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Effect of Packaging Materials on Retention of Quality Characteristics of Selected Dehydrated Green Leafy Vegetables During Storage

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Abstract: Green leafy vegetables such as *Alternathera sessilis* and *Amaranthus polygonoides* were dehydrated in a cabinet drier at 50±2°C and ground to fine powder and packed in three different packaging materials {300 gauge high density poly ethylene (HDPE), 200 gauge polypropylene (PP) and 300 gauge metalized polypropylene (MPP)} and stored at room temperature (28-36°C) for a period of three months to evaluate the best packaging material for maximum retention of quality characteristics in the selected green leafy vegetables during storage. Among the three different packaging materials MPP was retained significantly ($p<0.05$) higher levels of chlorophyll, ascorbic acid, β-carotene and rehydration ratio and absorb significantly ($p<0.05$) lower level of moisture in the both selected dehydrated green leafy vegetable powder samples when compare to HDPE and PP during three months of storage period.

Key words: Green leafy vegetables · Storage · Dehydration · Packaging Materials · Quality characteristics

INTRODUCTION

Green leafy vegetables have a unique place among vegetables because of their colour, flavour and health benefits. They are relatively inexpensive, easily and quickly cookable and serve as rich sources of β-carotene, ascorbic acid, folic acid, chlorophyll, calcium, iron, phosphorous, zinc and dietary fiber [1-3]. Deficiency in β-carotene, the precursor of vitamin A, makes bodies susceptible to cancer and coronary heart diseases. Ascorbic acid acts as an antioxidant, exerts an antihypertensive effect, prevents cataract formation and heart diseases and its deficiency leads to scurvy [4].

Green leafy vegetables are highly seasonal and abundant supply during the peak season results in spoilage of large quantities. Augmenting utilization and avoiding wastage calls for employing suitable preservation techniques that are user friendly and sustainable at the household level. Dehydration is a simple and economical method of preservation of these vegetables [5-6]. Processing by dehydration makes the green leafy vegetables light in weight, easily transportable and storable product. Dehydrated vegetables can be easily converted into fresh like form by rehydration and can be used throughout the year [7].

Negi and Roy [8] studied the changes in quality characteristics of dehydrated savoy beet and fenugreek leaves during storage. Singh and Sagar [9] studied the quality characteristics of dehydrated curry leaves and drumstick leaves influenced by packaging materials and storage temperature. In another study Singh *et al.* [10] observed losses in nutrient content during storage of selected dehydrated green leafy vegetable powders.

The current study was undertaken to assess the effect of different packaging materials on retention of quality characteristics of selected locally grown green leafy vegetables in Tamil Nadu, India viz. Ponnankanni *(Alternanthera sessilis)* and Sirukeerai (*Amaranthus polygonoides)* during storage.

MATERIALS AND METHODS

Selection and Dehydration of Green Leafy Vegetables: Two green leafy vegetables (GLV), Ponnankanni (*Alternenthera sessilis*) and Sirukeerai (*Amaranthus polygonoides*) were procured from the central market of the Madurai city and brought to Department of Food Science and Nutrition, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India to evaluate the effect of packaging materials on quality of dehydrated

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leaves. Leaves were separated from petioles and washed with portable water to remove adhering dirt. The leaves were steam blanched for 3minutes and cooled immediately to room temperature by dipping in cool water. Blanched leaves were spread on trays in single layer (Tray load of 0.75-1.00 kg/m^2) and dried in a cabinet dryer at 50±2°C to a moisture content of 5-6% in the finished product.

Packing and Storage: The dried green leafy vegetable samples were ground to fine powder by using a mixer grinder and sieved through a 100 mesh size sieve and packed separately in 300 gauge metalized polypropylene (MPP), 300 gauge high density polyethylene (HDPE) and 200 gauge polypropylene (PP) bags and kept at ambient conditions (Temperature 28-36°C and RH 52-65%) for a period of three months for storage studies and product was drawn in one month interval for physicochemical analysis.

Physicochemical Analysis: Moisture content was determined by the method of AOAC [11]. Ascorbic acid was estimated by the titration method using indophenol dye [12]. Total carotene content of samples was extracted with acetone-petroleum ether solvents and beta carotene was separated by column chromatography and then estimated colorimetrically by using a spectrophotometer (Systronics 2201, India) at 452nm [11]. Chlorophyll was extracted in 80% acetone and the absorption at 663nm and 645nm were read using a spectrophotometer. The amount of chlorophyll is calculated using absorption coefficients [13]. Rehydration was carried out by steeping the dried samples (5 g) in warm water (50 ml) at 60^{0}C for half an hour. Rehydration ratio of the green leafy vegetables was calculated by dividing the weight of the drained rehydrated sample by the weight of the dried sample [14].

Statistical Analysis: All measurements were performed in triplicate for each sample. Data were analyzed using statistical software (SPSS for Windows Version 16.0). Significant differences between the means were estimated using Duncan's multiple range tests. Differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

The changes in moisture, chlorophyll, ascorbic acid, β-carotene and rehydration ratio of the dehydrated *Alternanthera sessilis* and *Amaranthus polygonoides* leaves during storage were presented in the Table 1 and 2 respectively.

Moisture: The moisture content of both (*Alternanthera* and *Amaranthus)* dried green leafy vegetable samples packed in different packaging materials increased gradually with increase in storage period. The rate of increase in moisture was low in samples packed in MPP followed by HDPE and PP for a period of 90 days.

Table 1: Effect of packaging materials on quality characteristics of dehydrated *Alternanthera sessilis* leaves during storage (dry weight basis)

			Packaging materials		
Parameters	Storage period (days)	Initial value	MPP	HDPE	PP
Moisture (%)	30	5.61±0.04	5.70±0.08	5.77±0.14	5.82±0.08
	60		5.79±0.09	5.91±0.16	6.04±0.15
	90		5.89±0.04	6.09±0.11	6.28±0.07
Chlorophyll(mg/100g)	30	868.7±3.7	854.0±3.7	847.3±2.9	840.4±3.7
	60		840.1±2.7	829.2±2.9	811.5±2.4
	90		827.0±4.8	800.8±5.9	775.2±5.7
Ascorbicacid (mg/100g)	30	64.55±1.29	60.22±0.71	56.30±0.70	54.10±1.27
	60		55.00±0.80	50.15±1.30	46.76±0.69
	90		50.21±1.33	45.46±0.80	39.79±1.30
Beta carotene (mg/100g)	30	17.77±0.41	17.36±0.12	17.19±0.17	17.00±0.07
	60		16.96±0.15	16.52±0.30	16.20±0.17
	90		16.54±0.28	15.91±0.26	15.39±0.18
Rehydration ratio	30	1: 4.37	1: 4.36	1: 4.35	1: 4.34
	60		1: 4.34	1: 4.32	1: 4.31
	90		1: 4.32	1: 4.29	1: 4.29

Values are mean ± S.D of three replicates.

Table 2: Effect of packaging materials on quality characteristics of dehydrated *Amaranthus polygonoides* leaves during storage

			Packaging materials		
Parameters	Storage period (days)	Initial value	MPP	HDPE	PP
Moisture (%)	30	5.54±0.14	5.65±0.07	5.69±0.06	5.75±0.08
	60		5.74±0.08	5.85±0.05	5.95±0.05
	90		5.86±0.05	6.02±0.05	6.18±0.05
Chlorophyll(mg/100g)	30	955.0±4.1	940.3±7.0	929.8±5.2	921.9±4.2
	60		930.4±4.2	907.4±3.5	891.1±6.3
	90		919.4±4.1	883.6±3.7	860.7±4.1
Ascorbicacid (mg/100g)	30	103.56±0.76	97.96±0.69	94.49±0.77	91.46±0.82
	60		91.90±0.84	82.76±0.78	77.12±0.80
	90		84.09±0.72	71.00±0.79	64.06±0.73
Beta carotene (mg/100g)	30	26.45±0.39	26.04±0.18	25.61±0.24	25.46±0.29
	60		25.40±0.40	24.83±0.42	24.51±0.39
	90		24.99±0.28	24.01±0.34	23.35±0.31
Rehydration ratio	30	1:3.54	1:3.53	1:3.52	1:3.51
	60		1:3.51	1:3.49	1:3.49
	90		1:3.49	1:3.47	1:3.46

Values are mean ± S.D of three replicates.

Dried *Alternanthera* and *Amaranthus* leaves samples packed in MPP have significantly lower level ($p<0.05$) of moisture when compared to samples packed in HDPE and PP after 90 days of storage. But there was no significant differences in moisture content observed between the above samples packed in different packing materials after 30 and 60 days of storage. Similar increase in moisture content by different dried green leafy vegetables during storage has been reported in several studies [8-10, 15-16].

Chlorophyll: Chlorophyll content of both dried green leafy vegetables continuously decline during storage. The rate of loss in chlorophyll was low in samples packed in MPP followed by HDPE and PP throughout the 90 days of storage period. Dried *Alternanthera* and *Amaranthus* leaves samples packed in MPP retained significantly higher level ($p<0.05$) of chlorophyll (4.8 % and 3.7 % loss) after 90 days of storage compared to similar samples packed in HDPE (7.8 % and 7.5 % loss) and PP (10.8% and 9.9 % loss) packages. A similar loss in chlorophyll content of dehydrated fenugreek and savoy beet leaves packed in single and double layer of HDPE film has been reported in the literature [8, 15].

Ascorbic Acid: Ascorbic acid content of dried *Amaranthus* and *Alternanthera* leaves decreased significantly from 103.56 and 64.55 mg/100 g (dry weight basis), respectively, at the first day to 64.06-84.09 and 39.79-50.21 mg/100 g, respectively, after 90 days of storage. This decrease might have been due to the oxidation of ascorbic acid during storage. The rate of loss in ascorbic acid content was significantly low ($p<0.05$) in both dried *Amaranthus* and *Alternanthera* leaves samples packed in MPP (18.8% and 22.2% loss) when compared to same samples packed HDPE (31.5% and 29.6% loss) and PP (38.1% and 38.4% loss) after 90 days of storage. The decrease in ascorbic acid with storage has also been noted in dehydrated fenugreek and savoy beet leaves [8, 15 and 16] and dehydrated curry and drumstick leaves [9] and dehydrated spinach, mint, coriander, amaranthus and benghal gram leaves [10].

Percent loss in ascorbic acid are given in Figure 1 (*Alternanthera sessilis)* and 2 (*Amaranthus polygonoides),* respectively.

Percent loss in β-carotene are given in Figure 3 (*Alternanthera sessilis*) and 4 (*Amaranthus polygonoides*), respectively.

β- carotene: β- carotene content of all the dehydrated vegetables decreased significantly ($p < 0.05$) with increase in storage period. On comparing loss in beta carotene after three months of storage, the minimum loss was observed in the dehydrated *Alternanthera* and *Amaranthus* leaves powder samples packed in MPP and the maximum loss was observed in the samples packed in PP. The rate of loss in beta carotene content was significantly low ($p<0.05$) in both dried *Alternanthera* and *Amaranthus* leaves samples packed in MPP (6.9 % and 5.5% loss) when compared to same samples packed HDPE (10.5% and 9.2% loss) and PP (13.4 % and 11.7 % loss) after 90 days of storage (Fig. 3 and 4).

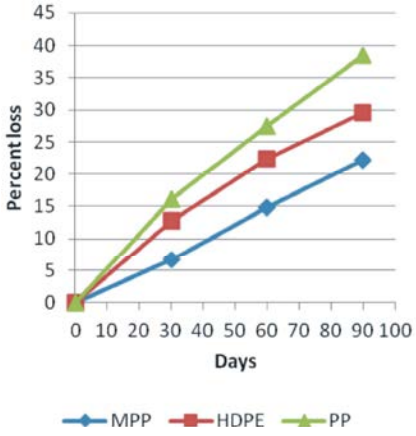

Fig. 1:

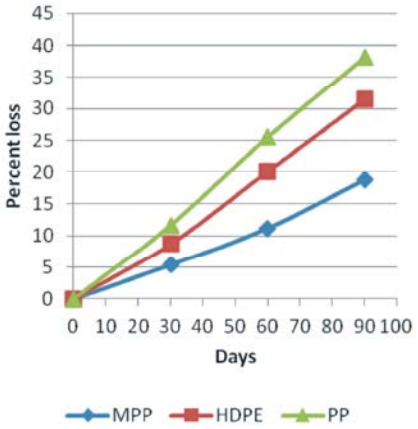

Fig. 2:

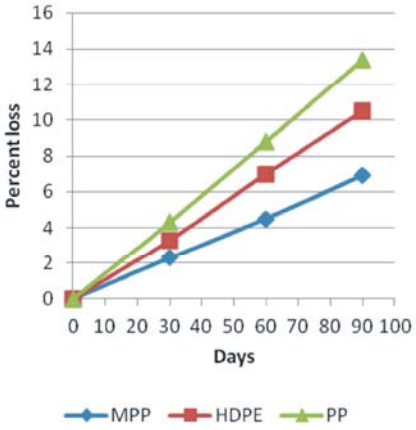

Fig. 3:

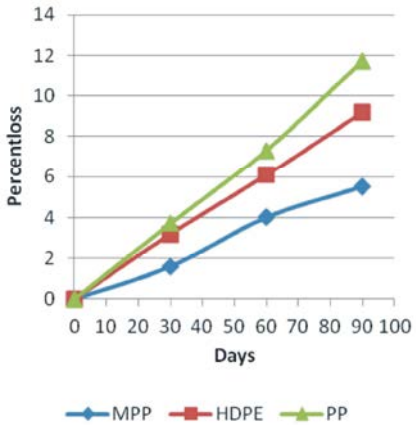

Fig. 4:

The observed reduction in β-carotene during storage might have been due to oxidative and/or non-oxidative changes as it is also heat sensitive. The decrease in β-carotene with storage has also been noted earlier in dehydrated fenugreek and savoy beet leaves [8, 15 and 16] and dehydrated curry and drumstick leaves [9] and dehydrated spinach, mint, coriander, amaranthus and benghal gram leaves [10].

Rehydration Ratio: Dried *Alternanthera* and *Amaranthus* leaves samples packed in MPP have higher level of rehydration ratio when compared to samples packed in HDPE and PP after 30,60 and 90 days of storage (Table 1). This may due to the less absorption of moisture by the samples packed in MPP when compared to HDPE and PP during storage period. Singh and Sagar [9] also reported similar results for the curry leaves and drumstick leaves samples packed different packaging materials.

CONCLUSION

Green leafy vegetables are the most underexploited class of vegetables despite high nutritional value. They are good sources of ascorbic acid and β- carotene. Although losses of beta carotene and ascorbic acid were noted during drying and storage, they still contained appreciable amounts of beta carotene and ascorbic acid after storage for three months. Loss of ascorbic acid was greater compared to beta carotene. Dehydrated green leafy vegetable samples packed in metalized polypropylene (MPP) retained highest amount of beta carotene and ascorbic acid during storage when compared to samples packed in high density poly ethylene (HDPE) and polypropylene (PP) So these green leafy vegetables can be dried during peak season and stored for use during the off season. Therefore the development of dehydrated green leafy vegetables have great potential to use throughout the year for the preparation of several types of mix vegetables and other new recipes after rehydration.

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