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

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Abstract— *The objective of this study was to investigate the influence of blanching, dehydration and packaging on nutrient composition of Amaranthus gangeticus and Spinach oleracea. There was a loss of sugars, Proteins, vitamin- c and carotenoids were noticed due to blanching. But the colour of green leafy vegetables (GLV) is retained due to blanching. Leafy vegetables were dehydrated in cabinet dryer at 60ºC and packed in three packaging materials (Metalized polypropylene (MPP) 300 gauge, high density polyethylene (HDPE) 300 gauge, low density polyethylene (LDPE) 200 gauge) and stored at room temperature for 45 days to evaluate the best package for maximum retention of nutrients in leafy vegetables during storage. PP followed by HDPE was found to be good for retention of nutrients in dehydrated leafy vegetables during 45 days of storage. Irrespective of the losses of nutrients that take place during dehydrated packaging, GLV can be preserved by dehydration which is eco-friendly and easily adoptable.*

Keywords— Blanching, dehydration, packaging, Spinach, Amaranthus, LDPE, HDPE, MPP.

I. INTRODUCTION

Green leafy vegetables are rich sources of micronutrients and antioxidants. These leafy vegetables are seasonal and perishable, owing to high moisture content. Green leafy vegetables have a unique place among vegetables because of their colour, flavour and health benefits. They are inexpensive, easy to cook serve as rich sources of carotene, ascorbic acid, folic acid, chlorophyll, calcium, iron, phosphorous, zinc and dietary fibre (1-3). Green leafy vegetables are abundant in supply during the peak season and results in spoilage of large quantities. The consumption of green leafy vegetables could improve the nutritional status of

poor rural and urban households because these plants are rich sources of minerals, vitamins carotenoids and phenolic agents (4,5).

Dehydration is a suitable alternative for post-harvest management to increase shelf-life and promote food security (6). Products with low moisture content can be stored at ambient temperatures for long period of time due to a reduced microbiological activity and minimized physical and chemical changes (7). Dried leafy vegetables are more concentrated tasty, nutritious, light weight and easy to prepare, store and use (8). Blanching is a primary step in processing of vegetables. It inactivate enzymes, retains colour and modification of product texture (9,10).

Among all the green leafy vegetables Amaranths plants were caped under the super food segment due to their health benefiting properties (11). Amaranths leaves are packed with carbohydrates, proteins, iron minerals and vitamins, and regular consumption helps in easing digestion, and weight management. Since it is high in iron content and dietary fibre, it is good for anaemic patients, and reduces cholesterol and risks of cardiovascular diseases.

Spinach is a super food loaded with protein, iron, vitamins, minerals and dietary fibres (12). The possible health benefits of consuming spinach include improving blood glucose control in people with diabetes, lowering the risk of cancer, reducing blood pressure, improving bone health, lowering the risk of developing asthma etc. Despite the importance of traditional vegetables in the diet, understanding of postharvest processing of traditional vegetables is limited. Considering the above mentioned importance the study was conducted to determine the characteristics of packed dried spinach and Amaranths leaf powder so as to use directly in the development of various food formulations.

II. MATERIALS AND METHODS

Plant materials

The leafy vegetables were procured directly from the field in Kanpur, Hyderabad. The leaves were separated from inedible portions and washed under running water to remove the adhering mud particles and drained completely.

Blanching

Washed leaves were Blanched at 100°C for 1 min in water and cooled immediately by dipping in cool water at a temperature of 20°C for few seconds. Blanched leaves were spread on trays in single layer and dried in a cabinet dryer at 60°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 MPP 300 gauge, HDPE 300 gauge, LDPE 200 gauge bags and kept at room temperature conditions (Temperature 32-38°C) for a period of two months for storage studies and product was drawn in 15 days interval for physico- chemical analysis.

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Analysis

The fresh GLV and blanched GLV were analyzed for the following components to study the effect of blanching. Dehydrated GLV powder was analysed to study the effect of packaging. Moisture content was determined by standard method of (13). Protein was estimated by (14) , Total chlorophyll, Total carotenoids, β-carotene, ascorbic acid content, ash content was determined by method of (15). Rehydration ratio of dehydrated GLVs was estimated as per (16).

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 $p < 0.05$.

III. RESULTS AND DISCUSSION

Dehydration is an excellent way to preserve food and is appropriate food preservation technology for sustainable development. GLVs are dehydrated to enhance storage stability, minimize packaging requirement and reduce transport weight. In the present study we have analyzed the effect of dehydration and packaging material on the nutritive value of spinach and Amaranthus leaves. The results of the study are presented in Tables 1, 2, 3.

Reducing sugars

Reducing sugars of blanched portion are higher than the dried portion. **(**17) also reported that carbohydrate content of blanched pumpkin leaves was more than air dried leaves. During the storage period, the spinach and amaranths showed decreased pattern of reducing sugar content. Packaging affected the reducing sugar content over the storage period of 45 days. MPP packaging material maintained higher value ($p<0.05$) of reducing sugar content than in HDPE and LDPE packaging. The reason for the decrease could be due to utilization of sugars for metabolic activities (18)

Total Sugars

GLVs showed a decrease in total sugars after blanching from 498.8µg/mg and 965.6µg/mg to 390µg/mg and 699.6µg/mg. Amaranths has more total sugars compared to spinach. PP, HDPE and LDPE film packaging showed maximum value of total sugars on day 15 and decreased thereafter. Spinach and amaranths leaves powder packed in MPP packaging have significantly higher level ($p<0.05$) of total sugars when compared to samples packed in HDPE and PP after 45 days of storage.

Moisture

Moisture content of food is very important on nutrient density and shelf-life of agricultural produce The moisture content of the unblanched and blanched GLV is ranged between 6.56 - 7.6% in spinach and 6.57- 7.5 in amaranths (Table 1). (19) Also observed more moisture retention capacity of blanched spinach leaves. Dried GLV packed in different packaging material showed a decrease in moisture content during the storage period. The rate of loss of moisture was low, there is a significant difference between the packing material at 5% level of significance after 45 days of storage, PP showed low moisture content than LDPE and HDPE for spinach, and PP showed low moisture content in Amaranthus powder than samples packed in HDPE and LDPE.

Table.1: The affect of packaging material on the dehydrated leafy vegetable (spinach).

		Packaging materials		
Parameter	storage period (days)	MPP	HDPE	LDPE
Reducing sugar	15	275.4+0.21	253.8+0.043	237.6+0.303
(µg/mg)	30	255.6+0.063	241.1+1.043	210.7+0.46
	45	243.2+0.003	235.1+0.97	201.2+0.04
Total sugar	15	249+1	224+1	212+1
(µg/mg)	30	220.3+0.333	197.6+0.333	175.3+1.33
	45	216.3+1.333	176.6+1.33	142+1
Protein	15	639+1	592.6+4.33	588.3+4.33
(µg/mg)	30	631+1	590.33+0.33	580.3+0.33
	45	630.3+1	585+1	573.6+2.33
chlorophyll	15	201.8+1.343	193.3+0.13	192.3+0.083
(µg/mg)	30	200.2+0.143	191.1+2.71	189.2+0.01
	45	198.3+0.13	187.2+0.063	185.2+0.01
Carotenoids	15	39.23+0.023	37.73+0.093	36.23+0.063
(µg/mg)	30	38.6+0.13	36.96+0.103	35.13+0.003
	45	36.52+0.129	34.36+0.093	32.4+0.173
Vitamin c	15	5.12+0.204	5.806+0.222	4.59+0.063
(mg/10g)	30	4.45+0.097	4.88+0.164	4.52+0.078
	45	4.33+0.093	4.82+0.129	4.44+0.207
Moisture	15	6.786+0.220	7.20+0.792	6.85+0.406
(%)	30	6.346+0.132	7.59+0.0007	6.29+0.016
	45	6.686+0.220	7.55+0.012	6.74+0.434
Rehydration	15	1.776+0.002	1.47+0.003	1.52+0.006
Ratio	30	1.85+0.009	1.96+0.004	2.21+0.01
	45	1.346+0.003	1.516+0.009	1.66+0.018
Ash content	15	1.79+4.9E-05	0.84+0.0004	1.15+0.001
(g)	30	1.78+3.6E-04	1.8+2.8E-05	1.82+9.33E-06
	45	1.8+0.0007	1.9+0.004	2.19+0.001

Table.2: The effect of packaging material on dehydrated leafy vegetable (amaranths).

		Packaging materials		
Parameter	storage period (days)	MPP	HDPE	LDPE
Reducing sugar	15	169.5+0.023	166.3+0.023	164.9+0.19
(µg/mg)	30	168.6+0.02	163.6+0.07	161.9+0.01
	45	166.4+0.043	159.4+0.01	156.1+0.043
Total sugar	15	509+1	496.3+2.33	379.3+1.33
(µg/mg)	30	485.5+2.33	462.6+2.33	371.3+1
	45	460.6+2.33	421.6+1.33	352+1
Protein	15	701+1	690+1	678.6+1.33
(µg/mg)	30	692.3+6.33	685.3+2.33	669+1
	45	689+1	678.6+2.33	659.6+2.33
chlorophyll	15	638.16+0.023	632.03+0.023	630.1+0.01
(µg/mg)	30	636.2+0.063	630.33+0.01	629.26+0.143

	45	635.4±0.043	629.63±0.143	625.43±0.063
Carotenoids	15	79±0.01	76.1±0.02	75.5±3.103
(µg/mg)	30	78.2±0.003	75.4±0.09	71.1±0.04
	45	77.06±0.02	74.2±0.01	60±0.01
Vitamin c	15	6.57±0.035	6.12±0.06	5.13±0.19
(mg)	30	6.61±0.078	5.51±0.129	4.43±0.023
	45	6.43±0.095	5.37±0.073	4.3±0.138
Moisture	15	5.413±1.654	6.93±0.059	6.826±0.920
(%)	30	5.34±1.57	6.25±0.780	6.506±0.924
	45	5.28±1.54	6.18+0.768	6.353±0.740
Rehydration	15	2.2±0.09	2.55±0.02	1.833±0.005
Ratio	30	2.523±0.03	2.52±0.01	2.472±0.09
	45	2.51±0.01	2.107±0.008	2.33±0.01
Ash content	15	0.677±0.0008	0.541±2.03	0.451±0.001
(g)	30	1.532±0.0001	1.29±0.0009	1.133±0.002
	45	1.88±0.004	1.873±0.002	2.03±0.007

The above values are means+_ s.d of triplicates of each sample.

Ascorbic acid

Singh and associates (20) studied the blanched fenugreek, mustard leaves, bathu and spinach showed higher ascorbic acid content than the unblanched samples. Spinach and amaranths showed decrease in vitamin c after blanching from 6.833mg/g and 7.143mg/g to 5.674mg/g and 6.207mg/g. Dried GLV packed in different packaging material showed loss of ascorbic acid. Loss of ascorbic acid may be due to oxidation of ascorbic acid. There was no significant difference between packaging materials at 5% level of significance after 45 days of storage. PP had more ascorbic acid in Amaranthus powder than samples in HDPE and LDPE packaging material.

Chlorophyll

In the recent years, there has been increasing interest in plant phytochemicals because of reduced risk of chronic diseases such as cancer and cardiovascular (21). Spinach and amaranths showed decrease in chlorophyll content after blanching from 599.66µg/mg and 994.433µg/mg to 218.5µg/mg and 6414.33µg/mg. Lower chlorophyll content of cabinet drier was due to an inactivation of chlorophyllase enzyme which may be responsible for degradation of chlorophyll (22). There was no significant difference in chlorophyll content between packaging materials at 5% level of significance after 45 days of storage. Premavalli and K.S. Majumdar (23) also reported that total chlorophylls decreased during blanching and de-hydration.

Carotenoids

Seshadri S and Jain M and Dhabhai D (24) reported that, total and beta carotene retention in blanched + sulphated leaves was 73 and 72 per cent respectively compared to 62 and 59 per cent in blanched leaves. Reference (25) reported that, on dehydration the retention of β-carotene in savoy beet and fenugreek leaves on drying was 40.9 and 38.1 mg/100g. Both the leafy vegetables spinach and amaranths showed a decrease in carotenoids after blanching, from 46.77µg/mg and 136.5µg/mg to 37 and 79.933µg/mg, amaranths had more carotenoids than spinach. Both spinach and amaranths packed indifferent packing material had no significant difference at 5% level of significance after 45 days of storage in both spinach and amaranths MPP had more carotenoids followed by HDPE.

Protein

Both leafy vegetables spinach and amaranths showed decrease in protein level after blanching from 743µg/mg and 778 µg/mg to 695µg/mg and 728µg/mg. For amaranth protein content was lower than reported by (26). The dried leafy vegetables spinach and amaranths packed in different packing material had low rate of loss of protein during the storage period. There was no significant difference between different packing materials at 5% level of significance. For both leafy vegetable spinach and amaranths MPP had more protein content followed by HDPE and LDPE.

Ash content

Both spinach and amaranths leaves showed a decrease in ash content after blanching. The lower ash content in boiled leaves compared to raw leaves could be due to transfer of minerals from leaves to the boiling water (27).Spinach leaves had more ash content than amaranths leaves. This suggests that the amaranths leaves in the study are lower in mineral composition than spinach leaves. The mineral composition of the pumpkin leaf extract is also low (28,29). Leafy vegetables low in mineral composition may be beneficial to renal patients. The dried leafy vegetables packed in different packing material had no significant difference at 5% level of significance after 45 days of storage. Both spinach and amaranths powder packed in LDPE had more ash content than HDPE and MPP.

Rehydration ratio

Leafy vegetables spinach and amaranths had no significant rehydration ratio difference after blanching. The different packing material used for packing of spinach and amaranths powder had no significant rehydration ratio difference at 5% level of significance. LDPE pouch showed more rehydration ratio than spinach powder packed in HDPE and MPP. Amaranths powder packed in MPP showed more rehydration ratio than LDPE and HDPE packaging material. Degree of rehydration is dependent on sample preparation, sample composition and extent of the structural and chemical disruption induced by drying (30).

IV. CONCLUSIONS

Blanching is one of the most possible strategies for preservation of GLV, which are highly seasonal and perishable too. Blanching pre-treatment was used to improve nutrition properties of spinach and Amaranthus leaves. The abundantly available inexpensive GLV can serve as a pool house of nutrients and can be used in the developing countries to combat micronutrient deficiencies. Dehydrated LV has great potential to use throughout the year for preparation of food after rehydration. Dehydrated LV are rich in nutrients and could be used to develop commercial products. Developing new packaging and storage techniques are essential to extend GLV shelf life.

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