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Studies on dehydration of purslane traditional leafy vegetable

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Abstract
The objective of this research work was to develop a technology for dehydration of purslane traditional leafy vegetable and to study the changes in chemical composition and sensory properties of dehydrated vegetable during storage packed in low density polyethylene and aluminium foil bag. Preliminary studies were carried out with pretreatment as blanching with chemicals and plain water to standardize the time and temperature for dehydtration. Amaranth vegetable blanched and dehydrated with this treatment T_2= KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl(1.5%) for 30 seconds in warm water at 45ºC and cooling immediately in tap water applied prior to dehydration in cabinet drier (45°C).Were found to be better than other combinations in respect to organoleptic properties and nutritional quality. The dehydrated purslane vegetable was packed in low density polyethylene and aluminium foil bag and stored at ambient (30 ± 2 ^{0}C) for 180 days. The stored samples were drawn periodically at 30 days interval for organoleptic and chemical analysis.
The chemical composition indicated that the fresh purslane vegetable contained on an average moisture 88.07 percent, ash 2.41 percent, protein 12.55 percent, crude fibre 3.95 mg/100g, iron 23.95 mg/100g, calcium 219.02 mg/100g, β-carotene 2.83 mg/100g, ascorbic acid 22.48 mg/100 g and chlorophyll 94.20 mg/100g. The mean score of fresh purslane vegetable for colour and appearance was 8.46, flavour 8.43, taste 8.34 and overall acceptability 8.36 on 9-point hedonic scale. While dehydrated purslane vegetable contains moisture 6.58 percent, ash 2.18 percent, protein 12.18 percent, crude fibre 3.87 mg/100g, iron 22.51 mg/100g, calcium 208.01 mg/100g, β-carotene 2.63 mg/100g, ascorbic acid 21.15 mg/100g chlorophyll 89.80 mg/100g, dehydration ratio 10.21 percent and rehydration ratio 4.28. The cost of dehydrated purslane vegetable for best combination was Rs. 602.69 per kg for various combinations of ingredients. The storage study indicated that the moisture, ash and dehydration ratio increased in storage period, while ascorbic acid, calcium, iron, crude fibre, chlorophyll, rehydration ratio and β-carotene decreased. The rates of increase or decrease were relatively higher in low density polyethylene bag than aluminium foil bag as packaging material.

Keywords: purslane vegetable, β-carotene, calcium, rehydration ratio, microbial growth

Introduction
Portulaca oleracea (Common purslane called ghol in Maharashtra, red root, pursley) is an annual succulent in the family Portulacaceae. Purslane may be eaten as a leaf vegetable. Purslane contains more omega-3 fatty acid than any other leafy vegetable. It also contains vitamins mainly vitamin A, vitamin C, vitamin E (alpha-tocopherol), vitamin B, carotenoids and dietary minerals such as magnesium, calcium, and iron. Vegetable dehydration is generally done either for preserving the perishable raw commodity against deterioration or to reduce the cost of packaging, handling, storing and transporting. Water in food is reduced to a very low level during dehydration (Ibarz and Barbosa-Canovas, 2000) [5], owing to the reduction in water activity. India's diverse climate ensures availability of all varieties of fresh fruits and vegetables. India ranks second in fruits and vegetables production in the world, after China. In India more than 40 kinds of vegetables belonging to different groups, like Solanaceous, Cucurbitaceous, Leguminous, Cruciferous, root crops and leafy vegetables are grown in tropical, subtropical and temperate regions. As per National Horticulture Database published by National Horticulture Board of India, during 2015-16 India produced 162.19 million metric tons of vegetables with cultivated area of 9.21 million hectares. India is blessed with an array of leafy vegetables some are cultivated

Materials and Methods
Materials
The experiment was conducted in the laboratory of Department of Food Science and Technology, Post Graduate Institute at Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 2018-2019.The purslane vegetable was collected from the local market. The major ingredients for the preparation of products were salt, citric acid, KMS, MgO and other chemicals were used from the laboratory store.

Packaging material
The packaging material *viz*., LDPE (above 51 micron) bags and Aluminium foil bags were procured from local market and used for packaging of cookies and for storage study.

Treatment details
Different combination of chemical treatment to leafy vegetable like purslane shown below:

Table 1: Chemical treatment details for purslane

Treatments	Blanching		Chemicals	Temp(^{0}c)
	Temp (^{0}c)	Time(Sec)		
T_0	45	30	Plain water	45
T_1	45	30	KMS (0.01%) + MgO (1 g) + citric acid (0.5%) + $NaHCO_3$ (1%) + NaCl (1%)	45
T_2	45	30	KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	45
T_3	45	30	KMS (0.03%) + MgO (2 g) + citric acid (1.5%) + $NaHCO_3$ (2%) + NaCl (2%)	45
T_4	45	30	KMS (0.01%) + MgO (1 g) + citric acid (0.5%) + $NaHCO_3$ (1%) + NaCl (1%)	50
T_5	45	30	KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	50
T_6	45	30	KMS (0.03%) + MgO (2 g) + citric acid (1.5%) + $NaHCO_3$ (2%) + NaCl (2%)	50
T_7	45	30	KMS (0.01%) + MgO (1 g) + citric acid (0.5%) + $NaHCO_3$ (1%) + NaCl (1%)	55
T_8	45	30	KMS (0.02%) + MgO (1.5 g) + citric acid (1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)	55
T_9	45	30	KMS (0.03%) + MgO (2 g) + citric acid (1.5%) + $NaHCO_3$ (2%) + NaCl (2%)	55

Method

Preparation of Leafy Vegetables

Roots, stems and damaged leaves were trimmed off and the tender fresh green leaves were plucked and thoroughly washed in cold water to remove adhering dirt dust.

Drying of Leafy Vegetables

Initially standardization of the temperature was done in dryer**.** The cleaned vegetable was subjected to drying at different temperatures viz., 45, 50 and 55°C. Drying temperature and time which yield vegetables with attractive colour was selected for further study.

Selection of Leafy vegetables
↓
Sorting
↓
Washing
↓
Blanching at 45^0 c for 30 sec
↓
Dehydration at 45^0 c for 8-10hr
↓
Packaging
↓
Labeling and storage

Fig 1: Flow chart of dehydration of leafy vegetables

Chemical Composition of Dehydrated Leafy Vegetables

Leafy vegetable was dried at different temperatures i.e. 45°C, 50°C and 55°C. Fresh and stored powder was used for the chemical analysis protein, fats, carbohydrates, dietary fiber, moisture, ash and energy was done in accordance with the Association of Official Analytical Chemists (AOAC) method.

Calcium content was estimated by AOAC method (2000). The ascorbic acid content in the products was estimated by titrimetic method as summarized by Ranganna (1986) [15] using 2-6, dichlorophenol indophenol dye and sugars reported by Ranganna (1986) [15] method.

Sensory evaluation of dehydrated purslane

Sensory evaluation of dehydrated Purslane was carried out according to the method of Amerine *et al.*, (1965) [4] on 9 point hedonic scale. The average scores of the seven semi-trained judges for different quality characteristics *viz.* colour and appearance, flavour, taste and overall acceptability were recorded.

Packaging and storage of dehydrated purslane

The selected treatment (T_2) of dehydrated Purslane was packed in low density polyethylene bag and aluminium foil bag and stored at ambient (30$\pm$ 2^{0}C) for 180 days. The samples were drawn at an interval of 30 days and evaluated for chemical and sensory quality.

Microbiological analysis of Purslane (yeast and mould count)

Microbial count was recorded by using standard plate count by Abadias *et al.* (2008) [3].

Statistical analysis

During storage study of dehydrated purslane vegetable data were recorded at monthly interval on different parameters were subjected to statistical analysis using Factorial Completely Randomized Design (FCRD) using three replications (Rangaswamy, 2010) [16].

Results and Discussion

The results of various experiments conducted during the study period are summarized below:

Chemical changes during storage of dehydrated purslane during storage

The data on chemical changes during storage of papaya guava fruit bar after 6 months storage are tabulated in Table 2. The fruit bar stored at ambient condition were analyzed for moisture, TSS, acidity reducing sugars, total sugars, ascorbic acid, calcium and ß-carotene content at every month.

Table 2: Biochemical changes during storage of dehydrated purslane after 6 months storage

T/PM	Moisture (%)	Ash (%)	Protein (%)	Ascorbic acid (mg/100g)	Calcium (mg/100)	Iron (mg/100)	ß-carotene (mg/100g)	Dehydration ratio
PM								
P_1	7.06	2.98	9.90	18.17	206.79	46.49	1.50	11.91
P_2	7.04	2.96	9.92	18.18	206.82	46.38	1.52	11.89
SEm(±)	0.005	0.006	0.005	0.006	0.006	0.006	0.005	0.006
CD5%	0.015	0.018	0.015	NS	0.018	NS	0.015	0.018
Treatments								
T_0	7.77	3.03	9.44	17.82	199.82	44.90	1.29	12.68
T_2	7.33	2.91	10.37	18.54	213.79	47.97	1.73	11.12

SEm(±)	0.005	0.006	0.005	0.006	0.006	0.006	0.005	0.006
CD5%	0.018	0.018	0.018	0.018	0.018	NS	0.018	0.018
Interaction								
T_0P_1	7.78	3.04	9.43	17.81	199.80	44.77	1.28	12.69
T_0P_2	7.76	3.02	9.45	17.82	199.83	44.78	1.30	12.67
T_2P_1	7.34	2.92	10.36	18.53	213.77	47.96	1.72	11.13
T_2P_2	7.32	2.90	10.38	18.54	213.80	47.97	1.74	11.11
SEm(±)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD5%	NS	NS	NS	NS	NS	NS	NS	NS
GM	8.05	2.97	9.91	18.18	206.80	44.44	1.51	11.90
CV (%)	0.24	0.57	0.17	0.09	0.01	0.04	1.12	0.14

Where, T- Treatments PM- Packaging material T_0-Plain water (control) P_1- LDPE, P_2-Aluminium foil T_2-KMS(0.02%) + MgO(1.5 g) + citric acid(1%) + $NaHCO_3$(1.5%) + NaCl(1.5%)

Table 3: Chemical composition of dehydrated purslane vegetable

Treatments	Moisture (%)	Ash (%)	Protein (%)	Ascorbic acid (mg/100g)	Calcium (mg/100)	Iron (mg/100)	ß-carotene (mg/100g)	Dehydration ratio
T_0	6.92	2.33	11.36	19.54	211.10	44.95	1.82	11.78
T_2	6.59	2.18	12.30	20.14	217.71	48.10	2.63	10.21

Moisture

The results on changes in moisture content of purslane, during storage. The moisture content increased in control ranged from 6.92 to 7.78 per cent in LDPE, 6.92 to 7.76 per cent in aluminium foil while in treatment ranged from 6.59 to 7.34 per cent in LDPE and 6.59 to 7.32 per cent in aluminium foil was observed within a storage period of 180 days. There was a non-significant variation in moisture content in both packaging material during storage study. Moisture contents as revealed in the present study was in agreement with those reported by (Premavalli *et al.*, 2001) [13] for dhantu, khirkhire, honagone, chakota., palak, kachi and fenugreek (Singh *et al.*, 2003) [18] for spinach, amaranthus, bengal gram leaves, cauliflower, mint and coriander (Singh *et al.*, 2006) [19] for amaranth, curry leaves, drumstick leaf, spinach and fenugreek.

Ash

The results on changes in ash content of purslane, during storage.

The results indicate that there was a non-significant variation in ash content in both packaging material during storage study. The ash content increased in control ranged from 2.33 to 3.04 per cent in LDPE, 2.33 to 3.02 per cent in aluminium foil while in treatment ranged from 2.18 to 2.92 per cent in LDPE and 2.18 to 2.90 per cent in aluminium foil was observed within a storage period of 180 days.

Protein

The results on changes in protein content of purslane, during storage. The results indicate that there was a non-significant variation in protein content in both packaging material during storage study. The protein content decreased in control ranged from 11.36 to 9.43 per cent in LDPE, 11.36 to 9.45 per cent in aluminium foil while in treatment ranged from 12.30 to 10.36 per cent in LDPE and 12.30 to 10.38 per cent in aluminium foil was observed within a storage period of 180 days. Dehydration leads to concentration of protein by 3-8 folds. In the present study protein content was significantly higher in blanched leaves subjected to cabinet drying. However, the values ranged from 14 to 33 in different vegetables. Similar enhanced values of protein from 22-31 per cent have been reported by (Singh *et al.*, 2003) [18]. The values reported in the present study fall in the same range. (Singh *et al.*, 2003) [18] revealed that, dried mint and cauliflower leaves possessed higher amounts of protein (30.99 and 29.98% respectively) compared to coriander (22.34%), Bengal gram leaves (26.17%) and carrot (9.82%).

Ascorbic acid

The results on changes in ascorbic acid content of purslane, during storage. The results indicate that there was a non-significant variation in ascorbic acid content in both packaging material during storage study.

The ascorbic acid content decreased in control ranged from 19.54 to 17.81 mg/100g in LDPE, 19.54 to 17.82 mg/100g in aluminium foil while in treatment ranged 20.14 to 18.53 mg/100g in LDPE and 20.14 to 18.54 mg/100g in aluminium foil was observed within a storage period of 180 days. (Kaur and kochar, 2005) [8] have reported the retention of ascorbic acid in mustard, mint and spinach to be as high as 13–38%.Saha *et al.*, (2015) [17] have reported that the ascorbic acid in amaranth oven dried green leafy vegetable is 13.40 mg/100g.

Calcium

The results on changes in calcium content of purslane, during storage. The calcium content decreased in control ranged from 211.10 to 199.80 mg/100g in LDPE, 211.10 to 199.80 mg/100g in aluminium foil while in treatment ranged from 217.71 to 213.77 mg/100g in LDPE and 217.71 to 213.80 mg/100g in aluminium foil was observed within a storage period of 180 day.

There was a non-significant variation in calcium content in both packaging material during storage study. The three varieties of amaranth varied significantly among themselves for their calcium content; Pusa Lal Chaulai being the richest source. Availability of calcium content from three varieties of amaranth was 7.25 to 8.25 per cent. (Punia *et al.*, 2004) [14] Reported that calcium content of amaranth leaves vary from 313.0 to 328.58 mg/100g. (Mibei, 2011) [9] Reported a calcium content of 94.1mg/100g in spider plant. (Kagale and Sabale, 2014) [7] Reported that calcium content of 393.10 mg/100g in dry vegetable of cassia.

Iron

The results on changes in iron content of purslane, during storage. The iron content decreased in control ranged from 44.95 to 44.77 mg/100g in LDPE, 44.95 to 44.78 mg/100g in aluminium foil while in treatment ranged from 48.10 to

47.96 mg/100g in LDPE and 48.96 to 47.97 mg/100g in aluminium foil was observed within a storage period of 180 day. There was a non-significant variation in iron content in both packaging material during storage study. The range of iron content in the present study is in agreement with those reported by (Singh *et al.*, 2003) [18].

B-carotene

The results on changes in β-carotene content of purslane, during storage. The β-carotene content decreased in control ranged from 1.82 to 1.28 mg/100g in LDPE, 1.82 to 1.30 mg/100g in aluminium foil while in treatment ranged from 2.63 to 1.72 mg/100g in LDPE and 2.63 to 1.74 mg/100g in aluminium foil was observed within a storage period of 180 days. There was a non-significant variation in β-carotene content in both packaging material during storage study. Similar result for the untreated and pretreated methi samples the β-carotene value was remained maximum in microwave dried methi leaves i.e.1603.3 μg/100g and 3133.3 μg/100g, respectively, compared to sun drying (1100 and 1840 μg/100g). This might be due to drying by direct exposure to sun resulting in significance loss of pigments owing to long time taken for drying, leading to more oxidation of carotene reported by (Jayaraman *et al.*, 1991) [6]. After six months of storage the loss of β-carotene was significantly lower among the different packaging materials (LDPE, aluminium foil) stored at low temperature compared to ambient temperature. Similar trends in β-carotene variations due to storage temperature have been reported by (Negi and Roy, 2001a) [10]. (Saha *et al.*, 2015) [17] Reported that the β-carotene in amaranth oven dried green leafy vegetable as 6.54 mg/100g.

Dehydration ratio

The results on changes in dehydration ratio of purslane, during storage. The results indicate that there was a non-significant variation in ratio content in both packaging material during storage study. The dehydration ratio increased in control ranged from 11.78 to 12.69 per cent in LDPE, 11.78 to 12.67 per cent in aluminium foil while in treatment ranged from 10.21 to 11.13 per cent in LDPE and 10.21 to 11.11 per cent in aluminium foil was observed within a storage period of 180 days.

Microbial quality of purslane

The data on microbial quality of purslane are presented in Table 4. The microbial count was taken at 0 days. However, no very much microbial colonies were observed on PDA media during the initial period. The microbial counts of vegetable were 0 or nil at zero days. This may be due to the addition of potassium meta-bisulphite. On 180 days storage at ambient temperature standard plate count was noticed as 5×10^5cfu/g in LDPE, while 4×10^5cfu/g in aluminium foil packaging material (Table 4.55). Less microbial growth was observed in the purslane vegetables stored in aluminium foil than LDPE. This indicates that the packaging material ie. Aluminium foil controlled the microbial growth. It indicated that the microbial count was more increased in LDPE than aluminium foil this might be due to LDPE absorb moisture more than aluminium foil. The values obtained for purslane are within the acceptable limits and by (Abadias *et al.*, 2008) [3].

Table 4: Changes in the microbial count of purslane during storage

Standard plate count ($\times 10^3$cfu/g) of mold/yeast				
	Initial (0 Days)		Final (180 Days)	
T/PM	T_0	T_2	T_0	T_2
P1	0	0	6	5
P2	0	0	5	4

Changes in sensory quality of purslane during storage

The data sensory scores of purslane during storage for parameters like colour and appearance, flavour, taste and overall acceptability of dehydrated vegetable samples are tabulated in Table 4.

Colour and appearance

The results on colour and appearance score of purslane as influenced by storage are presented in Table 4. The results indicate that colour and appearance score decreased in control ranged from 8.20 to 6.00 in LDPE and 8.20 to 6.50 in aluminium foil while in treatment ranged from 8.50 to 7.00 in LDPE and 8.50 to 7.20 in aluminium foil was observed within storage period of 180 days.

Flavour

The results on flavour score of purslane as influenced by storage are presented in Table 4. The results indicate that flavour score decreased in control ranged from 8.50 to 6.00 in LDPE, 8.50 to 6.50 in aluminium foil while in treatment ranged from 8.57 to 6.50 in LDPE and 8.57 to 7.00 in aluminium foil was observed within storage period of 180 days.

Table 4: Sensory quality of dehydrated purslane after 180 days of storage

T/PM	Colour and appearance	Flavour	Taste	Overall acceptability
PM				
P1	6.20	6.15	6.65	6.10
P2	6.45	6.65	6.80	6.25
SEm(±)	0.006	0.006	0.006	0.006
CD5%	0.018	0.018	0.018	0.018
Treatments				
T_0	6.00	6.25	6.25	6.00
T_2	6.75	6.75	7.00	6.75
SEm(±)	0.006	0.006	0.006	0.006
CD5%	0.018	0.018	0.018	0.018
Interaction				
T_0P1	6.00	6.00	6.70	6.00
T_0P2	6.50	6.50	6.80	6.10
T_2P1	7.00	6.50	6.90	6.50
T_2P2	7.20	7.00	7.00	7.00
SEm(±)	0.01	0.01	0.01	0.01
CD5%	0.03	NS	0.03	0.03
GM	6.38	6.50	6.63	6.38
CV (%)	0.27	0.26	0.26	0.27

Where, T-Treatments PM- Packaging material T_0-Pain water (control) P_1- LDPE, P_2-Aluminium foil T_2-KMS (0.02%) + MgO (1.5 g) + citric acid(1%) + $NaHCO_3$ (1.5%) + NaCl (1.5%)

Taste

The results on the taste score of purslane as influenced by storage are presented in Table 4. The results indicate that taste score decreased in control ranged from 8.50 to 6.70 in LDPE, 8.50 to 6.80 in aluminium foil while in treatment ranged from 8.60 to 6.90 in LDPE and 8.60 to 7.00 in aluminium foil was observed within storage period of 180 days.

Overall acceptability

The overall acceptability is a combined effect of colour, flavour, and taste of the purslane presented in Table 4. As storage period up to 180 days there was a decreased in the overall acceptability score. The rate decrease was slightly higher in the sample stored in a LDPE as compared to aluminium foil during a storage period of 180 days. Overall acceptability score that decreased in control ranged from 7.80 to 6.0 in LDPE and 7.80 to 6.10 in aluminium foil while in treatment ranged from 8.50 to 6.50 in LDPE and 8.50 to 7.00 in aluminium foil was observed within storage period of 180 days.

Conclusion

The experimental results related to the different pretreatments used for dehydration of purslane in that treatment T_2 was acceptable throughout the storage period of 180 days at ambient temperature. As per the chemical parameters the respective of the treatment. That the moisture, ash and dehydration ratio increased in storage period, while ascorbic acid, calcium, iron, crude fibre, chlorophyll, rehydration ratio and β-carotene decreased. The rates of increase or decrease were relatively higher in low density polyethylene bag than aluminium foil bag as packaging material recorded appreciable. The highest score in overall acceptability observed in treatment (T_2) after 180 days storage study. On the basis of organoleptic properties and chemical analysis of the dehydrated purslane vegetable considered as the best in comparison to the other treatments. The cost of dehydrated purslane vegetable for best combination was Rs. 602.69 per kg.

References

1. ACC. Official Methods of Analysis of AACC International, American Association of Cereal Chemists, Washington D.C, 2000.
2. OAC. Offical Methods of Analysis, 18th edition. Association of Official Analytical Chemist. Washignton, DC, 2000. pp. 454.
3. Abadias M, Usall J, Anguera M, Solsona C, Vinas I. Microbiological quality of fresh, minimally-processed fruit vegetables, and sprouts from retail establishments. International Journal of Food Microbiology. 2008; 123(7):121-129.
4. Amerine MA, Pangborn RM, Roseler CB. Principles of Sensory Evaluation of Foods. Academic Press, New York, 1965, 350-376.
5. Ibarz A, Barboda-Canovas GV. Unit operations in food engineering. Journal of Agriculture Science. 2000; 23(9):306-310.
6. Jayaraman KS, Dasgupta DK, Babu Rao N. Quality characteristics of some vegetables dried by direct and indirect sun drying. Indian Food Packer. 1991; 45(1):16-23.
7. Kagale L, Sabale A. Nutritional composition and antoxidant potential of coastal, wild leafy vegetables. World Journal of Pharmacy and Pharmaceutical Sciences. 2014; 3(10):890-897.
8. Kaur TJ, Kochar GK. Organoleptic evaluation and retention of vitamin C in commonly consumed food preparations using underexploited greens. Indian Journal of Nutraceutiacal Diet. 2005; 42(12):425-31.
9. Mibei EK. Nutritional, Phytochemical and in vitro antimicrobial screening of some indigenous leafy vegetables. Jomo Kenyatta University of Agriculture and Technology, 2011.
10. Negi PS, Roy SK. Effect of drying conditions on quality of green leaves during long term storage. Food Research International. 2001a; 34(4):283-287.
11. Negi PS, Roy SK. Retention of quality characteristics of dehydrated green leaves during storage. Plants Foods for Human Nutrition. 2001b; 56(9):285-295.
12. Negi PS, Roy SK. The effect of blanching on quality attributes of dehydrate carrots during long-term storage. European Food Research Technology. 2001c; 212(12):445-448.
13. Premavalli KS, Majumdar TK, Madhura CV. Processing effect of on colour and vitamins of green leafy vegetables. Journal of Food Science and Technology. 2001; 38(1):79-81.
14. Punia D, Yadav SK, Gupta M, Khetarpaul N. Nutrient composition of amaranth (*Amaranth tricolour*) and khondhara (*Digeria arvensis*) leaves and their products. Journal of Food Science and Technology. 2004; 41(5):563-566.
15. Ranganna S. Hand book of Analysis and Quality Control of Fruits and Vegetables Products. II Edition. Tata Mc-Graw Hill. New Delhi, 1986, 7-12.
16. Rangaswamy R. A Text Book of Agricultural Statistics, Second edition and New Age International Publishers. New Delhi, 2010, 234-458.
17. Saha J, Biswal AK, Deka SC. Chemical composition of some underutilized green leafy vegetables. International Food Research Journal. 2015; 22(4):1466-1473.
18. Singh G, Kawatra A, Sehgal S, Pragati. Effect of storage on nutritional composition of selected dehydrated green leafy vegetable powders. Plant Foods for Human Nutrition. 2003; 58(6):1-9.
19. Singh U, Sagar VR, Behera TK, Suresh Kumar P. Effect of drying condition on quality of dehydrated selected leafy vegetables. Journal of Food Science Technology, 2006.