



## Analysis of Selected Micronutrients Before And After Leaching of Spinach and Amaranth gangeticus, Processed by Different Cooking Methods

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### ABSTRACT

The study aims to study the effect of different cooking methods like soaking and cooking, normal cooking, double cooking, pressure cooking and microwave cooking on the iron, thiamine, riboflavin, niacin, ascorbic acid and folic acid content of spinach and Amaranth gangeticus before and after leaching. The results clearly indicated that among various cooking methods soaking and cooking was the most effective method in retaining iron (72%), thiamine (91%), riboflavin (56%), niacin (91%), ascorbic acid (91%) and folic acid (92%) in spinach, similarly in retaining iron (99%), thiamine (99%), riboflavin (97%), niacin (94%), ascorbic acid (96%) and folic acid (64%) in Amaranth gangeticus. Leaching of vegetables is recommended to renal patients in order to reduce the food mineral load. The results of the study will provide guidance to nutritionists regarding the effectiveness in advising patients with compromised renal function on the importance of leaching vegetables.

**Keywords: Leaching of vegetables, green leafy vegetables.**

### INTRODUCTION

Food is the basic necessity of life which satisfies the physiological and social needs of human beings. The nutritional approach which has dominated in most of the research works on food consumption views food and eating in relation to the nutrient composition of foods and their instrumental roles in the physiologic functioning of the human body (Shils, 2006).

Vegetables form an essential part of the diet of both rich and the poor as majority of the Indian population is vegetarian (Bedi. R et al., 2006). In India a substantial proportion of the population, perhaps approximately 35%, follows a traditional vegetarian diet for many generations (Refsum. H et al., 2001). Vegetables are the major source of vitamins and minerals which are the chief regulators in metabolism in human beings (Shahnaz et al., 2003).

Minerals are necessary for human life and play very important roles in bodily functions. Nutrition professionals recommend that they should be consumed as part of a balanced diet, primarily as fruits and vegetables, rather than in the form of dietary supplements (Piotr Szefer and Jerome, 2007). Vitamins are essential part of foods and feeds. Humans and animals require a certain amount of vitamins for normal health (Mian, Muhammad Asif and Rashida Ali, 2009).

Leafy green vegetables occupy an important place in the diets of millions of people in India. A wide range of vegetables can be grown on the Indian subcontinent as it has a variety of natural habitats, climates and seasons (Singh et al. 2001). These leafy vegetables are generally inexpensive foods rich in important nutrients such as carotenoids, vitamins, ascorbic acid, riboflavin, folic acid, polyphenols, iron, calcium and other minerals (Radek. M and Savage. G. P., 2008).

Cooking is an essential process for vegetables not only to make them edible but also for enabling maximum utilization of the starch present in the vegetables as a source of energy (Kala and Prakash, 2001). Losses of vitamins and minerals during processing and cooking can occur either due to oxi-

dation or by dissolving in water (Tapadia et al., 1995). The degree of vitamins and other nutrient losses is influenced by various factors, for example the type of food, variety of vegetables, the way of cutting, preparation, duration and method of cooking (Rumm-Kreuter D et al., 1990).

Arunachalam Kala and his co-worker in 2006 who evaluated the nutrient composition of four vegetables suggested that ascorbic acid was destroyed to the greatest extent by pressure cooking followed by microwave cooking and conventional method. Mineral content of the vegetables did not differ significantly in raw and cooked vegetables. Santosh et al., 2010 recommend that microwave cooking could be the best method for legume preparation, not only for improving nutritional quality, but also for reducing the cooking time. With respect to the whole soaking and cooking processes, the best conditions, which result in minimum vitamin loss, are 9 hours of soaking in 0.1% citric acid solution or in water and subsequent microwave cooking of the seeds. These conditions are found to be optimal for best retention of other nutrients as well.

Leaching of vegetables is recommended to renal patients in order to reduce the food mineral load. The effect of cooking losses on vitamin and mineral intake is an important consideration in dietary and epidemiological studies in India. Ironically, there is a paucity of data available on the total percentage retention of water soluble vitamins after leaching of potassium rich vegetables in India, except for a few limited studies. The present study investigates the percentage of iron and selected water soluble vitamins retained in potassium rich green leafy vegetables (Spinach and Amaranth gangeticus) after leaching by different cooking methods and to determine the best cooking method that minimize the nutrient loss in cooked vegetables. These results will also provide guidance to nutritionists regarding the effectiveness in advising patients with compromised renal function on the importance of leaching vegetables.

### MATERIALS AND METHODS

The present study involves pre-test post-test experimental design for estimating the iron, thiamine, riboflavin, niacin,

ascorbic acid and folic acid content of potassium rich green leafy vegetables like spinach and Amaranth gangeticus before and after leaching by various cooking methods like soaking and cooking, normal cooking, double cooking, pressure cooking and microwave cooking. The samples were selected by means of purposive sampling technique. The samples of raw vegetables namely spinach and Amaranth gangeticus were weighed and 100g of each green leafy vegetable were taken for each cooking method. The green leafy vegetables were cleaned and chopped evenly for processing.

#### Processing methods

Metro water was selected for each processing method. For the soaking and cooking method the selected green leafy vegetables (GLV) were soaked in hot water (50–60° C) overnight for 8 hours in 1:5 ratio (100g GLV: 500ml of water). The soaked water was discarded and the green leafy vegetables were cooked for 10 minutes by sprinkling minimal amount of water. For the normal cooking and double cooking 100g of chopped green leafy vegetables were added to the boiling water (100° C) and cooked for 10 minutes. In case of double cooking the

same procedure was repeated again. For pressure cooking, the green leafy vegetables were pressure cooked for 2 to 3 minutes with the same ratio of water. The same ratio of each green leafy vegetable with water was cooked in microwave at  $95 \pm 2$  C for 10 minutes. After cooking, the water was discarded from all the samples and 100g of all the leached green leafy vegetable samples were given for iron, thiamine, riboflavin, niacin, ascorbic acid and folic acid analysis. All the water soluble vitamins were estimated by high-performance liquid chromatography (HPLC) and iron by atomic absorption spectrophotometry. The analysis was carried out by qualified analyst in the laboratory attached to A to Z pharmaceuticals, Chennai.

The data collected were analyzed using statistical methods like arithmetic mean, standard deviation and student't test.

#### RESULTS & DISCUSSION

The results from the micronutrient analysis showed that the percentage of the iron retained in spinach which is 72% after leaching by soaking and cooking was more significant when compared to other cooking methods ( $p < 0.01\%$ ) (Table 1).

**Table – 1: Comparison of iron, thiamine, riboflavin, niacin and ascorbic acid content of spinach before and after leaching by different cooking methods**

S. No	Cooking methods	Micronutrients in Spinach	Before leaching mg/100g	After leaching mg/100g	't' value
			Mean $\pm$ SD	Mean $\pm$ SD	
1.	Soaking and cooking	Iron	1.13 $\pm$ 0.01	0.818 $\pm$ 0.001	77.517**
		Thiamine	0.034 $\pm$ 0.001	0.031 $\pm$ 0.001	4.243**
		Riboflavin	0.211 $\pm$ 0.001	0.119 $\pm$ 0.001	65.054**
		Niacin	1.69 $\pm$ 0.015	1.54 $\pm$ 0.015	13.156**
		Ascorbic acid	32.30 $\pm$ 0.158	29.41 $\pm$ 0.153	913.898**
2.	Normal cooking	Iron	1.13 $\pm$ 0.01	0.804 $\pm$ 0.001	70.307**
		Thiamine	0.034 $\pm$ 0.001	0.012 $\pm$ 0.001	31.113**
		Riboflavin	0.211 $\pm$ 0.001	0.093 $\pm$ 0.001	83.439**
		Niacin	1.69 $\pm$ 0.015	1.33 $\pm$ 0.015	37.947**
		Ascorbic acid	32.30 $\pm$ 0.158	26.31 $\pm$ 0.158	2443.77**
3.	Double Cooking	Iron	1.13 $\pm$ 0.01	0.414 $\pm$ 0.001	141.789**
		Thiamine	0.034 $\pm$ 0.001	0.00 $\pm$ 0.00	48.083**
		Riboflavin	0.211 $\pm$ 0.001	0.00 $\pm$ 0.00	298.399**
		Niacin	1.69 $\pm$ 0.015	0.78 $\pm$ 0.015	86.765**
		Ascorbic acid	32.30 $\pm$ 0.158	22.41 $\pm$ 0.155	2471.00**
4.	Pressure cooking	Iron	1.13 $\pm$ 0.01	0.394 $\pm$ 0.00	168.407**
		Thiamine	0.034 $\pm$ 0.001	0.00 $\pm$ 0.00	48.083**
		Riboflavin	0.211 $\pm$ 0.001	0.00 $\pm$ 0.00	298.399**
		Niacin	1.69 $\pm$ 0.015	0.530 $\pm$ 0.01	122.275**
		Ascorbic acid	32.30 $\pm$ 0.158	21.31 $\pm$ 0.159	2935.063**
5.	Microwave Cooking	Iron	1.13 $\pm$ 0.01	0.402 $\pm$ 0.001	154.174**
		Thiamine	0.034 $\pm$ 0.001	0.00 $\pm$ 0.00	48.083**
		Riboflavin	0.211 $\pm$ 0.001	0.00 $\pm$ 0.00	298.399**
		Niacin	1.69 $\pm$ 0.015	0.64 $\pm$ 0.015	100.114**
		Ascorbic acid	32.30 $\pm$ 0.158	19.31 $\pm$ 0.158	3246.00**

\*\* - Significant at 1 % level

The percentage of thiamine retained in spinach after leaching by soaking and cooking (91%) was more significant when compared to normal cooking (35%) ( $p < 0.01\%$ ). There was a complete loss of thiamine in spinach after leaching by double cooking, pressure cooking and microwave cooking. The riboflavin content in spinach which was 0.119 mg/100g after leaching by soaking and cooking was more significant when compared to other cooking methods ( $p < 0.01\%$ ). There was a complete loss of riboflavin in spinach after leaching by double cooking, pressure cooking and microwave cooking (Table 1).

The percentage of niacin retained in spinach after leaching

by soaking and cooking (91%) was more significant when compared to normal cooking (79%), double cooking (46%), pressure cooking (31%) and microwave cooking (38%) ( $p < 0.01\%$ ). Similarly the percentage of ascorbic acid retained in spinach after leaching by soaking and cooking (91%) was more significant when compared to normal cooking (81%), double cooking (69%), pressure cooking (66%) and microwave cooking (60%) ( $p < 0.01\%$ ).

The present results matches at par with the findings of Dr. Steve Blake (2007) where the author states that the water-soluble vitamins are vulnerable to losses during cooking as they can easily leach out in to cooking water and also many of these vitamins are sensitive to heat.

**Table – 2: Comparison of iron, thiamine, riboflavin, niacin and ascorbic acid content of Amaranth gangeticus before and after leaching by different cooking methods**

S. No	Cooking methods	Micronutrients in Amaranth gangeticus	Before leaching mg/100g	After leaching mg/100g	't' value
			Mean ± SD	Mean ± SD	
1.	Soaking and cooking	Iron	3.94 ± 0.01	3.90 ± 0.01	8.55**
		Thiamine	0.183 ± 0.001	0.181 ± 0.002	2.058NS
		Riboflavin	1.33 ± 0.01	1.29 ± 0.000	5.657**
		Niacin	7.34 ± 0.015	6.922 ± 0.004	71.686**
		Ascorbic acid	103.60 ± 0.158	99.44 ± 0.015	60.360**
2.	Normal cooking	Iron	3.94 ± 0.015	3.70 ± 0.019	16.243**
		Thiamine	0.183 ± 0.001	0.104 ± 0.001	144.234**
		Riboflavin	1.33 ± 0.015	0.99 ± 0.001	50.369**
		Niacin	7.34 ± 0.015	6.540 ± 0.015	63.246**
		Ascorbic acid	103.60 ± 0.158	95.56 ± 0.015	112.035**
3.	Double Cooking	Iron	3.94 ± 0.015	3.52 ± 0.008	51.500**
		Thiamine	0.183 ± 0.001	0.003 ± 0.000	282.214**
		Riboflavin	1.33 ± 0.015	0.894 ± 0.001	65.359**
		Niacin	7.34 ± 0.015	6.33 ± 0.015	79.848**
		Ascorbic acid	103.60 ± 0.158	89.34 ± 0.015	198.708**
4.	Pressure cooking	Iron	3.94 ± 0.01	3.122 ± 0.01	140.286**
		Thiamine	0.183 ± 0.001	0.001 ± 0.00	272.230**
		Riboflavin	1.33 ± 0.015	0.656 ± 0.001	89.668**
		Niacin	7.34 ± 0.015	5.45 ± 0.014	597.670**
		Ascorbic acid	103.60 ± 0.15	80.34 ± 0.015	337.492**
5.	Microwave Cooking	Iron	3.94 ± 0.01	3.63 ± 0.01	49.015**
		Thiamine	0.183 ± 0.001	0.004 ± 0.00	230.003**
		Riboflavin	1.33 ± 0.015	0.915 ± 0.001	62.211**
		Niacin	7.34 ± 0.015	5.34 ± 0.010	533.988**
		Ascorbic acid	103.60 ± 0.158	91.45 ± 0.015	169.306**

\*\* - Significant at 1 % level,

NS - Not Significant

It was noticeable from table 2 that in Amaranth gangeticus samples before and after leaching by soaking and cooking, normal cooking, double cooking, pressure cooking and microwave cooking there was 99%, 94%, 89%, 79% and 92% retention of iron respectively ( $p < 0.01\%$ ). The percentage of thiamine retained in Amaranth gangeticus after leaching by soaking and cooking (99%) was more significant when compared to normal cooking (57%). There was an excessive loss of thiamine in Amaranth gangeticus after leaching by double cooking, pressure cooking and microwave cooking ( $p < 0.01\%$ ).

The percentage of riboflavin retained in Amaranth gangeticus after leaching by soaking and cooking (97%) was more significant when compared to normal cooking (74%), microwave cooking (69%), double cooking (67%) and pressure cooking (49%), ( $p < 0.01\%$ ). Similarly the percentage of niacin (94%) and ascorbic acid (96%) retained in Amaranth gangeticus after leaching by soaking and cooking was more significant compared to other cooking methods ( $p < 0.01\%$ ). The study falls in line with the finding of Rajabu et al. (2001), during their study on the nutrient and antinutrient contents of raw and cooked *Amaranthus hybridus*.

The folic acid content of spinach and Amaranth gangeticus after leaching by pressure cooking reduced significantly from

54.5 mcg/100g to 50.26 mcg/100g and from 0.139 mcg/100g to 0.089 mcg/100g respectively compared to other cooking methods ( $p < 0.01\%$ ). The highest percentage retention of folic acid for spinach (92%) and Amaranth gangeticus (64%) was reported after leaching by soaking and cooking ( $p < 0.01\%$ ).

### CONCLUSION

Processing and cooking conditions cause variable losses of vitamins. Losses vary widely according to cooking method and type of food. It can be concluded that among various cooking methods soaking and cooking was the most effective method in retaining iron (72%), thiamine (91%), riboflavin (56%), niacin (91%), ascorbic acid (91%) and folic acid (92%) in spinach, similarly in retaining iron (99%), thiamine (99%), riboflavin (97%), niacin (94%), ascorbic acid (96%) and folic acid (64%) in Amaranth gangeticus. The iron content was least affected when leached by different cooking methods compared to other micronutrients.

Leaching of vegetables is recommended to renal patients in order to reduce the food mineral load. The effect of cooking loss on vitamin and mineral intake is an important consideration in dietary and epidemiological studies in India. The results of the study will provide guidance to nutritionists regarding the effectiveness in advising patients with compromised renal function on the importance of leaching vegetables.

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