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Effect of storage on calcium and iron content of cabinet dried fenugreek, spinach and coriander leaves

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Abstract
The present research was carried out to study the effect of storage on calcium and iron content of dehydrated fenugreek, spinach and coriander. Three fresh green leafy vegetables namely fenugreek, spinach and coriander were given pretreatments of plain water blanching and chemical blanching [KMS (0.02 per cent) + MgO (1.5gram) + citric acid (1 per cent) + $NaHCO_3$ (1.5 per cent) + NaCl (1.5 per cent)] and dehydrated in cabinet tray dryer at the temperature of 55 ^{0}C for time of 7-8 hours. These dehydrated leafy greens were packed in polypropylene plastic bags and stored at (30+2 ^{0}C) ambient temperature for a period of 3 months. The stored samples were chemically analysed for calcium and iron content at monthly intervals. The calcium content of dehydrated fenugreek was 396.22mg per 100g, in spinach 97.81mg per 100g and in coriander 183.05mg per 100g respectively. The iron content of dehydrated fenugreek was 4.05mg per 100g, in spinach 2.68mg per 100g and in coriander 2.15mg per 100g respectively. The calcium content and iron content of chemically blanched dehydrated samples were found higher than plain water blanched samples.

Keywords: Ambient, blanching, cabinet dryer, dehydration, duration, pre-treatment

1. Introduction

Green leafy vegetables are important part of our balanced diet as they are main natural sources of vitamins like ascorbic acid, folic acid, tocopherols, β-carotene, riboflavin and minerals like iron, calcium, magnesium and phosphorous. They increase the resistance power and improve health of human beings. Their consumption provides taste, palatability, increases appetite and provides fibre for digestion and prevents constipation (Seidu, 2012) [10]. Locally available green leafy vegetables rich in micronutrients are highly perishable and are cheapest source of raw materials. Production of those leafy greens is seasonal and market will be over flooded during peak seasons at particular period resulting in spoilage of large quantity. The market glut and huge wastage can be prevented by preserving the vegetables. Considering the lower bulk density of dried leafy greens, drying is considered as most suitable and easy method of preservation providing nutrients in concentrated form throughout the year (Singh *et al.* 2007) [9]. To incorporate these leaves in the diet, efforts are made to develop a nutritional supplement using these traditional medicinal plants (Anita *et al*. 2007) [2].

To a large population of the world, balanced diets are not accessible and this is particularly seen in developing countries. The health of vulnerable groups of population is severely affected by malnutrition and micronutrient deficiency. Calcium and vitamin D are inseparable nutrients required for bone health. In the past half a century, the dietary calcium intake of rural, tribal and urban India has declined. Dietary calcium deficiency can cause secondary vitamin D deficiency. Fenugreek leaves are rich sources of iron, calcium, beta carotene and vitamin K (Annida and Venugopal 2010) [3]. Coriander leaves also abound in vital minerals and vitamins like vitamin A, vitamin C, vitamin E, zinc, calcium, magnesium, iron and phosphorous augmenting bone density and soothes aching joints in arthritis and osteoporosis. It requires a multipronged strategic approach to tackle the dietary calcium deficiency to achieve strong bone health while solving the problem of nutritional deficiency. Iron is an important micronutrient essential for various functions in human body. Iron deficiency anaemia is characterized by a defect in haemoglobin synthesis, resulting in hypochromic and microcytic red blood cells (Provan D, 1999) [8]. Presently India is leading in world in context of iron deficiency anaemia as more than 50 percent of population is suffering from it. Indian population depends largely on vegetables for supply of iron and hence, if vegetables are dried and included in diet, from a small amount of bulk relatively large amount of iron can be made available which will be helpful in prevention of iron deficiency anaemia.

Spinach leaves are excellent source of iron which helps create haemoglobin. However, during processing and storage, changes in chemical composition of Leafy vegetables takes place to slight extent. Keeping this in view, present research was undertaken to study effect of storage duration on calcium content and iron content in dried vegetable samples.

2. Materials and Methods

2.1 Study area

The study was carried out in the Department of Food Science and Technology at Post Graduate Institute of Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 2020-21.

2.2 Sample collection and preparation

The green leafy vegetables *viz*., fenugreek, spinach and coriander were procured from the local market of Rahuri. Leafy vegetables were washed thoroughly, sorted and blanched. Leafy vegetables were dehydrated at the temperature of 55^{0}C for time of 7-8 hours in cabinet tray dryer. After dehydration, vegetable samples were packed in polypropylene bags and stored for 3 months duration for further study. The samples were chemically analysed for calcium and iron content at 30 days interval.

2.3 Sample treatment details

Table 1: Treatment details for fresh fenugreek, spinach and coriander prior to dehydration

Treatments	Blanching		Chemicals	Drying Temp (^{0}C)
	Temp (^{0}C)	Time (sec)		
T_0 (Fenugreek)	45	30	Plain water	55
T_1 (Fenugreek)	45	30	KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	55
T_2 (Spinach)	45	30	Plain water	55
T_3 (Spinach)	45	30	KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	55
T_4 (Coriander)	45	30	Plain water	55
T_5 (Coriander)	45	30	KMS (0.02%) + MgO (1.5g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	55

2.4 Determination of mineral content

The amount of minerals such as iron, calcium were determined by using dry ash procedure (A.O.A.C, 1990) [1]. About 2g sample was pre-ashed in a silica crucible on hot flame for 10-15 minutes and then kept in a muffle furnace at 550^{0}C for 4-5 hours until the ash turned white completely. After ashing, the sample was cooled, weighed and then conveyed into volumetric flask of 50 ml capacity by carefully giving the crucible washing of 5 ml of 30% HCl. Final volume of 50 ml was made with distilled water. This solution was later used for individual mineral determination using spectronic-20 and flame photometer.

2.4.1 Determination of calcium content

Amount of Calcium present within the vegetable sample was determined by titrimetric method. Aliquot of 25 ml of mineral solution was prepared and further diluted to make 150 ml volume by adding distilled water. 2-3 drops of methyl red indicator was added with the addition of strong ammonia to neutralize the solution which changes pink to yellow. Then the mixture was boiled for few minutes and addition of 10 ml of ammonium oxalate was done. Mixture was again boiled for 2 minutes and glacial acetic acid was added till the colour become pink. Then mixture was kept aside in warm place for overnight and after settling of precipitate at bottom, the supernatant was tested with a drop of ammonium oxalate which ensured the completion of precipitation process. Precipitate was then strained with Whatman No. 4 filter paper and washed with warm distilled water. The precipitate was then shifted into a beaker by making a hole in centre of filter paper and given 2 washings of 5ml sulphuric acid (2N). Then the solution was heated at 70^{0}C and titrated against 0.01N $KMnO_4$ until the colour turns pink persisting permanently. 1ml of $KMnO_4$ = 0.2004mg calcium. It is calculated by using formula –

$$\underset{(mg/100g)}{\text{Calcium}} = \frac{\text{Titre x N of } KMnO_4 \times 0.02 \text{ x Total vol. of ash solution (ml)}}{\text{ml of ash solution taken x Weight of sample (g)}} \text{ x } 100$$

2.4.2 Determination of iron content

Aliquots of standard sample solution and blank solution were pipetted in cuvettes and absorbance was measured at wavelength of 248 nm by using air-acetylene flame. Calibration curve of absorbance was then drawn against concentration of iron which provided value of iron concentration present within sample (A.O.A.C, 1990) [1].

3. Results and Discussion

The pre-treated and dehydrated vegetable samples were packed in polypropylene bags and stored for 3 months storage study at ambient temperature conditions. The results pertaining the studies on effect of storage duration on calcium and iron content of dehydrated green leafy vegetables *viz*., fenugreek, spinach and coriander are discussed under this topic.

3.1 Effect of storage on calcium content of dehydrated green leafy vegetables

The results on changes in calcium content in fenugreek, spinach and coriander during storage period of 3 months are presented in Table 2, Table 3 and Table 4 respectively. The findings show that the calcium content in control was found to be decreased from 395.67 to 394.64 mg/100g in fenugreek, 94.55 to 93.47 mg/100g in spinach, 182.12 to 181.22 mg/100g in coriander while in treatment from 396.22 to 395.41 mg/100g in fenugreek, 97.81 to 96.76 mg/100g in spinach and from 183.05 to 182.04 mg/100g in coriander. Statistical results exhibited significant effect of storage and treatments on calcium content of all three dehydrated leafy greens. Hanif *et al.* (2006) [7] reported calcium content about 76 mg/100g in spinach and 52 mg/100g in cabbage. Gopalan *et al*. (1996) [5] also given similar results for spinach and coriander leaves.

Table 2: Calcium content of dehydrated fenugreek

Calcium (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_0	395.67	395.22	394.87	394.64	395.10
T_1	396.22	395.80	395.63	395.41	395.76
Mean	395.94	395.51	395.25	395.02	395.43
	P	TT	P × TT	CV (%)	
SEm (±)	0.007	0.005	0.010	0.004	
CD@5%	0.021	0.014	0.029		

Table 3: Calcium content of dehydrated spinach

Calcium (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_2	94.55	94.20	93.82	93.47	94.01
T_3	97.81	97.59	97.04	96.76	97.30
Mean	96.18	95.89	95.43	95.11	95.65
	P	TT	P × TT	CV (%)	
SEm (±)	0.009	0.006	0.013	0.024	
CD@5%	0.028	0.020	0.040		

Table 4: Calcium content of dehydrated coriander

Calcium (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_4	182.12	181.90	181.57	181.22	181.70
T_5	183.05	182.77	182.38	182.04	182.56
Mean	182.59	182.34	181.98	181.63	182.13
	P	TT	P × TT	CV (%)	
SEm (±)	0.007	0.005	0.010	0.009	
CD@5%	0.021	0.015	0.030		

All values are mean of three replications. P- Storage period, TT- Treatment, P × TT- Interaction

T_0, T_2, T_4 - Plain water and T_1, T_3, T_5 - Chemical treatment

3.2 Effect of storage on iron content of dehydrated green leafy vegetables

The results for changes in amount of iron in case of dehydrated fenugreek, spinach and coriander during storage is given in Table 5, Table 6 and Table 7 respectively. The results indicates that iron content in control decreased from 3.96 to 3.68 mg/100g in fenugreek, 2.62 to 2.43 mg/100g in spinach and 2.10 to 1.54 mg/100g in coriander while in treatment from 4.05 to 3.76 mg/100g in fenugreek, 2.68 to 2.42 mg/100g in spinach and 2.15 to 1.58 mg/100g in coriander during 3 months storage studies at ambient temperature. Statistical results showed that there was non-significant effect of storage and treatments on iron content of all three dehydrated green leafy vegetables. Values obtained in present study are corresponding to the range of iron content reported by S. Gupta *et al*., (2013) [6] for fenugreek. Bhosale and Arya, (2010) [4] found iron content of 2.12 mg/100g in okra and 4.40 mg/100g in spinach dried by cabinet drying.

Table 5: Iron content of dehydrated fenugreek

Iron (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_0	3.96	3.87	3.77	3.68	3.82
T_1	4.05	3.97	3.89	3.76	3.92
Mean	4.01	3.92	3.83	3.72	3.87
	P	TT	P × TT	CV (%)	
SEm (±)	0.007	0.005	0.011	0.494	
CD@5%	0.023	0.016	NS		

Table 6: Iron content of dehydrated spinach

Iron (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_2	2.62	2.51	2.47	2.43	2.51
T_3	2.68	2.54	2.49	2.42	2.53
Mean	2.65	2.52	2.48	2.43	2.52
	P	TT	P × TT	CV (%)	
SEm (±)	0.009	0.006	0.013	0.930	
CD@5%	0.020	0.028	NS		

Table 7: Iron content of dehydrated coriander

Iron (mg/100g)					
Treatment	Storage period (days)				Mean
	0	30	60	90	
T_4	2.10	1.91	1.73	1.54	1.82
T_5	2.15	1.94	1.77	1.58	1.86
Mean	2.13	1.93	1.75	1.56	1.84
	P	TT	P × TT	CV (%)	
SEm (±)	0.007	0.005	0.010	0.941	
CD@5%	0.021	0.014	NS		

All values are mean of three replications. P- Storage period, TT- Treatment, P × TT- Interaction

T_0, T_2, T_4 - Plain water and T_1, T_3, T_5 - Chemical treatment

4. Conclusion

The studies on effect of storage on calcium content and iron content of dehydrated leafy greens *viz*., fenugreek, spinach and coriander revealed that among the pretreatments given, chemically blanched vegetable samples [T_1, T_3 and T_5] showed more retention of nutrients as compared to plain water blanched vegetable samples [T_0, T_2 and T_4] in all three cabinet dried leafy greens. Significant effect of storage was observed with context to calcium content in all three dried leafy greens while non-significant effect of storage was observed on iron content in all three dried leafy greens during 3 months storage period. It can be also concluded that calcium and iron content were better preserved by polypropylene packaging material in dried form of vegetables.

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