°C showed a reduction but

Table 1 : Effect of blanching temperature on the retention of ascorbic acid (%)

Leafy vegetables	Ascorbic acid			
	mg/100g	% retention		
		Blanched for 4 minutes in distilled water at		
		80°C	90°C	98°C
Amaranth	31.7	8.4	8.0	7.0
Keerae	15.6	22.7	14.0	11.9
Kilkeerae	32.7	27.9	13.2	11.3
Shepu	23.5	29.9	26.8	23.9
Spinach	8.1	16.7	14.3	12.0
Fenugreek	38.9	29.7	28.7	25.1
Ambat chuka	7.2	58.8	55.9	50.0
Drumstick	103.4	9.2	2.6	1.9
Brahmi	38.5	17.7	16.1	13.4
Bathua	9.6	32.5	30.9	23.9
Statistical Analysis				
F ratio	-	0.83^{ns}		

ns - not significant

the extent of loss varied between the vegetables. Retention was comparatively higher in *ambat chuka* (>50%), moderate in *kilkeerae*, *shepu*, fenugreek and *bathua* (25-30%) and lower in the remaining greens (Table 1). The differential loss of ascorbic acid in the leafy vegetables treated under identical conditions could be attributed to differing vulnerabilities due to surface area, mechanical damage, initial ascorbic acid content and enzymatic activities. With increase in temperature by another 10°C, *keerae* and *kilkeerae* showed a further reduction of 1.5 to 2 folds and drumstick leaves by 3.5 folds while other greens showed marginal reduction. When the temperature of blanching water was raised to boiling point (98°C), *ambat chuka* and *bathua*, which exhibited a higher retention of ascorbic acid at 80 and 90°C, reduced by another 5-7%, while in the other greens, it was marginal. On the whole the greens blanched at boiling point showed retention of 10-30% ascorbic acid in all except *ambat chuka* (50%) and drumstick leaves (2%). These findings confirm the earlier reports that ascorbic acid is a highly soluble substance and thermal processing results in maximum losses[15, 16]. Further increase in temperature though reduced the ascorbic acid content, the extent of differences between the different temperature treated samples was not significant (P>0.05). These findings are in accordance to those reported by Gupte and Francis[17] wherein they have shown that there is an increase in the loss of ascorbic acid in fenugreek leaves with every 10°C rise in the temperature of blanching media.

Effect of blanching time and media on retention of ascorbic acid

Of the greens blanched at 80°C for 1 min in distilled water, amaranth, *shepu* and drumstick leaves showed least retention (10-20%) while *ambat chuka* and *brahmi* showed highest retention (70-75%) of ascorbic acid. With increase in blanching time for another 1 min, drumstick, *brahmi* and *bathua* showed a further loss of 5-10% while in others it was marginal. When the blanching time was increased to 4 min, *ambat chuka*, *kilkeerae* and *brahmi* showed a reduction of 10, 20 and 40%, respectively in comparison with the samples blanched for 2 min, while in others the losses were negligible. Analysis of variance revealed that increasing the blanching time by 1-2 min at same temperature would not significantly affect the loss of nutrients (P>0.05). The findings are similar to those reported for Swiss chard (***Beta vulgaris* Linn.**) leaves wherein a 18% increase in loss of ascorbic acid was reported with increase in the blanching time from 30-120 sec[18].

Greens blanched in the chemical solution at 80°C for 1 min showed maximum retention of ascorbic acid in *ambat chuka*, *brahmi* and *keerae* (92-97%) and least in drumstick leaves (25%). With increase in blanching time to 4 min, *keerae* and spinach showed a further loss of 15%, *brahmi* showed a remarkable loss of 49% while in others the losses were marginal. No significant losses were encountered with increase in the blanching time by 1-2 min at the same temperature in chemical media (P>0.05). The chemically treated green leafy vegetables had a better colour retention as magnesium oxide and sodium bicarbonate used in the media has a protective effect on colour of these vegetables.

Table 2: Effect of blanching time on the retention of ascorbic acid (%)

Leafy vegetables	Blanched at 80°C					
	Time in minutes					
	Chemical			Water		
	1	2	4	1	2	4
Amaranth	67.3	65.4	61.1	11.3	10.9	8.4
Keerae	97.4	71.0	57.4	34.8	30.1	22.7
Kilkeerae	75.2	53.4	50.9	49.8	46.4	27.9
Shepu	70.2	60.9	53.3	38.6	36.1	29.9
Spinach	39.6	37.6	21.5	23.7	17.4	16.7
Fenugreek	42.3	34.0	31.3	30.8	30.5	29.7
Ambat chuka	92.5	79.8	73.1	70.5	67.7	58.8
Drumstick	24.9	16.5	15.5	16.0	11.3	9.2
Brahmi	95.0	89.9	40.4	75.0	60.0	17.7
Bathua	58.1	55.2	50.0	42.8	33.3	32.5
Statistical Analysis						
Time variant	**Chemical blanched**			**Water blanched**		
F ratio	1.09^{ns}			1.46^{ns}		
Water vs Chemical blanched greens						
Time in min	F ratio					
1	3.67^{ns}					
2	5.61*					
4	7.47 *					

ns - not significant , * - significant at 5% level

Greens blanched at 80°C for 1 min in chemical solution had 10-15% higher retention of ascorbic acid compared to water blanched ones. Even with increase in blanching time by 1-2 min, chemically blanched greens showed significantly higher (P<0.01) retention of ascorbic acid over water blanched ones. Similar observations were reported for fenugreek leaves and other vegetables[13, 17].

These findings infer that chemical media offer a protection against oxidation of ascorbic acid and thereby a higher retention of the water soluble vitamin was observed in spite of subjecting the green leafy vegetable to thermal treatment. From Table 2 it can be seen that chemically blanched greens for longer time (4 min) had higher retention of ascorbic acid (in all except *brahmi*) compared to those blanched in water for a shorter time (1 min) also.

Steam blanching and ascorbic acid retention

On steam blanching for 5 min the retention of ascorbic acid content ranged from 11-26% in 4 greens and 45-85% in 6 greens (Table 3). Chemically pretreated greens showed a comparatively higher retention i.e. 21-40% in three and 52-90% in seven greens, respectively. Of the greens, amaranth showed the least and *ambat chuka* the highest retention irrespective of treatment. With increase in blanching time to 10 min, a further reduction of 20-50% was observed in six of untreated and 14-20% in four of the chemically pretreated greens. The time of steam blanching showed no association with ascorbic acid retention both in treated and untreated greens (P>0.05). The greens blanched for five minutes were better in appearance than those blanched for ten minutes. Systemic sensory analysis was not done. However, the observations of Aguero *et al*[18] found that the deterioration observed in sensory parameters with increase in blanching time was not significant in Swiss chard leaves.

Microwave blanching and ascorbic acid retention

Greens blanched in a microwave oven for 1 min showed 60% retention of ascorbic acid in *bathua* and *ambat chuka* while in others it ranged from 17-40% (Fig.1). With increase in time by another 30 sec, four greens showed a further loss of 10-20% but the extent of losses were not found to be statistically significant (P>0.05).

Peroxidase test (qualitative)

Peroxidase is the most thermally stable enzyme present in vegetable systems, hence this is usually used as an index of the effectiveness of blanching treatments. If this enzyme is inactivated, other enzymatic systems responsible for tissue degradation will also be inactivated[18]. Blanching time would be the time required to achieve inactivation of peroxidase. This would depend on a wide

Table 3 : Effect of steam blanching at different time intervals on ascorbic acid retention (%)

Leafy vegetables	Time of blanching in minutes			
	Chemically treated		Untreated	
	5	10	5	10
Amaranth	21.0	19.5	11.6	11.4
Keerae	73.6	42.9	45.1	20.5
Kilkeerae	43.4	37.7	17.4	15.2
Shepu	74.7	59.7	60.1	27.3
Spinach	33.7	23.2	21.3	14.3
Fenugreek	58.1	44.7	56.4	40.3
Ambat chuka	90.0	83.3	85.0	82.1
Drumstick	67.0	46.7	52.6	12.2
Brahmi	52.6	36.8	26.8	13.4
Bathua	63.1	62.2	83.0	59.1
Statistical Analysis				
Time variant	**Chemically treated**		**Untreated**	
F ratio	1.85^{ns}		2.11^{ns}	
Untreated vs Chemically treated vegetables				
	Time in min		F ratio	
	5		1.24^{ns}	
	10		2.78^{ns}	

ns - not significant

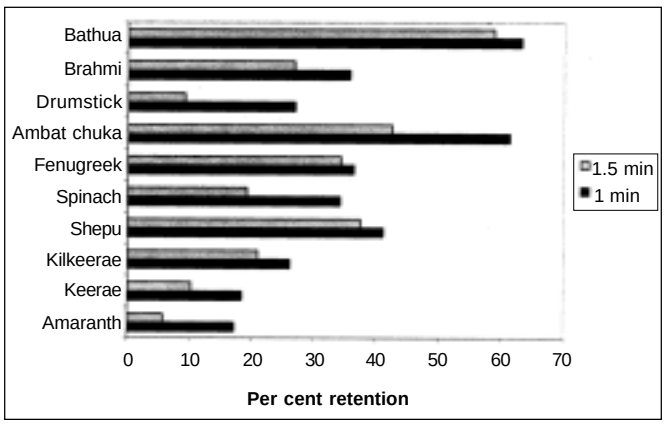

Fig. 1: Effect of Microwave blanching at different time intervals on ascorbic acid retention

range of factors as heating method, temperature, size, shape and thermal conductivity of product, type and concentration of enzymes. During present study it was observed that blanching at 80°C for 1 min in water, steam blanching for 5 min and microwave treatment for 1 min were found sufficient for peroxide inactivation for most of the greens. Chemical treatment did not have any additional benefit in this process.

Conclusion

Among the greens selected, *ambat chuka* had maximum retention of ascorbic acid followed by *bathua* and *shepu* by all blanching treatments irrespective of time and temperature. Chemically treated samples showed better retention of ascorbic acid than their respective untreated samples irrespective of blanching method or greens. Blanching at 80°C for 1 min ensured peroxidase inactivation in all except two greens, which was found inactivated on extending the blanching time for another one minute. Thus, it can be suggested that 80°C for 1 min and chemical media are most ideal for blanching greens with maximum nutrient retention. The study results may serve as a guide to select blanching method, time, media and temperature for processing the commonly consumed green leafy vegetables.

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