

## Comparative study of dehydration and food applications of five green leafy vegetables

Chaynika Verma<sup>1</sup>, Mrigya Bansal<sup>2</sup>, Priya Pal<sup>3</sup>

*Assistant professor<sup>1</sup>, Student<sup>2</sup>, Student<sup>3</sup> Department of Food Technology, Shaheed Rajguru College of Applied Sciences for Women (University of Delhi), Vasundhara Enclave, Delhi- 110096*

**Abstract-** Preservation by dehydration is very popular. Dried vegetables are likely to have good potential in food industry, as fresh vegetables are not available throughout the year and thus they can be preserved for availability in the off season. In this study, five green leafy vegetables including spinach, fenugreek, coriander, mustard greens and (*Chenopodium album*) bathwa were dehydrated, rehydrated and cooked by different recipes. The main objective behind this research is to study the organoleptic characteristics (flavour, colour, texture etc.) of dehydrated vegetables, quality of rehydrated vegetables and the acceptability of the recipes prepared by using rehydrated vegetables.

**Keywords-** Dehydration, Rehydration, Spinach leaves, Fenugreek leaves, Coriander leaves, Mustard leaves and Bathwa.

### I. INTRODUCTION

The green leafy vegetables are rich sources of vitamins like  $\beta$ -carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron; phosphorous along with high fiber content which play an important role in nutrient metabolism and slowing down of degenerative diseases. [1] Dried ginger and garlic are widely consumed in ayurvedic medicines and vegetables such as dehydrated cabbage, carrot, okra are widely used in the manufacturing of instant vegetable noodles, soups mixes, snacks and salads. Dried vegetables have good potential in food industry, pharmaceutical, defense, hotels etc., as fresh green leafy vegetables are not available throughout the year. [2]

This study is an attempt to use dehydration to tackle the problem of short shelf life, high losses of nutrients, as well as sensory attributes of green leafy

vegetables during cooking. Further rehydration and cooking of the rehydrated samples was carried out.

#### A. Dehydration

Dehydration is the process of removing water or moisture from a food product. [3] The main principle of this method is the reduction of water activity through heat and mass transfer which inhibits the development of microorganisms, and reduces the rate of reactions causing spoilage, thus prolonging the shelf life of the product. [4]

#### B. Changes during Dehydration

Both physical and chemical changes occur during drying: physical changes include rigidity of cell wall which is the result of loss of water and segregation of components, damage and disruption of the cellular walls leading to collapse of the cellular tissue. Also, the product porosity and the bulk density increases as the water and volatiles are removed. [5] The chemical change such as colour, flavour, texture, viscosity, nutritional value and storage stability contribute to the quality of both the final product and the reconstituted food. [6]

#### C. Rehydration

Rehydration process is aimed at the reconstitution of the dehydrated materials by addition of water. Rehydration can be considered as a measure of the injury to the material caused by drying and treatments preceding dehydration. Rehydration of dried plant tissues is composed of three simultaneous processes: the imbibition of water into dried material, swelling and the leaching of soluble solids. [7]

## II. MATERIAL AND METHODOLOGY

**Procurement of vegetables**-All five green leafy vegetables spinach, fenugreek, coriander, mustard greens and (*Chenopodium album*) bathwa were procured from the local vegetable market of East Delhi.

**Cutting and sorting**-bright coloured leaves were selected and rotten, fady leaves were discarded.

**Washing and weighing**-These leaves were thoroughly washed, cleaned and weighed.

The wastage and discarded leaves should be considered for percentage peel loss and was calculated using formula:-

$\%age\ peel\ loss = \frac{\text{weight of peels (wastage and discarded)}}{\text{weight of raw sample}} \times 100$



Fig.1.Raw sample

**Pre-treatment (blanching)**- The sorted leaves were blanched in hot water for 30-45 seconds with addition of small amount of sodium bicarbonate for maximum color retention of green leafy vegetables that tend to lose color easily due to chlorophyll degradation. Immediately the samples were dipped in cold water to arrest the chances of cooking. Water was drained off and the leaves were spread on a clean filter paper to remove excess water.

**Drying**- 5-6 trays were taken out of tray dryer (make: NSW-148) cleaned and perforated polypropylene sheets were spread on them with prepared leaves on it. The dryer was preheated and

the samples were dried at 60 degree Celsius for 3 ½ hours.



Fig.2.Tray dryer

**Moisture estimation**- Empty dishes and lid were dried in an oven (make: KI-181) at 131 degree Celsius. 5gms of fresh and dried samples were spread on the dried dishes and these dishes were placed in oven for 1hr at 131 degree Celsius. After 1hr, dishes were taken out and samples were cooled in desiccators and weighed properly. Then these samples were again placed in oven for 10minutes and this step was repeated till constant weights were obtained. Moisture content of fresh and dried samples was calculated using the formula,

$\text{Moisture content} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$



Fig.3.oven drying for moisture estimation

**Post drying treatments and storage-** After drying the samples were cooled for 15-20 minutes in the desiccators and were weighed accurately before packing in polypropylene pouches for further processing.



Fig.4.Dried sample

**Rehydration-** 5gm of each sample was taken. The rehydration process was carried out by two methods i.e. hot water and continuous boiling water rehydration.

a) **HOT WATER-** A Large bowl 2/3 full of water was taken. After vigorous boiling of water, the flame was turned off. After recording the temperature the leaves were immersed in it. Time of rehydration and final temperature were noted when the leaves were completely rehydrated. Water was drained off and the weights of rehydrated leaves were measured.



Fig.5.Hot water rehydration

b) **CONTINUOUS BOILING WATER-** A Large bowl 2/3 full of water was taken. After initiation of boiling, initial temperature of water was noted and then leaves were immersed in it. Time of rehydration and final temperature was noted when the leaves were completely rehydrated. Water was drained off and the weights of rehydrated leaves were measured.



Fig.6. Continuous boiling water rehydration

Rehydration ratio was calculated using formula,

Rehydration ratio = weight of rehydrated sample / weight of dried sample

### Applications

#### BATHWA RAITA

Freshly rehydrated bathwa sample was taken. It was blended using blender. Curd was whisked with salt, pepper, roasted cumin seeds and asafoetida. Bathwa puree was added and mixed well. It was transferred to a bowl and served to panelist for sensory evaluation.

#### ALOO METHI

After rehydration, fenugreek leaves were kept aside. Cumin, garlic and a pinch of asafoetida were fried till aromatic in hot oil. Potatoes, turmeric were added and fried for 2 minutes. After the potatoes were cooked, green chillies, fenugreek leaves, spices and salt were added. Flame was turn off and tomatoes

were added to it. Pan was covered for 2min; it was served in a bowl to panelists for sensory evaluation.

#### ALOO PALAK

Potatoes were boiled, peeled and diced. Rehydrated sample of spinach was taken and pureed. Asafoetida, cumin seeds and finely chopped onions were fried in hot oil in a pan. Tomato puree was added with constant stirring. Condiments like garam masala, salt, red chilly powder, turmeric was added and cooked for for 5 to 10 seconds. Spinach puree and boiled diced potatoes were added. It was covered with lid and cooked for another few minutes on low flame. Flame was turned off and the cooked preparation was served for sensory evaluation.



Fig.7.Food applications

### III. SENSORY EVALUATION

All the dehydrated, rehydrated along with the cooked preparation were evaluated organoleptically. A panel of ten members were selected comprising both semi trained and untrained panelist. A 5 point hedonic

S.no	Sample	Weight of raw sample(g)	Weight of prepared sample (g)	Peel loss(g)	%age peel loss
1.	Bathwa	1025	545	480	46.82
2.	Fenugreek	880	285	595	67.61
3.	Spinach	975	515	460	47.17
4.	Coriander	875	225	650	74.28
5.	Mustard greens	940	380	560	59.57

scale was used for the evaluation test. Sensory evaluation of

dried and rehydrated samples was carried out with reference to the raw sample. The cooked preparations were analyzed keeping in mind the flavor of vegetables cooked using fresh green leafy vegetables samples.

### IV. OBSERVATIONS AND RESULTS

All the peels and the discarded leaves were collected and weighed calculate percentage peel loss which is depicted in the following table.

TABLE.I PERCENTAGE PEEL LOSS FOR FRESH GREEN LEAFY VEGETABLES

PARAMETER	FLAVOR	TEXTURE	TASTE	AROMA	COLOR	OVERALL ACCEPTANCE
SAMPLES						
BATHWA						
FENUGREEK						
SPINACH						
CORIANDER						
MUSTARD GREENS						

**SENSORY EVALUATION CARD**

NAME:

PRODUCT:

DATE:

EVALUATE THE PRODUCT ON THE FOLLOWING PARAMETERS:

1. POOR 2. FAIR 3. GOOD 4. VERY GOOD 5. EXCELLENT

SIGNATURE

TABLE .II WEIGHTS DURING MOISTURE ESTIMATION OF FRESH SAMPLES

S.no	Sample	Initial weights(g)	Weights after 1hr	Weights after 1hr 10min	Weights after 1hr 20min	Weights after 1hr 30min
1.	Bathwa	2.5	0.340	0.331	0.328	0.328
2.	Fenugreek	1.5	0.238	0.233	0.229	0.225
3.	Spinach	5	0.473	0.455	0.454	0.453
4.	Coriander	1.5	0.195	0.178	0.178	0.178
5.	Mustard greens	4	0.437	0.422	0.420	0.420

TABLE.III WEIGHTS DURING MOISTURE ESTIMATION OF DEHYDRATED SAMPLE

S.no	Sample	Initial weights(g)	Weights after 1hr	Weights after 1hr 10min	Weights after 1hr 20min	Weights after 1hr 30min
1.	Bathwa	4	3.408	3.385	3.360	3.339
2.	Fenugreek	2.5	2.163	2.143	2.116	2.116
3.	Spinach	3	2.592	2.583	2.576	2.576
4.	Coriander	1.7	1.521	1.505	1.497	1.496
5.	Mustard greens	7.5	6.999	6.974	6.944	6.944

TABLE.IV PERCENTAGE MOISTURE CONTENT OF FRESH AND DEHYDRATED SAMPLE

S.no.	Sample	%age moisture of fresh sample	%age moisture of dehydrated sample
1.	Bathwa	86.88	16.52
2.	Fenugreek	85	15.36
3.	Spinach	90.94	14.13
4.	Coriander	88.13	12
5.	Mustard greens	89.5	7.41

5gm of each sample was taken for continuous boiling water rehydration and the initial temperature of the water before immersing the sample were recorded as 100degree Celsius.

5gm of each sample was taken for hot water rehydration and the initial temperature of the water before immersing the sample were recorded as 99degree Celsius.

TABLE.V FINAL TIME, TEMPERATURE AND WEIGHTS AFTER HOT WATER REHYDRATION

S.no	Sample	Final time	Final temperature (degree Celsius)	Final weight (g)
1.	Bathwa	5min5s	83	46
2.	Fenugreek	2min59s	86	40
3.	Spinach	3min8s	86	36.5
4.	Coriander	5min	83	41
5.	Mustard greens	13min10sec	64	29

TABLE.VI FINAL TIME, TEMPERATURE AND WEIGHTS AFTER CONTINUOUS BOILING WATER REHYDRATION

S.no.	Sample	Final time	Final temperature (degree Celsius)	Final weight (g)
1.	Bathwa	2min24s	100	37
2.	Fenugreek	2min17s	100	44
3.	Spinach	2min22s	100	38
4.	Coriander	2min23s	100	48
5.	Mustard greens	4min25s	100	26.5

TABLE.VII REHDRATION RATIOS FOR HOT WATER AND CONTINUOUS BOILING WATER REHYDRATION

S.no	Sample	Hot water rehydration ratio	Continuous boiling water rehydration ratio
1	Bathwa	9.2:1	7.4:1
2	Fenugreek	8:1	8.8:1
3	Spinach	7.3:1	7.6:1
4	Coriander	8.2:1	9.6:1
5	Mustard green	5.8:1	5.3:1

A. Graph depicting sensory evaluation

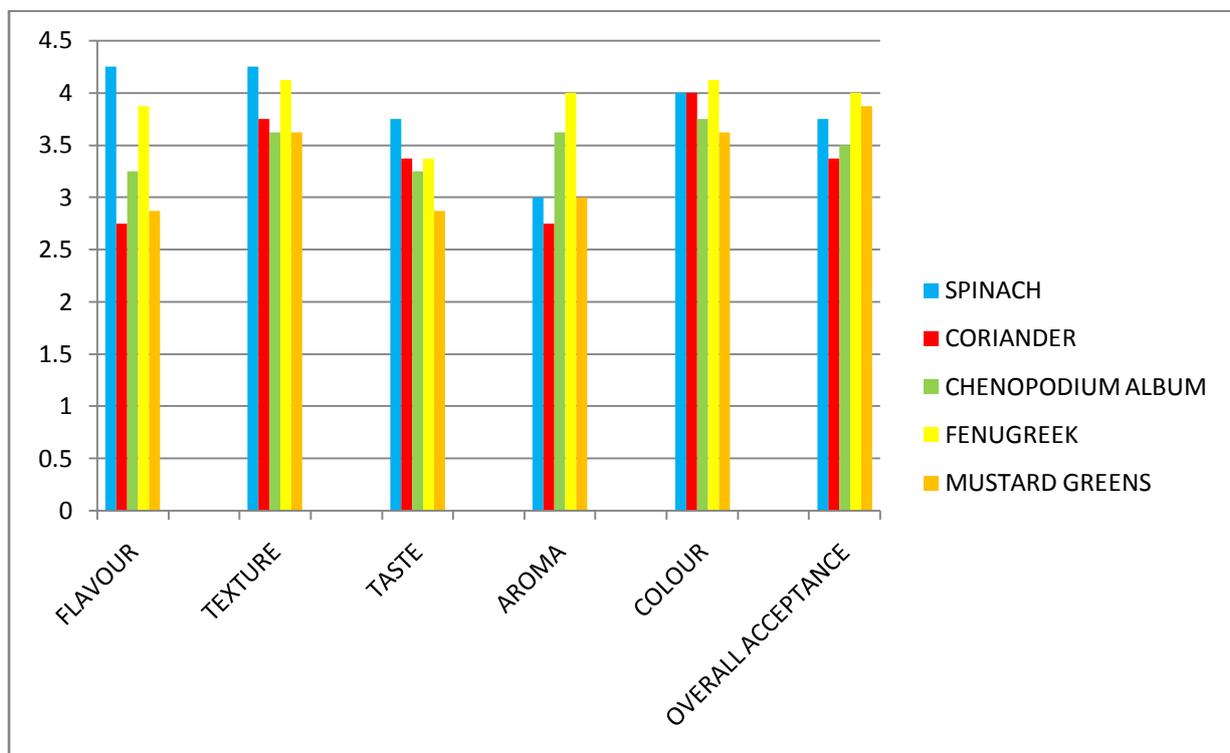


Fig.8 Dehydrated samples

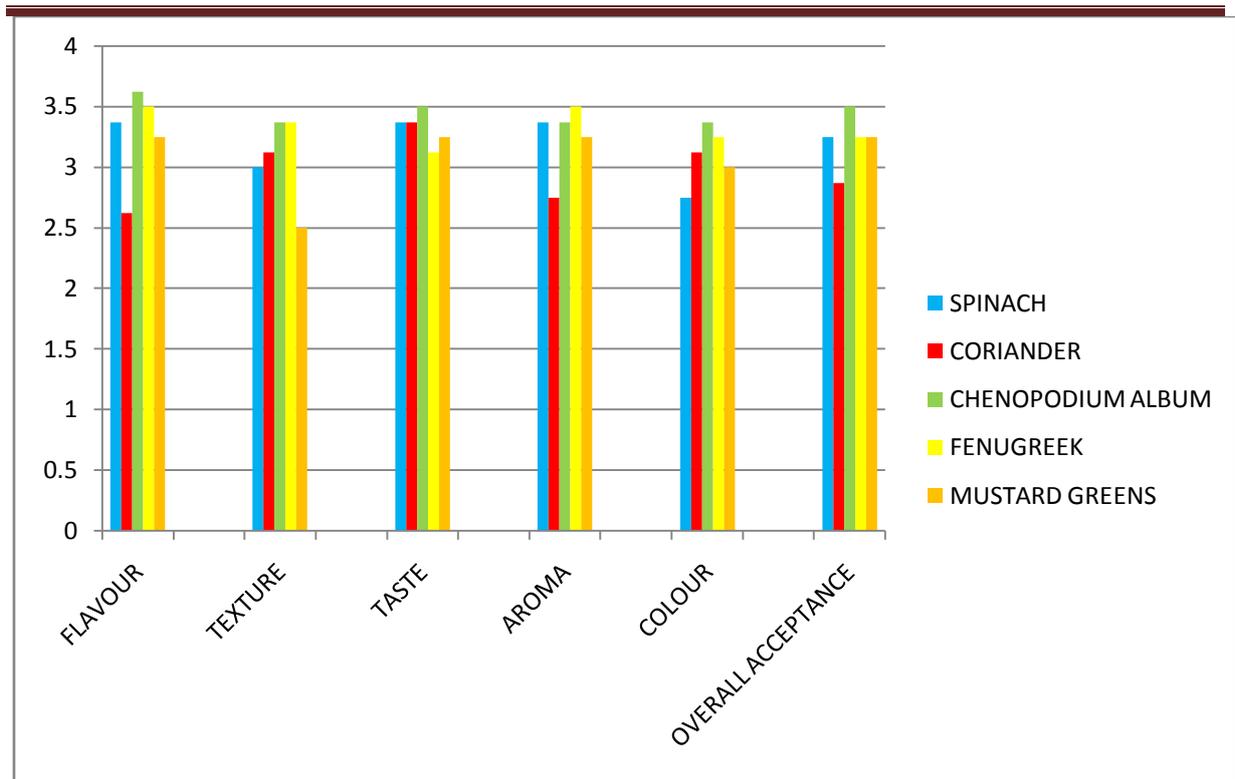


Fig.9 Hot water rehydration

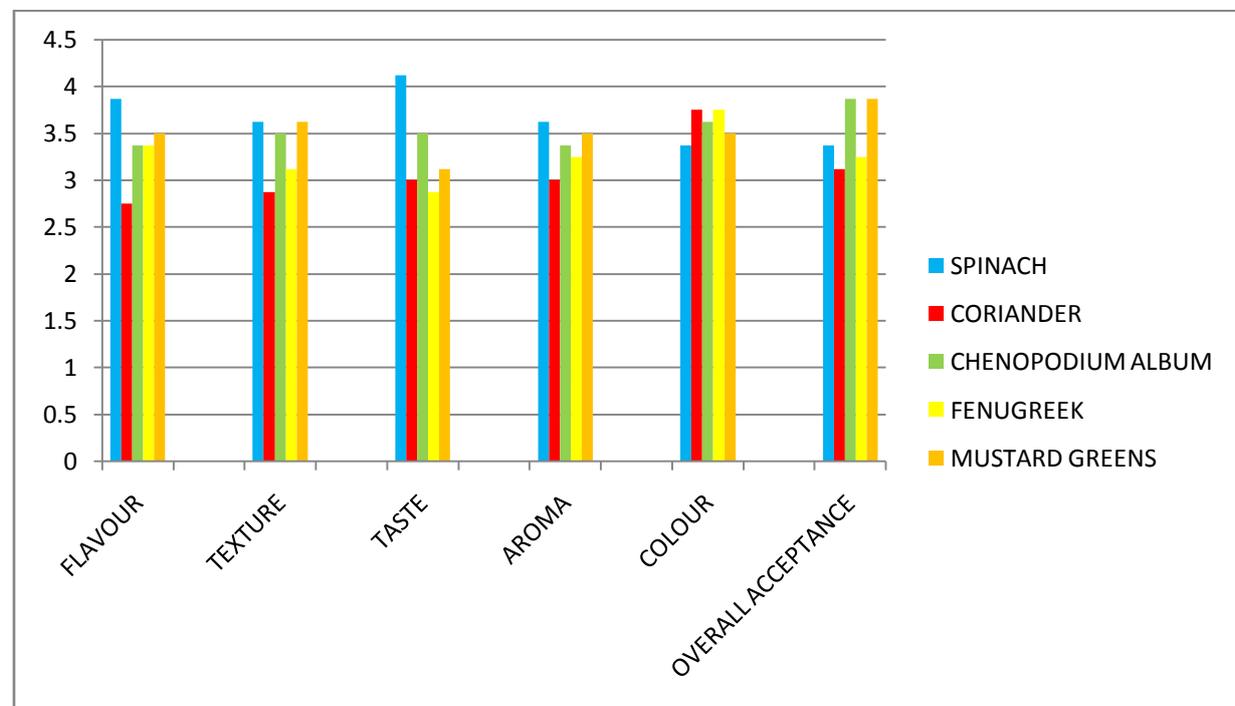


Fig.10 Continuous boiling water rehydration

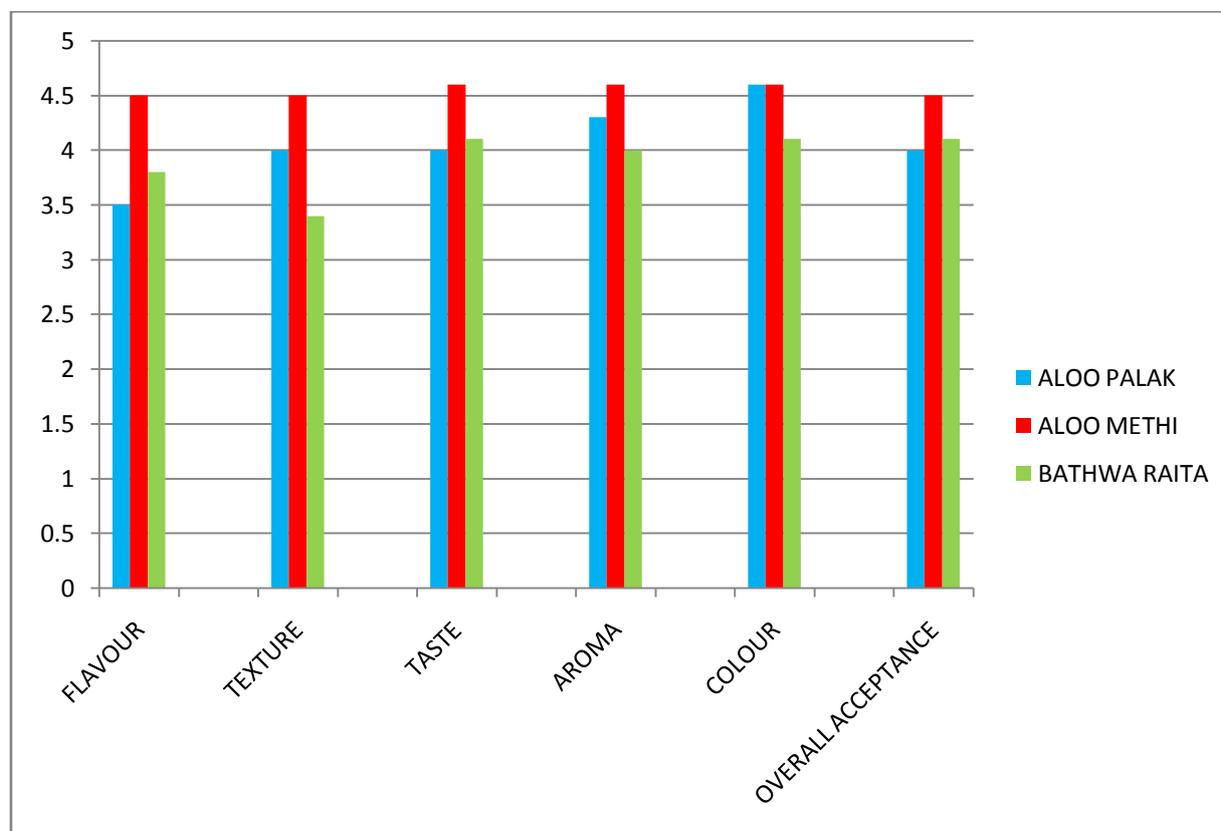


Fig.11 Dried samples food application

## V. CONCLUSION

A study on five green leafy vegetables was carried out to evaluate the effect of drying, rehydration and cooking. The organoleptic characteristics of these green leafy vegetables were evaluated at various stages including dehydration, rehydration and the product formulation of rehydrated samples. Generally, green leafy vegetables lose their characteristic colour on cooking but in this case, the dehydrated samples retained their colour to a large extent due to the pretreatment of blanching prior to dehydration.

In this study fresh green leafy vegetables were procured and used for drying. Blanching was a key step in this process for maximum colour retention, so these vegetables were blanched

with spoonful of sodium bicarbonate. Blanched vegetables were dried in tray dryer for 3 and ½ hours. Then percentage moisture content was estimated by oven drying for both fresh and dried samples. This was followed by rehydration of dried samples using both hot water and continuous boiling water rehydration. After this rehydration ratios were calculated. For the purpose of sensory evaluation and comparison of their organoleptic properties, different food recipes were prepared by using the rehydrated samples. Samples prepared at different stages i.e. dehydration, rehydration and cooked recipes were evaluated by ten sensory panelists using five point hedonic scale.

Results and sensory evaluation study of the dehydrated samples indicate that the spinach

was most preferred in terms of flavor, colour and taste while overall acceptability of the fenugreek was highest because of its aroma and colour. There was a drastic reduction in moisture content after dehydration which is depicted in Table.V. Rehydration could be performed by any of the two methods followed but it was observed that overall acceptability of continuous boiling water rehydration was more than of hot water rehydration samples as they had better texture and flavor. All recipes prepared by rehydrated green leafy vegetables were liked by the panelists but organoleptic characteristics and overall acceptance of aloo methi was superior to other food recipes of dried samples.

Therefore, it is inferred that dehydration can be used to extend the shelf life of green leafy vegetables and along with retention of the pleasing green colour and characteristics flavor. As, these dried green leafy vegetables are processed and do not have plate waste they can be conveniently used in various recipes all around the year. The above studies prove that the food applications of dried samples were as appealing as fresh ones in terms of organoleptic characteristics.

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