5. DISCUSSIONS

Micronutrient deficiency is a major public problem among the population. Despite the fact that several programmes have been launched by Government of India to allay this deficiency, the problem still exists in the country with higher magnitude. At this juncture, it is essential to look for sustainable, culturally acceptable, cost effective strategy with multiple benefits. Hence, food based strategy is excellent strategy to combat micronutrient deficiency since it is culturally acceptable and sustainable as well as cost effective (Dairo & Ige, 2009). India is bestowed with a number of beta carotene and iron rich foods including cereals, pulses, oilseeds, nuts, green leafy vegetables and dry fruits. Among these, green leafy vegetables form an integral part of the diet of the Indian population. Despite the fact that green leafy vegetables are treasure trove of nutrients, they provide variety in terms of color and flavor. Green leafy vegetables are available in plenty at affordable price, although the consumption is limited. Therefore preservation is an alternative to prevent spoilage and render availability throughout the year at remunerative cost (Nambiar & Kosambia, 2005).

Dehydration is a simple user friendly, traditional technology which converts the vegetables in to crisp form, reducing in size to facilitate the utility throughout the year. Another added advantage of this method is that the dried vegetable powder can be then easily incorporate in to different traditional recipes (Gupta & Prakash, 2011). Blanching offers destruction or inactivation of enzymes that can affect the color, texture, flavor and nutritional quality, hence improvement in the quality of final produce. Blanching helps in increasing the physico-chemical accessibility of micronutrients, decrease the content of inhibitors such as oxalic acid, phytate and increase the compounds that enhance net bioavailability of micronutrients (Mepba, Eboh, & Banigbo, 2007). Incorporation of green leafy vegetables in various traditional recipes helps in value addition. It is a simple method and can be practiced in routine. Hence, in the present study we assessed the nutrient composition of fresh Daucus carota (Carrot) and Brassica oleracea (Cauliflower) leaves. Then, they were processed to improve the shelf life and incorporated in various traditional recipes to form value added products.
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Procurement and Preparation of selected Green leafy vegetables (*Daucus carota* and *Brassica oleracea*)

Green Leafy Vegetables flood the market during glut and excess gets spoilt owing to their perish ability. Further, the consumption of leafy vegetables is restricted during rainy season due to lowered temperature, high humidity and gastrointestinal problems. In order to minimize wastage and utilize during off season it is necessary to process and preserve the vegetables by simple traditional methods like oven drying. Among the traditional drying methods, drying under sun and shade are the cheapest methods commonly practiced in places of plenty of sunshine and dry atmosphere (low relative humidity). But the limitation is, it cannot be practiced at all places, during all the seasons of the year, takes longer time for drying as well as hygiene cannot be ensured.

Dehydration of vegetables by using modern equipments like oven drier is a popular and commercially adopted drying technique. In the present study on an average, oven drying was accomplished within 6 hours; *Daucus carota* (Carrot) leaves took 4-5 hours Non Blanched dehydrated and 5-6 hours for Blanched dehydrated sample while the *Brassica oleracea* (Cauliflower) leaves took 6-7 hours for Non Blanched dehydrated sample and 7-8 hours for Blanched dehydrated sample. Temperature required for drying depends on initial moisture and anatomical morphological characteristics of the material to be dried. In order to decide upon the best temperature for drying the green leafy vegetables, we considered the method which ensures better yields in shorter time with retention of visual quality, both the leaves (*Daucus carota* and *Brassica oleracea*) were dehydrated at 60°C in the present study.

*Soysal, Oztekin, & Eren, (2006)* reported that longer exposure to heat might continue the loss of volatile compounds. *Kaur, Kumar, Arora, Chawala, & Singh, (2009)* reported that lower temperature of drying showed better retention in color. Similarly, in the present study, the dehydration at 60°C exhibited bright green color. As the temperature of drying increased removal of moisture from the leaves occurred at a faster rate. Since, drying takes place at faster rate at higher temperature probably the loss of volatile compounds and dry matter along with moisture is reduced resulting in slightly better retention in comparison to low temperature. Similar findings of better retention of decrease in drying time with increase in temperature has been reported by *Ahmad, Shivhare, & Singh(2001)* for coriander leaves and *Pande, Sonune, & Philip, (2000)* for coriander and methi leaves.
The rate of moisture removal in oven drying was much faster than other drying techniques. The drying curves of the vegetables indicated that the loss of moisture was at its highest magnitude in the beginning first hour of drying. After first hour, there was continuous decrease in moisture content of the vegetables. Singh et al., (2007) highlighted that the average duration of oven drying for bathua leaves was about 3 to 4 hours. Singh, Sagar, Behera, & Kumar, (2006) also reported that oven drying was best for dehydration of leafy vegetables as it reduced maximum moisture content, which is quite similar to the oven drying time period of spinach and fenugreek as given by Bhosale & Arya, (2004). Madalgiri, Mahadev, & Hiremath, 1996 suggested that the drying curry leaves in oven at 50°C was reported to be completed in 5.02 hours while drying in sun (35°C) and shade (25°C) required 3.16 and 7.20 days, respectively. Among the three drying methods, oven drying was superior with emerald green colored curry leaf powder. The better results of hot air oven drying were due to high temperature, low relative humidity and fast removal of water.

In the present study, approximately 15 gram of leaf powder was procured from 100 gram of fresh destalked Daucus carota (Carrot) and Brassica oleraceae (Cauliflower) leaves after oven drying. The temperature, rate of air flow and structural difference of individual vegetables might also be responsible for difference in per cent yield of GLVs dried by different modes of drying. Less time and higher per cent yield of GLVs dehydrated in microwave and hot air oven may be due to the controlled temperature and constant flow of hot air which must have evaporated moisture more rapidly from the GLVs at constant temperature without any external disrupting factors (Bhosale & Arya, 2004). Lalitha & Sathya (2003) have also found that the yield of sun dried vegetable powder was less than that of oven dried ones. The lower yield in sun dried samples over shade dried vegetables must have been resulted from higher evaporation of moisture from the vegetables due to heat of the sun. It is desirable to dry the GLVs using microwave and hot air oven in order to attain more per cent yield within shorter period of time and ensure better retention of color as well as nutrients in the dehydrated sample.
Nutritional estimation of fresh and processed Green leafy vegetables (*Daucus carota* and *Brassica oleracea*)

Green leafy vegetables are rich sources of several nutrients (*Rao, Doesthale, & Pant, 1989*). Dehydration in particular helps in making green leafy vegetables a concentrated source of nutrients.

**Nutritional components:**

**Iron content:**

In the present study, concentrated quantities of iron with multifold enhancement were reported. The iron content of fresh *Daucus carota* and *Brassica oleracea* leaves was estimated to be 8.13 mg/100g and 32.88 mg/100g in fresh sample. However, in the case of processed *Daucus carota* sample, it was estimated to be 36.90 mg/100g in blanched dehydrated sample and 33.11 mg/100g in non blanched dehydrated sample, however in *Brassica oleracea*, it was 192.52 mg/100g in blanched dehydrated sample and 187.69 mg/100g in non blanched dehydrated sample respectively. Similarly, *Joshi and Mehta, (2010)* conducted a study on the effect of dehydration on the nutritive value of drumstick leaves. The value of iron content for fresh drumstick leaves was taken from *NIN, (2000).* Fresh drumstick leaves have an iron content of 0.085 mg/100g where as the iron content of the leaf powder prepared by different methods of dehydration (Sun, Shade and Oven) was estimated to be 21 mg/100g (Sun dried), 24 mg/100g (Shadow dried) and 19 mg/100g (Oven dried) which was 95 to 96% more than their fresh counter parts. *Singh et al., (2007)* conducted a study on preparation of value added products from dehydrated bathua leaves. Iron content of dehydrated bathua leaves was 27.48 mg/100g, which was 6 times greater than the fresh values i.e. 5.46 mg/100g.

*Lakshmi & Kohila, (2007)* evaluated the effect of different dehydrating techniques (Sun, Shade and Cabinet), an iron content of various green leaves. The value of iron content for fresh green leaves was taken from *Gopalan, Ramasashtri, & Balasubramaniyam, (2000).* Maximum increment of iron was observed in shade drying method. The iron content of fresh Agathi, Coriender, Curry, Drumstick leaves were 3.9 mg/100g, 1.4 mg/100g, 0.9 mg/100g and 440 mg/100g respectively. On dehydration, the iron content raised up to 22.7 mg/100g (Sun dried), 25.3 mg/100g (Shade dried) and 24.6 mg/100g (Cabinet dried). Iron content of dried coriander leaf powder was 18.1 mg/100g (Sun dried), 19.2 mg/100g (Shade dried) and 18.4 mg/100g (Cabinet dried). Iron content of
dried curry leaf powder was 14.1 mg/100g (Sun dried), 15.7 mg/100g (Shade dried) and 15.3 mg/100g (Cabinet dried). Iron content of dried drumstick leaf powder was 13.5 mg/100g (Sun dried), 13.90 mg/100g (Shade dried) and 13.9 mg/100g (Cabinet dried).

Kowsalya & Vidhya, (2004) highlighted in their study that the iron content of selected fresh green leaves of Arai keerai, Mulla keerai, Paruppu keerai and Drumstick leaves was 35 mg/100g, 20.8 mg/100g, 20.8 mg/100g and 0.72 mg/100g respectively. On dehydration the iron content increased, however maximum increment was observed by cabinet drying technique. The iron content of dehydrated leaf powder for Arai keerai was 263 mg/100g (Sun dried), 267 mg/100g (Shade dried) and 269 mg/100g (Cabinet dried); Mulla keerai was 119.89 mg/100g (Sun dried), 119.89 mg/100g (Shade dried) and 121.33 mg/100g (Cabinet dried); Paruppu keerai was 122.3 mg/100g (Sun dried), 123.7 mg/100g (Shade dried) and 127.1 mg/100g (Cabinet dried); Drumstick was 25.5 mg/100g (Sun dried), 25.5 mg/100g (Shade dried) and 26 mg/100g (Cabinet dried). Nutritional composition of selected green leafy vegetables, herbs and carrots was estimated by Singh, Kawatra, Sehgal, (2001). The vegetables under study were Mint, Coriender, Bengal gram, Spinach, Cauliflower, Amaranthus and Carrots. Analysis of total iron content was highlighted that it ranged from 22.3 to 84.4 mg/100g on a dry weight basis. Maximum iron content was found in Bengal gram leaves (84.4 mg/100g) and minimum was noted in carrots (7.7 mg/100g). This also indicates that green leaves are better source of iron in comparison to carrots. Similarly, there are number of studies which have coded that dehydration makes these green leaves very rich source of iron like Gafar & Itodo, 2011; Akubugwo, Obsai, Chinyere, & Ugbovu, 2007; Gupta, Lakshmi, Manjunath, & Prakash, 2005.

**Calcium content:**

In the present study, calcium content significantly increased in post processing. Dehydration of green leafy vegetables leads to concentration of calcium by 4 to 5 folds. From the present study, the calcium content of Daucus carota and Brassica oleracea leaves was estimated to be 319.23 mg/100g and 604 mg/100g in fresh sample. However, in the case of processed Daucus carota sample, it was analyzed to be 1432.76 mg/100g in blanched dehydrated sample and 1416.88 mg/100g in non blanched dehydrated sample, however in Brassica oleracea was estimated to be 3100.57 mg/100g in blanched dehydrated sample and 3087.65 mg/100g in non blanched dehydrated sample respectively.
Similarly, Joshi and Mehta, (2010) conducted a study on the effect of dehydration on the nutritive value of drumstick leaves. The value of calcium content for fresh drumstick leaves was taken from NIN, (2000). Fresh drumstick leaves had a calcium content of 440 mg/100g where as the calcium content of the leaf powder prepared by different methods of dehydration (Sun, Shade and Oven) was estimated to be 3382 mg/100g (Sun dried), 3405 mg/100g (Shadow dried) and 3467 mg/100g (Oven dried) which was 82 to 87% more than their fresh counter parts. The maximum retention was observed in Oven drying technique.

Lakshmi & Kohila, (2007) evaluated the effect of different dehydrating techniques (Sun, Shade and Cabinet), a calcium content of various green leaves. The value of calcium content for fresh green leaves was taken from Gopalan, Ramasashtri, & Balasubramaniyam, (2000). Maximum increment of calcium was observed in shade drying method. The calcium content of fresh Agathi, Coriender, Curry, Drumstick leaves was 1130 mg/100g, 184 mg/100g, 830 mg/100g and 440 mg/100g respectively. On dehydration, the calcium content raised up to 2289 mg/100g (Sun dried), 2923 mg/100g (Shade dried) and 2914 mg/100g (Cabinet dried). Calcium content of dried coriander leaf powder was 1219 mg/100g (Sun dried), 1273 mg/100g (Shade dried) and 1289 mg/100g (Cabinet dried). Calcium content of dried curry leaf powder was 2101 mg/100g (Sun dried), 2187 mg/100g (Shade dried) and 2127 mg/100g (Cabinet dried). Calcium content of dried drumstick leaf powder was 1298 mg/100g (Sun dried), 1330 mg/100g (Shade dried) and 1326 mg/100g (Cabinet dried).

Kowsalya & Vidhya, (2004) highlighted in their study that the calcium content of selected fresh green leaves of Arai keerai, Mulla keerai, Paruppu keerai and Drumstick leaves was 0.35 g/100g, 0.78 g/100g, 0.10 g/100g and 0.42 g/100g respectively. On dehydration, the calcium content increased however, maximum increment was observed by cabinet drying technique. The calcium content of dehydrated leaf powder for Arai keerai was 2.69 g/100g (Sun dried), 2.72 g/100g (Shade dried) and 2.79 g/100g (Cabinet dried); Mulla keerai was 4.35 g/100g (Sun dried), 4.39 g/100g (Shade dried) and 4.55 g/100g (Cabinet dried); Paruppu keerai was 0.93 g/100g (Sun dried), 0.93 g/100g (Shade dried) and 0.96 g/100g (Cabinet dried); Drumstick was 1.50 g/100g (Sun dried), 1.54 g/100g (Shade dried) and 1.57 g/100g (Cabinet dried). Similarly, there are number of studies which have highlighted that dehydration makes these leaves a treasure trove of several nutrients like calcium Gafar & Itodo, 2011; Akubugwo, Obsai, Chinyere, & Ugbogu, 2007; Singh, Lakshmi, & Prakash, 2005.
Phosphorus content:

From the present study, the phosphorus content of *Daucus carota* and *Brassica oleracea* leaves was researched to be 104.31 mg/100g and 100.68 mg/100g in fresh sample. However, in processed *Daucus carota* leaf sample, it was estimated to be 316.81 mg/100g in blanched dehydrated and 338.64 mg/100g in non blanched dehydrated samples whereas in *Brassica oleracea*, 221.67 mg/100g in blanched dehydrated sample and 240.65 mg/100g in non blanched dehydrated sample respectively. The result indicated that the concentration of phosphorus content was reduced by blanching. This lost of nutrient is due to the leaching of mineral salt into the blanching (Ihelaboye, Amoo, & Pikuda, 2013).

Ihelaboye, Amoo, & Pikuda,(2013) investigated a study on the effect of cooking methods on mineral and anti nutrient content of seven green leafy vegetables. The phosphorus content of fresh leaves was 547.36 mg/kg (*Talium triangulae*), 1677.43 mg/kg (*Amaranthus hydrides*), 876.57 mg/kg (*Colocasia esculenta*), 1245.78 mg/kg (*Telfairia occidentials*), 1064.62 mg/kg (*Solanum nigrum*), 760.17 mg/kg (*Crassocephalum crepidiodes*) and 566.74 mg/kg (*Cindosculus aconitifolis*). In blanched leaves, phosphorus content was found to be 440.57 mg/kg (*Talium triangulae*), 1556.09 mg/kg (*Amaranthus hydrides*), 759.64 mg/kg (*Colocasia esculenta*), 1034.19 mg/kg (*Telfairia occidentials*), 944 mg/kg (*Solanum nigrum*), 656.15 mg/kg (*Crassocephalum crepidiodes*) and 489.12 mg/kg (*Cindosculus aconitifolis*).

Joshi and Mehta, (2010) conducted a study on the effect of dehydration on the nutritive value of drumstick leaves. The value of phosphorus content for fresh drumstick leaves was taken from NIN, (2000). Fresh drumstick leaves had a phosphorus content of 70 mg/100g where as the calcium content of the leaf powder prepared by different methods of dehydration (Sun, Shade and Oven) was estimated to be203 mg/100g (Sun dried), 218 mg/100g (Shadow dried) and 215 mg/100g (Oven dried) which was 64 to 68% more than their fresh counter parts. The maximum retention was observed in Oven drying technique.

Lakshmi & Kohila, (2007) evaluated the effect of different dehydrating techniques (Sun. Shade and Cabinet), a phosphorus content of various green leaves. The value of phosphorus content for fresh green leaves was taken from Gopalan, Ramasashtri, & Balasubramaniyam, (2000). Maximum increment of phosphorus was observed in shade drying method. The phosphorus content of fresh Agathi, Coriender, Curry, Drumstick leaves was 80 mg/100g, 71 mg/100g, 57 mg/100g and 70 mg/100g respectively. On dehydration, the phosphorus content raised up to 267 mg/100g (Sun dried), 292 mg/100g
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Phosphorus content of dried coriander leaf powder was 226 mg/100g (Sun dried), 249 mg/100g (Shade dried) and 252 mg/100g (Cabinet dried). Phosphorus content of dried curry leaf powder was 156 mg/100g (Sun dried), 164 mg/100g (Shade dried) and 164 mg/100g (Cabinet dried). Phosphorus content of dried drumstick leaf powder was 260 mg/100g (Sun dried), 280 mg/100g (Shade dried) and 260 mg/100g (Cabinet dried).

Kowsalya & Vidhya, (2004) highlighted in their study that the phosphorus content of selected fresh green leaves of Arai keerai, Mulla keerai, Paruppu keerai and Drumstick leaves was 54.75 mg/100g, 41 mg/100g, 39.25 mg/100g and 71.5 mg/100g respectively. On dehydration, the phosphorus content increased however, maximum increment was observed by cabinet drying technique. The phosphorus content of dehydrated leaf powder for Arai keerai was 402.6 mg/100g (Sun dried), 416.2 mg/100g (Shade dried) and 425 mg/100g (Cabinet dried); Mulla keerai was 227.5 mg/100g (Sun dried), 235 mg/100g (Shade dried) and 235 mg/100g (Cabinet dried); Paruppu keerai was 337.5 mg/100g (Sun dried), 350 mg/100g (Shade dried) and 362.5 mg/100g (Cabinet dried); Drumstick was 249 mg/100g (Sun dried), 255 mg/100g (Shade dried) and 255 mg/100g (Cabinet dried). Other studies based on nutritional estimation of dehydrated greens have reflected that dehydration increased the phosphorus content many folds like Sood, Modgil, Sood, & Chuhan, 2012; Kwenin, Wolli, & Dzomeku, 2011; Akubugwo, Obsai, Chinyere, & Ugbugu, 2007.

Beta carotene content:

The beta carotene content of Daucus carota and Brassica oleracea were estimated to be 4,008 µg/100g and 5,239.76 µg/100g in fresh samples respectively. However, in blanched dehydrated sample, the values of Daucus carota and Brassica oleracea were evaluated to be 13,708.56 µg/100g and 15,406.84 µg/100g respectively. In non blanched sample, the beta carotene content was analyzed to be 12,402.2 µg/100g in Daucus carota leaves and 14,289.69 µg/100g in Brassica oleracea leaves. Beta carotene content was significantly higher in blanched dehydrated leaf powder subjected to non blanched dehydrated sample, hence the percent increment being higher in blanched dehydrated sample. Joshi and Mehta, (2010) reported that the fresh drumstick leaves had calcium content of 6780 µg/100g (value taken from NIN, 2000) whereas, the leaf powder prepared by different methods of dehydration (Sun, Shade and Oven) was 36000 µg/100g.
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(Sun dried), 39600 µg/100g (Shade dried) and 37800 µg/100g (Oven dried) leaf powder which was 86 to 87% higher than the fresh counterparts. The difference between the three samples of drumstick leaves was statistically significant.

Singh et al., (2007) evaluated a study on value added products from dehydrated bathua leaves (Chenopodium album Linn). Total carotenoid content of dehydrated bathua leaves was 14826.6 µg/100g, which was 6 times greater than the fresh values i.e. 1740 µg/100g. Dutta, Raychaudhuri, & Chakraborty, (2005) also reported that Blanching results in an increase in the beta carotene content perhaps because of greater chemical extractability and loss of moisture and soluble solids which further concentrate the sample. Inactivation of certain oxidative enzymes takes place and it results in the breakdown of some structures leading to a higher net bioavailability of beta-carotene. Kowsalya & Vidhya, (2004) conducted a study on the nutritive value of selected dehydrated green leafy vegetables. The beta carotene content of dehydrated leaf powder for Arai keerai was 52.75 mg/100g (Sun dried), 66.56 mg/100g (Shade dried) and 74.78 mg/100g (Cabinet dried); Mulla keerai was 48.62 mg/100g (Sun dried), 52.76 mg/100g (Shade dried) and 61.96 mg/100g (Cabinet dried); Paruppu keerai was 72.16 mg/100g (Sun dried), 82.28 mg/100g (Shade dried) and 97.84 mg/100g (Cabinet dried); Drumstick was 41.74 mg/100g (Sun dried), 46.70 mg/100g (Shade dried) and 54.19 mg/100g (Cabinet dried). Thus, result indicated that beta carotene content increased however, maximum increment was observed by cabinet drying technique.

Negi & Roy, (2001a) carried out an investigation on the effect of blanching on quality of dehydrated carrots. The results revealed that the carotene content of carrots was higher (29.16 mg/100g) in blanched samples as the comparison was done with the non blanched (23.38 mg/100g). Yadav & Sehgal, (1995) conducted a study on the effect of home processing on ascorbic acid and beta carotene content of spinach and amaranth leaves. These leaves were blanched for 5, 10 and 15 minutes. Results revealed that there is a proportional connection between the beta carotene content and blanching time. As the time of blanching increases, loss of beta carotene content was high. Beta carotene content was estimated to be 48.7 mg/100g (Spinach) and 32.4 mg/100g (Amaranth), 44.2 mg/100g (Spinach) and 29.7 mg/100g (Amaranth), 39.3 mg/100g (Spinach) and 26.7 mg/100g (Amaranth) for 5, 10 and 15 minutes of blanching respectively. Other researches had reported that blanched and dehydrated green leafy vegetables powders retained fair amount of beta carotene; Akubugo, Obsai, Chinyere, & Ugbogu, 2007; Singh, Kawatra, &
Ascorbic acid content:

The ascorbic acid content of *Daucus carota* and *Brassica oleracea* leaves was estimated to be 69.84 and 7.32 mg/100g in fresh sample respectively. The ascorbic acid content of *Daucus carota* was estimated to be 35.61 mg/100g in blanched dehydrated sample and 42.65 mg/100g in non blanched dehydrated sample however in *Brassica oleracea* was evaluated to be 4.13 mg/100g in blanched dehydrated sample and 5.62 mg/100g in non blanched dehydrated sample respectively. Results suggested that after processing, there was a reduction in ascorbic acid content in comparison with their fresh counterparts. Percent decrement of both the processed samples, prepared by *Daucus carota* and *Brassica oleracea* was approximately 20 to 50 percent.

Similarly, Gupta & Prakash, (2011) posted that fresh green leafy vegetables has good amounts of ascorbic acid 65.4 and 58.3 mg/100g in Amaranthus paniculatus and Peucedanum graveolens respectively. When Amaranthus paniculatus was subjected to oven drying, it reduced to 3 mg/100g whereas in Peucedanum graveolens, it was estimated to be 22.9 mg/100g. Joshi & Mehta, (2010) suggested that fresh drumstick leaves have a ascorbic acid content of 220 mg/ 100 g (Value was taken from NIN, 2000), where as the ascorbic acid content of the leaf powder prepared by different methods of dehydration (Sun, Shadow and Oven) was 92 mg/100g (Sun dried), 140 mg/100g (Shadow dried) and 56 mg/100g (Oven dried) leaf powder. The maximum amount of ascorbic acid was in shadow - dried sample as in this technique the leaves were not exposed to direct heat and air.

Babalola, Tugbobo, & Daramola,(2010) designed a study to determine the effect of processing on the ascorbic acid content of seven Nigerian green leafy vegetables: Telfaria occidentalis (ugu), Talinum triangulare (waterleaf), Basella alba (indian spinach), Celosia argentea (soko), Vernonia amygdalina (bitter leaf), Amaranthus hybridus (tete) and Crassephalum crepidioees (rorowo). Processing methods employed were blanching, boiling, sun drying, squeeze-washing, squeeze-washing with salt and squeeze-washing with boiling. Raw ugu had highest ascorbic acid content of 62.50 mg/100g while raw waterleaf had the lowest value of 9.30 mg/100g. Blanching and boiling reduced the ascorbic acid content of soko and tete tremendously with a value of 91.50% reduction for
boiled tete. The percentage loss for sundried vegetables was the lowest when compared with other processing methods with a reduction of 6.50 and 12.40% in Indian spinach and rorowo, respectively. Squeeze washing reduced the ascorbic acid content of ugu from 62.50 mg/100g to 6.47 mg/100g (89.65%) and bitter leaf from 42.40 mg/100g to 4.28 mg/100g (89.90%). Squeeze-washing followed by boiling of bitter leaf reduced the ascorbic acid content from 42.40 mg/100g to 2.18 mg/100g recording the highest loss of 94.90% when compared with other processing methods.

**Gupta, Lakshmi, & Prakash, (2008)** found that with increase in blanching time to 1 min, in case of fresh Drumstick, Brahmi and Bathua leaves there was a further loss of ascorbic acid up to 5 to 10%. When the blanching time was increased to 4 min, Ambat chukka, kilkeerae and brahmi showed a reduction of 10, 20 and 40% respectively in comparison with the samples blanched for 2 min. They also reported that 18% loss of ascorbic acid was seen with increase in the blanching time from every 30-120 sec. **Yadav & Sehgal, (1995)** highlighted in their study that ascorbic acid content of fresh leafy vegetables varied from 624.1 mg/100g in Spinach to 629 mg/100g in Amaranth leaves. Ascorbic acid content was reduced by 83.4 (Sun dried) and 82.5 (Oven dried) percent in Amaranthus leaves and 90.5 (Sun dried) and 90 (Oven dried) percent in Spinach leaves. Reduction of ascorbic acid was almost similar (82 to 90 percent) in sun and oven dried leaves and they had significantly less ascorbic acid than fresh leaves. Losses of ascorbic acid varied from 52 to 93% in leaves blanched for 5 to 15 minutes. Significant reduction in ascorbic acid content was observed in blanched leaves. The losses increased with the increase in blanching duration. Similarly, there are number of studies which have coded that after processing, there was a reduction in ascorbic acid content in comparison with their fresh counterparts *(Gupta, Lakshmi, Manjunath, & Prakash, 2005; Oboh, 2005; Maharaj & Sankat, 1996)*.

**Non nutritional components:**

**Moisture content:**

Moisture content of the dried product is an indicator of efficiency of dehydration. The moisture content of *Daucus carota* and Brassica olerecea leaf sample was estimated to be 92.34% and 88.4% in fresh sample. However, in processed *Daucus carota* sample, it was researched to be 3.72% in blanched dehydrated sample and 2.37% in non blanched dehydrated sample, however in *Brassica olerecea*, moisture content was 3.23% in
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blanched dehydrated sample and 2.15% in non blanched dehydrated samples respectively. Besides this in a study conducted by Gupta et al in 2011 moisture content of oven dried Amaranthus gangeticus was estimated and it was reported to be 3.6%. Gupta & Prakash (2009) analyzed the moisture content of fresh green leafy vegetables and Trigonella graecum (87.92%) was at the top with highest amount of moisture content followed by Amaranthus sp (86.54%), Centella asiatica (85.67%) and lastly Murraya koenigii (77.12%).

Singh, Kawatra, & Sehgal, in 2001 estimated moisture content of oven dried Cauliflower and Spinach greens and their moisture content was reported to be 2.52% and 2.20% respectively, these values are quite near to our observations. Moisture content of several other green leaves in fresh state was estimated by different researchers and they have reported nearly similar results for example: Amaranthus paniculatus (86.5%), Indigofera astragalina (51%), Ipomoea batatas (82.21%), Coriender (77.9%), Bathua (89.04%), and Fenugreek (86.84%) (Gupta & Prakash, 2011; Gafar & Itodo, 2011; Akubugo, Obsai, Chinyera, & Ugbogu, 2007; Antia, Akpan, Okon, & Umoren, 2006; Lalitha & Sathya, 2003; Yadav & Sehgal, 2003).

Ash content:

The ash content of Daucus carota and Brassica oleracea leaves was estimated to be 4.2 g/100g and 4.6 g/100g in fresh sample respectively. However, in the case of processed Daucus carota leaf samples, it was analyzed to be 15.4 g/100g in blanched dehydrated sample and 13.7 g/100g in non blanched dehydrated sample however in processed Brassica oleracea leaves, 15.8 g/100g in blanched dehydrated sample and 14.4 g/100g in non blanched dehydrated sample. Results revealed that blanched dehydrated sample contained higher amount of ash therefore, high ash content is a reflection of the mineral contents preserved in the food materials. The result therefore suggested a high deposit of mineral elements in blanched dehydrated sample of both the leaves.

Similarly, Kowsalya & Vidhya, 2004 highlighted in their study that the ash content of selected fresh green leaves of Arai keerai, Mulla keerai, Paruppu keerai and Drumstick leaves was 2.1 g/100g, 3.2 g/100g, 2.4 g/100g and 2.6 g/100g respectively. On dehydration, the ash content increased however, maximum increment was observed by cabinet drying technique. The ash content of dehydrated leaf powder for Arai keerai was 12 g/100g (Sun dried), 14 g/100g (Shade dried) and 15 g/100g (Cabinet dried); Mulla
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keerai was 17 g/100g (Sun dried), 17 g/100g (Shade dried) and 18 g/100g (Cabinet dried); Paruppu keerai was 17 g/100g (Sun dried), 18 g/100g (Shade dried) and 20 g/100g (Cabinet dried); Drumstick was 8.5 g/100g (Sun dried), 9 g/100g (Shade dried) and 9 g/100g (Cabinet dried).

Yadav & Sehgal (2003) analyzed the ash content of oven dried green leaves like Amaranthus, Bathua, Fenugreek and Spinach and the amount was reported to be 26.28 g/100g, 26.02 g/100g, 19.34 g/100g and 26.02 g/100g respectively. Lockett, Calvert, & Grivetti, (2000) has also reported high ash content in dehydrated bitter leaves such as Veronia colorate (15.86 g/100g) and Moringa oleifira (15.09 g/100g). The ash content of both the leaves was quite similar to the ash content estimated in dehydrated samples of Ipomea batatas (11.10 g/100g), Carchones tridens (8.7g/100g), Amaranthus incarvatus (14.4 g/100g), Amaranthus hybridus (13.8 g/100g), and Momordica balsamina (18 g/100g) by other researchers (Akubugwo, Obsai, Chinyera, & Ugbogu, 2007; Hassan & Umar, 2006; Antia, Akpan, Okon, & Umoren, 2006; Asibey-Beerko & Tayie, 1999).

Phenol content:

The phenol content of Daucus carota and Brassica oleracea leaves was estimated to be 59.29 mg/100g and 54.25 mg/100g in fresh sample respectively. However, in the case of processed Daucus carota leaf sample, 221.32 mg/100g in blanched dehydrated sample and 201.96 mg/100g in non blanched dehydrated sample, however in Brassica oleracea was estimated to be 224.70 mg/100g in blanched dehydrated sample and 206.80 mg/100g in non blanched dehydrated sample respectively. The percent gain in the total phenol content during processing may be due to the breakdown of tough cell walls and release of phenolic compounds trapped in the fiber of green leafy vegetables for easier absorption in the small intestine (Oboh & Rocha, 2007a).

Adefegha & Oboh, (2011) evaluated the phenol content of raw eight green leafy vegetables were 146.9 mg/100g in Talinium triangulare, 253.1 mg/100g in Senecio biafrae, 198.1 mg/100g in Amaranthus hybridus, 693.8 mg/100g in Ocimum gratissimum, 367.5 mg/100g in Ipomea batata, 290.6 mg/100g in Telfairia occidentalis, 350 mg/100g in Baselia alba and 241.1 mg/100g in Cnidoscolus aconitifolius leaves. The phenol content of cooked green leafy vegetables were 272.8 mg/100g in Talinium triangulare, 443.8 mg/100g in Senecio biafrae, 300 mg/100g in Amaranthus hybridus, 1037.5 mg/100g in Ocimum gratissimum, 531.3 mg/100g in Ipomea batata, 403.1 mg/100g in Telfairia occidentalis, 540.6 mg/100g in Baselia alba and 285.1 mg/100g in Cnidoscolus
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aconitifolius. This indicates that most of the phenolic compounds trapped in fiber of green leafy vegetables are actually more available in the processed sample compared to their fresh counterparts.

Similarly, Oboh, (2005) reported that the phenol content of fresh Cindoscolus acontifolus was estimated to be 0.7%, however, the various food processing methods (Blanching, Soaking, Squeezed with or without salt) caused an increase of phenol content (0.8 – 1.2%) in the sample. Numbers of studies have reported that processing like blanching and dehydration makes the leaves a concentrated natural source of phenol (Ahmed & Beigh, 2009; Rickman, Bruhn, & Barrett, 2007).

Fiber content:

The fiber content of Daucus carota and Brassica oleracea leaves was estimated to be 2.01 g/100g and 2.15 g/100g in fresh sample respectively. However, in the case of processed Daucus carota leaf sample, it was researched to be 12.52 g/100g in blanched dehydrated sample and 14.53 g/100g in non blanched dehydrated sample, however in Brassica oleracea, it was estimated to be 12.73 g/100g in blanched dehydrated sample and 14.86 g/100g in non blanched dehydrated sample respectively. Satwase, Pandhre, Sirsat, & Wade, (2013) suggested a study on the drying characteristic and nutritional composition of drumstick leaves by using sun, shadow, cabinet and oven drying method. The fiber content of fresh drumstick leaves was estimated to be 0.9 g/100g, where as the fiber content of the leaf powder prepared by different methods of dehydration (Sun, Shadow, Cabinet and Oven) was 11.95 g/100g (Sun dried), 11.90 g/100g (Shadow dried), 12.05 g/100g (Cabinet dried) and 12.20 g/100g (Oven dried) leaf powder. It can be concluded that the oven dried drying method was the best method of dehydration of drumstick leaves.

Yakubu, Amuzat, & Hamza, (2012) suggested a study on the effect of processing methods on the nutritional contents of bitter leaf (Vernonia amygdalina). The fiber content of fresh Vernonia amygdalina leaf was 2.3 g/100g whereas after blanching it reduced to 2.2 gram/100g. Joshi & Mehta, (2010) analyzed the fiber content of fresh drumstick leaves was 0.9 g/100g. After dehydration, (Sun, Shadow and Oven) drumstick leaf powder was highest level in shadow dried sample (12.1 g/100g) followed by Oven dried (11.8 g/100g) and the minimum values of fiber were found in sun dried sample (11.3 g/100g). Similarly, Akubugwo, Obsai, Chinyera, & Ugbogu, 2007 revealed in their study that the crude fiber content of sun dried Amaranthus hybridus sample was found to be 8.61 g/100g.
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Kowsalya & Vidhya, (2004) highlighted in their study that the fiber content of selected fresh green leaves of Arai keerai, Mulla keerai, Paruppu keerai and Drumstick leaves was 0.85 g/100g, 1.2 g/100g, 1.2 g/100g and 0.85 g/100g respectively. On dehydration, the fiber content increased however, maximum increment was observed by cabinet drying technique. The fiber content of dehydrated leaf powder for Arai keerai was 6.1 g/100g (Sun dried), 6.3 g/100g (Shade dried) and 6.3 g/100g (Cabinet dried); Mulla keerai was 6.6 g/100g (Sun dried), 7 g/100g (Shade dried) and 7 g/100g (Cabinet dried); Paruppu keerai was 10.5 g/100g (Sun dried), 10.5 g/100g (Shade dried) and 11 g/100g (Cabinet dried); Drumstick was 2.9 g/100g (Sun dried), 3.1 g/100g (Shade dried) and 3 g/100g (Cabinet dried). The retention of fiber content in the selected green leafy vegetables ranged between 87.89 to 96.49 percent. Other studies based on the nutritional estimation of dehydrated green leaves had reflected that dehydration increased the fiber content many folds like Gafar & Itodo, 2011; Gupta, Lakshmi, Manjunath, & Prakash, 2005; Yadav & Sehgal, 2003.

Anti nutritional components:

Heat treatment is a reliable method of reducing anti nutritional factors in green leafy vegetables (Mosha & Gaga, 1999), although this could lead to leaching of nutrients (Mepba, Eboh, & Banigbo, 2007). Blanching causes the rupture of the plant cell walls resulting in the leaching of soluble anti nutritional factors into the blanching medium. Blanching and cooking significantly reduce the levels of oxalic acid and phytic acid in green leafy vegetables. Similarly, some other researchers have also reported that the level of oxalate and phytate content were significantly reduced by blanching of Green Leafy Vegetables (Mosha, Pace, Adeyeye, Mtebe, & Laswai, 1995).

Oxalate content:

From the results, the oxalate content of Daucus carota and Brassica oleracea leaves was estimated to be 43.42 mg/100g and 8.47 mg/100g in fresh sample respectively. However, in the case of processed Daucus carota leaf sample, it was estimated to be 326.54 mg/100g in blanched dehydrated sample and 430.64 mg/100g in non blanched dehydrated sample, however in Brassica oleracea, it was estimated to be 47.86 mg/100g in blanched dehydrated sample and 68.47 mg/100g in non blanched dehydrated sample respectively. Helaboye, Amoo, & Pikuda, (2013) investigated a study on the effect of cooking methods on mineral and anti nutrient content of seven green leafy vegetables. The
oxalate content of fresh leaves was 28.93 mg/100g (Talium triangulae), 47.35mg/100g (Amaranthus hydrides), 15.74 mg/100g (Colocasia esculenta), 48.17 mg/100g (Telfairia occidentials), 5.89 mg/100g (Solanum nigrum), 21.49 mg/100g (Crassocephalum crepido) and 37.08 mg/100g (Cindosculus aconitifolis). In blanched leaves, oxalate content was found to be 15.84 mg/100g (Talium triangulae), 32.55 mg/100g (Amaranthus hydrides), 9.49 mg/100g (Colocasia esculenta), 30.13 mg/100g (Telfairia occidentials), 2.99 mg/100g (Solanum nigrum), 13.20 mg/100g (Crassocephalum crepido) and 23.11 mg/100g (Cindosculus aconitifolis); blanching caused a significant reduction of 31.26% to 49.24%.

Paul, Verma, Paul, & Paul,(2012) conducted a study on the effect of cooking and processing methods on oxalate content of spinach and bathua leaves. Results revealed that oxalic content of fresh spinach and bathua leaves were 88.8 mg/100g and 174.5 mg/100g respectively. Leaves were blanched for 10 minutes showed the significant reduction for oxalate. Oxalate content of fresh blanched leaves was 48.4 mg/100g for spinach and 58.6 mg/100g of bathua leaves. Joshi & Mehta, (2010) reported in their study that in the fresh drumstick leaves the oxalate content was estimated to be 101 mg/100g where as the leaf powder prepared by three different methods of dehydration (Sun, Shade and Oven) it was in the range of 430 to 500 mg/100g.

Adeboye & Babajide, (2007) conducted a study on the effect of processing methods on anti nutrients in selected leafy vegetables. The effect of different processing methods on the reduction of selected anti nutrients in Ewuro (Vernonia amygdalina), Igbo (Solanum macrocarpon), Ugwu (Talferia occidentalis) and Utazi (Marsdenia latifolium) was assessed. The oxalate content of selected fresh green leaves of Ewuro, Igbo, Ugwu and Utazi leaves was 78.36 mg/g, 84.78 mg/g, 95.36 mg/g and 75.81 mg/g respectively. The oxalate content of selected blanched green leaves of Ewuro, Igbo, Ugwu and Utazi leaves was 33.37 mg/g, 39.13 mg/g, 36.80 mg/g and 35.68 mg/g respectively. Numbers of studies have reported that processing like blanching and dehydration reduces the oxalate content (Musa & Ogbadoyi, 2012; Sood, Modgil, Sood, & Chuhan, 2012; Ogbadoyi, Musa, Oladiran, Ezenwa, & Akanya, 2011).

Phytate content:

The phytate content of Daucus carota and Brassica oleracea leaves was estimated to be 21.82 mg/100g and 2.83 mg/100g in fresh sample respectively. However,
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in the case of processed *Daucus carota* leaf sample, it was estimated to be 161.77 mg/100g in blanched dehydrated sample and 216.64 mg/100g in non blanched dehydrated sample, however in *Brassica oleracea* was estimated to be 12.31 mg/100g in blanched dehydrated sample and 16.80 mg/100g in non blanched dehydrated sample respectively. Ilaboye, Amoo, & Pikuda, (2013) investigated a study on the effect of cooking methods on mineral and anti nutrient content of seven green leafy vegetables. The phytate content of fresh leaves was 210.54 mg/100g (Talium triangulae), 155 mg/100g (Amaranthus hydrides), 191.25 mg/100g (Colocasia esculenta), 84.72 mg/100g (Telfairia occidentials), 97.21 mg/100g (Solanum nigrum), 249.16 mg/100g (Crassocephalum crepidiodes) and 313.67 mg/100g (Cindosculus aconitifolis). In blanched leaves, phytate content was found to be 106.20 mg/100g (Talium triangulae), 78.31 mg/100g (Amaranthus hydrides), 81.65 mg/100g (Colocasia esculenta), 59.41 mg/100g (Telfairia occidentials), 92.67 mg/100g (Solanum nigrum), 161.93 mg/100g (Crassocephalum crepidiodes) and 209.21 mg/100g (Cindosculus aconitifolis). Oboh, (2005) conducted a study on the effect of some post harvest treatments on the nutritional properties of Cnidoscolus acontifolus leaf. The phytate content of fresh Cnidoscolus acontifolus leaves was 479.4 mg/100g whereas the blanched leaves, it was estimated to be 435.9 mg/100g.

Adeboye & Babajide, (2007) conducted a study on the effect of processing methods on anti nutrients in selected leafy vegetables. The effect of different processing methods on the reduction of selected anti nutrients in Ewuro (Vernonia amygdalina), Igbo (Solanum macrocarpon), Ugwu (Talferia occidentalis) and Utazi (Marsdenia latifolium) was assessed. The phytate content of selected fresh green leaves of Ewuro, Igbo, Ugwu and Utazi leaves was 55.24 mg/g, 58.81 mg/g, 53.20 mg/g and 60.80 mg/g respectively. The phytate content of selected blanched green leaves of Ewuro, Igbo, Ugwu and Utazi leaves was 38.36 mg/g, 45.97 mg/g, 39.94 mg/g and 51.75 mg/g respectively. Numbers of studies have reported that processing like blanching and dehydration reduces the phytate content (Sood, Modgil, Sood, & Chuhan, 2012; Nkafamiya, Osemeahon, Modibbo, & Aminu, 2010).

**Organolectic evaluation of control and value added recipes**

In India, each region is endowed with typical traditional food habits which are culturally bound highly acceptable to the population because these recipes are transferred from generation to generation with little modifications. Hence, enriching the traditional
foods with micronutrient rich, nutritious leafy vegetable could pave a way for sustainable utilization in routine diets and to attain micronutrients level. In the present study, the selected products were prepared by incorporating dehydrated *Daucus carota* (Carrot) and *Brassica oleracea* (Cauliflower) leaf powder at 5% 10% and 15% level. Recipes which were prepared by incorporating these two leaves were Khakhra, Atta-ladoo, Besan-ladoo and Panjiri (Roasting), Idli and Khaman (Steaming), Nan-khatai and Biscuit (Baking). Results revealed that 5 percent incorporated sample had the highest scores for overall acceptability among all the value added products. Hence, from this it can be interpreted that 5 percent incorporation of dried leaf powder had no detrimental effects on sensory attributes and there was no statistically significant difference among control and 5% incorporated sample.

Gupta & Prakash, in (2011) concluded a research aimed to formulate micronutrient rich products with dried greens [Keerae (Amaranthus paniculatus) and shepu (Peucedanum graveolens)]. Dehydrated greens were incorporated into ‘Mathri’ and ‘Thalipeeth’ at 4, 8 and 12% levels. Results of sensory analysis revealed that products incorporated with 4% dehydrated greens were similar to control in texture, taste and overall acceptability. However, acceptability scores reduced with increasing concentration of greens. Kowsalya & Indra, (2010) undertook a study on development and evaluation of extruded products from Amaranthus incorporated nutritious mix. Results revealed that the sensory attributes of Idli, Missi roti and porridge prepared with the addition of developed nutritious mix were accepted at the level of 5% amaranthus incorporation; adai at 7.5 percent incorporation and pittu at 2.5 percent incorporation. It proved feasibility of developing nutritious mix by incorporating low cost micronutrient rich greens like Amaranthus and development of extruded products from them. Hence, such food based strategies can help in combating micronutrient deficiency particularly Iron and beta carotene.

Another study was done by Joshi & Mathur, (2010) and an attempt was made to analyze the nutritional potential and acceptability of leaf mixtures (LM) prepared from the less utilized leaves of beet root (Beta vulgaris), carrot (*Daucus carota*), cauliflower (*Brassica oleracea*) and turnip (*Brassica rapa*). The leaf mixture was prepared by mixing the powders of above mentioned greens in a definite ratio (1:2:1:1). Twenty different recipes with different levels (0, 5, 10, 15 and 20%) of LM incorporation were prepared and
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were assessed for quality on the basis of sensory attributes. The products were well accepted at the level of 10%.

A study was undertaken for the development and sensory evaluation of beta carotene rich food preparations using underexploited carrot greens by Kaur & Kochar, (2009). Dry leaf powder was added in Mathri at 8%, 9% and 10% levels. Best acceptable level of incorporation of dry carrot powder was 9 percent and the scores for overall acceptability were 6.05. Lakshmi & Kohila, (2007) highlighted a study on the development and evaluation of vegetable based mixes. Four green leafy vegetables namely Agathi (Sesbania grandiflora), Coriender (Coriandrum sativum), Curry (Murraya koenigii) and Drumstick (Moringa oleifera) were selected for the study. Green leafy vegetable based food mixes were prepared using sprouted and roasted green gram flour, wheat germ, powdered sugar and shade dried vegetable powder in varying proportions at 5%, 10% and 15%. Results of the acceptability scores revealed that the green leafy vegetable based food mixes made by using five grams of four vegetable powder per 100g had the highest acceptability for all the food mixes (ratio was 55:20:20:5 of sprouted green gram flour: wheat germ: powdered sugar and vegetable powder respectively).

Singh et al., (2007) prepared two value added products namely green gram dal and parantha by incorporating dehydrated bathua (Chenopodium album Linn) leaves. Incorporation level of bathua leaves in green gram dal was 3, 5 and 7 percent whereas in parantha it was incorporated at 5, 10 and 15 percent levels in wheat flour. Incorporation level up to 7% was acceptable on hedonic scale in case of green gram dal, however parantha was most acceptable at 5% incorporation level. Shah (2005) carried out a study to develop value added products by incorporating bengal gram leaf powder. Sixteen recipes, based on cereals, pulses, oil seed, were developed by incorporation of Bengal gram leaf powder at four, eight, 12 and 16 per cent. The products were evaluated for sensory attributes using five point hedonic scale. The results indicated that among the cereal based recipes (stuffed paratha, puri, dhapate and thalipeeth), the scores for overall acceptability ranged from 4.41 to 5.00, for pulse based recipes (plain dal, mung dal, masoor dal and moth bean usal) from 4.66 to 5.00, for nuts and oil seed based chutneys (prepared from ground nut, sesameum, niger and linseed) from 4.58 to 5.00 and for snacks (udad dal wada, chakli, mung dal wada and shev) from 4.75 to 4.83.
Shanthala & Prakash, (2005) explored the possibility of incorporating oven dried curry leaf powder at 5 and 10% level to common dish like chapatti (unleavened Indian bread) to increase the intake of greens as a source of micronutrients. The addition of curry leaf powder affected the color and appearance of the products. At the level of 5%, the texture, odor and taste were accepted by panel of members. Scores were lower as the level of curry leaf powder was increased. At the level of 10% curry leaf powder incorporation in chapatti, a significant reduction was observed in all the sensory attributes and the acceptability of the product was decreased. Singh & Awasthi (2003) conducted a study to investigate the acceptability of food products like biscuits, murukku, mathri and namakpare on sensory parameters by incorporating powders prepared from kachnar, drumstick, colocasia and curry leaves. Green leafy vegetable powders were incorporated at five, 10, 15 and 20 per cent level and products were evaluated organoleptically. Acceptable level of GLV in biscuits, murukku, mathri and namakpare was 15, 10, 20 and 10 per cent respectively. Similar kind of results are reported in other researches like Pandey, Abidi, Sadhana, & Singh, 2006; Kaur & Kochar, 2005; Kaur & Bajwa, 2003; Lalitha & Sathya, 2003; Lakshmi & Vimla, 2000. From the above observations, it can be concluded that value addition of traditional products with dehydrated green leafy vegetables is advocated as a feasible food based approach.

Effect of cooking on nutrient retention

Green leafy vegetables are not only rich in micronutrients but are also available at low cost and throughout the year. These green leafy vegetables are often consumed in cooked form rather than raw and in the composite form. Cooking softens the cell walls and makes the extraction of micronutrient content easier. The time-temperature relationship is important for all types of food preparation employing heat, but the impact varies with different cooking methods and products (Sungpuag, Tangchipianvit, Chittchang, & Wasantwisut, 1999; Miglio, Chivaro, Visconti, Fogliano, & Pellegrini, 2008). Hence, micronutrient content of control and most accepted recipe was evaluated in order to check the effect of selected method of cooking on retention of iron and beta carotene content. In the present study, the selected cooking methods were Roasting, Steaming and Baking. The most acceptable value added products developed by incorporating greens at 5% level showed remarkable increment in their beta carotene and iron content in comparison to control counterparts. Results revealed that the retention of beta carotene and iron was
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highest in Khakhra prepared by using roasting as cooking method. It was highest in Idli prepared by steaming. It was highest in biscuits prepared by baking.

Singh et al (2007) evaluated a study on dehydrated Bathua (chenopodium album linn). These dehydrated leaves were incorporated at 3 – 15% levels in two conventional foods namely green gram dal and paratha. Green gram dal and paratha incorporated with 7 and 5% dehydrated bathua leaves were liked most. Iron content of green gram dal (8.8 mg/100 g) and paratha incorporated with dehydrated bathua leaves was higher than their respective control. In comparison to control value added paratha (4255.66±0.6 µg/100 g) and green gram dal (984 ±1.8 µg/100 g) had many fold greater carotene content.

Singh & Kawatra, 2006 conducted a study on development and nutritional evaluation of recipes prepared using dried amaranthus leaves. Pakora, vada, namakpara, kurmura, biscuit and cake were prepared with the addition of dried powder of amaranthus leaves. Beta-carotene content was maximum in namakpara (368.5 mg/100 g) enriched with amaranthus leaf powder. Total iron content ranged from 7.9 (kurmura) to 12.4 mg/100 g (vada) cake prepared by incorporating dried amaranthus leaves. Motey & Lee (2003) also reported the similar results in a study done on dehydrated leaves.

Begum, Deshpande, & Farzana, (2000) also reported cauliflower leaf powders to be a good source of protein and other micronutrients. Therefore, it can be concluded that the value addition enriched the nutritive value of traditional recipe appreciably. There was a substantial increase in the nutritional value of all the products developed by incorporating dried greens. Beta carotene and Iron content in all food preparations increased significantly (P<0.05) with incorporation of dried greens in comparison to their control recipes with 0% incorporation. Hence, incorporation of dehydrated greens to conventional food items can improve the nutritional quality of the products as well as add variety in the diet. It also helps in combating vitamin A and iron deficiency and thereby helps in improving the health conditions.

Shelf life assessment of most accepted recipe

Sensory evaluation:

Shelf life is the recommendation of time that products can be stored during which the defined quality of a specified proportion of the goods remains acceptable under specified conditions of distribution, storage and consumption. In the present study, six
most acceptable recipes were selected for the evaluation of shelf life. The selected recipes were Khakhra, Atta-ladoo, Besan-ladoo (Sattu), Panjiri, Nan-khatai and Biscuits. Idli and Khaman were not selected for the shelf life study as steamed products are perishable and have higher moisture content. Shelf life study of the best acceptable variation among all the six recipes was done.

The products prepared by 5 percent incorporation of processed leaves (blanched dehydrated Daucus carota and Brassica oleracea) were stored at room temperature, for different lengths of time. These were evaluated for sensory attributes like appearance, color, texture, taste, and overall acceptability, by 10 panel members, according to 5 point rating scale on zero day, 15th day, 30th day and 45th day. The scores were assigned in comparison with control recipe or zero day recipe. It can be concluded that the products except Panjiri were can be stored to 15 days after that they get deteriorated with a greater extent.

Microbial analysis prepared value added products:

Total viable count method was analyzed through total microbial load in the sample on zero day, 15th day, 30th day and 45th day. Khakhra stored at room temperature for a period of 45 days, showed that the total viable count remained almost unchanged till 30 days of storage. The number of bacteria colonies in Atta-ladoo and Besan-ladoo during storage was under permissible limit till completion of 30 days. Similarly, in the case of baked products like Nan-khatai and Biscuits the bacterial load was observed to be lowest even after 45th day, it was within permissible limit. Panjiri is the only product which showed a number of colonies on 30th day, the total viable bacterial count remained almost same or unchanged till 15th day of storage at room temperature.

Peroxide value:

Peroxide value was estimated the very first day and there after every week till 4th week. Peroxide values for Khakhra, Atta-ladoo and Besan ladoo were in permissible limit after completion of third week of storage. On analyzing the samples after 4th week, a remarkable increment was observed, which was beyond the permissible limit. Therefore it is suggested that these products can be kept at room temperature in air tight containers for 3 weeks without deterioration but there after off flavors start developing in the samples because of rancidity. However, the peroxide values of Panjiri, Nan-khatai and Biscuit
were in permissible limit till the second week therefore; these can be kept for 2 weeks in air tight containers at room temperature. On analyzing the samples after 3rd week, a remarkable increment was observed in peroxide value as hydrolyses of fat increases with time of storage.

**Microbial analysis of dehydrated green leafy vegetables:**

Green leafy vegetables are highly perishable in nature having higher moisture content and presence of natural enzyme. Hence, in order to increase the shelf-life, dehydration was carried out. Several studies, have reported that, dehydrated GLVs can be stored for duration of up to nine months without any spoilage. Advantages of stored GLVs are that they can be utilized as and when required, by incorporating into products. In the present study, dehydrated GLVs were stored for a period of six months in air tight containers at ambient condition in aluminum boxes. The main purpose of dehydration is to preserve the products under ambient conditions without sophisticated equipment. Hence, the storage quality was assessed under ambient conditions. Some other researchers have also reported in their study that dehydrated green leafy vegetable powder had much more shelf life as there was a comparison done with their fresh counterparts.

**Ukegbu & Okereke, 2013** evaluated the effect of solar and sun drying on the nutrient composition of three species of vegetables. The species are Amaranthus hybridus (African spinach), Telferia occidentalis (ugu) and Hibiscus esculentus (okra). Sun drying was carried out under the sun, while a locally fabricated solar dryer designed by the Department of Agricultural Engineering of Michael Okpara University of Agriculture, Umudike was used for solar drying. Results showed that microbial load in solar dried vegetable samples were significantly lower than that of sun dried samples at the end of the drying period. The results further showed that microbial load was not high enough to harm the body and that the vegetables could be preserved over a considerable period of time. *Food and Agriculture Organization (2004)* reports showed that solar dryers are freer from microbial contamination and are better preservers and give good quality products than sun dried products.

**Awogbemi and Ogunleye, 2009** highlighted the effect of solar drying on the quality of threespecies of vegetables. These species areamaranthus (tete in local language), vernonia (ewuro) andfluted pumpkin (ugu). Microbial loadanalysis was carried out on the vegetable samples after eachday of drying for a total of 5 days. Result revealedthat their
microbial load decreases with each day of drying. For storage purposes, irrespective of the species and quantity, two days of drying is sufficient to prevent spoilage and at the same time retain most of their nutritional composition.