Nutritional evaluation of value added products using dehydrated greens for security of haematinic nutrient

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Green leafy vegetables (GLVs) are known to be inexpensive rich sources of micronutrients such as vitamin A, iron, β-carotene, etc. and utilizing them is one way of ensuring the micronutrient intake. Dehydration is one of the traditional methods of preservation, which converts the food in to light weight, easily transportable and storable product. It facilitates the utilization of the dried leaves in other parts of the country or world where this vegetable is unavailable in plenty. In addition to increasing variety in the menu, reducing wastage, labour and storage space, dehydrated vegetables are simple to use and have longer shelf-life than fresh vegetables. On one hand dehydrated greens are concentrated form of iron and on the other home preparations based on cereals and pulses contain negligible amount of iron so addition of dehydrated greens as natural means into it become a long term sustainable, culturally acceptable, rational applicable, feasible, cost effective and suitable approach to attain iron security and combat iron deficiency anaemia.

Key Words : Anaemia, Dehydration, Micronutrients, Iron security

seasons are ascribed to availability and consumption of green leafy vegetables and other foods rich in blood forming nutrients like orange, papaya, guava, carrot, grapes, amla and pumpkin. This is contributed to improvement in haemoglobin level.

Steps for dehydration of green leafy vegetables:
The following dehydration technique can be used for dehydration of GLVs and iron security at household level:

Sorting:
Collect the fresh leaves and remove the stems and other unwanted parts from green leafy vegetables.

Washing:
Wash the leaves with slightly warm water to remove the dirt particles. Drain out the excess water from leaves.

Blanching:
Blanch the leaves (enclosed in muslin cloth) in a stainless steel pan for 2 minutes at 80°C and dry them by following suitable and available technique.

Drying:
The leaves can be dried by using a variety of common household methods for drying which are as following:

Sun drying:
After blanching and air drying for few minutes put on filter paper. Place the trays at place where adequate area of sun light is available. Solar drying can be used for the drying of green leafy vegetables.

Shadow drying:
Spread the blanched and air dried leaves on filter papers and keep it in well ventilated room.

Cabinet tray drying:
In this technique, blanched greens are spread on tray and placed in cabinet dryer at 60°C for 5 hours.

Oven drying:
The blanched and air dried leaves are kept in single layer loaded tray in preheated oven (60°C). Maintain the temperature at 60°C and the process is carried out.

Storage:
Dehydrated GLVs is packed in low density polyethylene bags and in air tight aluminum containers for future use.

Development and nutritional evaluation of value added products:
Dehydrated leafy vegetables are concentrated source of several nutrients including iron and β-carotene. Development of the products by incorporation of the dehydrated GLVs in traditional preparations can assist to meet the daily nutritional requirements of the adolescent girls. These products if included in routine diet can help to reduce the incidence of iron deficiency anaemia. Relevant literatures pertaining to these aspects are reviewed in this section.

Vijayalakshmi and Devdas (1994) carried out a study on enhancing the nutritive value of convenience foods by incorporating green leafy vegetables. It was concluded from the study that addition of coriander and curry leaves in vadai mix and bhaji mix increased the nutritive value of convenience foods with respect to protein, β-carotene, calcium and iron. The protein, β-carotene, calcium and iron contents before adding greens were 16 g, 0.0 µg, 42 mg and 13 mg in vadai mix and 16 g, 0 µg, 50 mg and 7 mg in bhaji mix which increased to 12 g, 2171 µg, 181 mg and 12.9 mg (vadai mix) and 12 g, 2170 µg, 187 mg and 8.9 mg in bhaji mix, respectively.

The acceptability of products with cauliflower leaves was carried out by Kowsalya and Mohandas (1999). The study revealed that cauliflower leaves were used in the common south Indian preparations such as, poriyal and kootu. The drumstick leaves poriyal and kootu were used as standard for comparison. Identical scores were obtained for both standard and test poriyal with respect to appearance (4), color (4), and texture (3.8) on four point numerical rating scale. The higher total score was obtained for cauliflower leaf poriyal (19.8) with 90 per cent of panel members opting it. Standard and test kootu was equally acceptable for appearance and colour (4) but the total score was highest for drumstick leaves kootu (19.6).

Lakshmi and Vimala (2000) dehydrated amaranth, curry leaves, gogu and mint leaves to prepare powders for incorporation in different products which were evaluated by panel of trained judges. The food products prepared using powders of amaranth (soup, dhal with greens and pesarattu), curry leaves (hot powder, pakodi and pesarattu), gogu (dhal with greens, chutney and mutton curry) and mint (vegetable biryani, chutney and bone soup) were rated as highly acceptable for all the sensory attributes and were scored from good (4) to excellent (5) on five point scale. However, soup with amaranth powder received slightly lower scores of 3.8 for overall acceptability, taste and flavour. Value added traditional products of Bangalore were acceptable with scores of 4.2 (upma and dosa) 4.1 (majjigeulu, ambole and ladoo) to 3.9 (Bisebele bhath) on five point scale in a study conducted at Bangalore (Anonymous, 2003). Masala bun with knolghol greens received lowest scores of 3.3. Report from Hisar indicated that value added products (VAPs) with underutilized leafy vegetables, fruits and other vegetables were highly acceptable with scores of more than 7.0 on nine point hedonic
scale (Anonymous, 2003). Oogal namakpara of Pantanagar was less acceptable with score of 7.0. Other VAPs namely, soy chat, soy mathari, soy leaves pakora received the overall acceptable scores of 7.5 and 8.0.

Nalwade et al. (2002) studied the proximate composition, calcium, iron and β-carotene contents of green leafy vegetable preparations. The moisture content varied from 80.86 g in Bengal gram leaves curry to 90.75 g/100 g in spinach curry. Ash content varied from 1.20 g to 2.80 g in ambat chukka and drumstick curry. Other preparations like palak, methi, shepu, green gram dal curries recorded similar values (2 to 2.26%). Iron content of the vegetable preparations differed from 0.26 to 27.33 mg per cent with highest in methi green gram curry and lowest in drumstick leaves curry. Colocasia curry registered highest β-carotene (10.321 µg/100 g) followed by shepu mung dhal curry (5094 µg/100 g) whereas, Bengal gram leaves curry recorded lowest β-carotene (12.28 µg/100 g).

Sathya et al. (2002) developed some recipes and analysed them for in vitro iron availability and found the highest iron availability for sun dal with 423 µg/100g followed by drumstick leaves kootu 321, cabbage kootu 312, pakoda 289, agathi kootu 219, masiyalo 216 and adai 112 µg/100g. In vitro iron availabilities of iron were 2.79 and 3.03 per cent in bathu and spinach leaves, respectively.

Vijayalakshmi et al. (2003) enhanced the nutritive value of convenience foods by incorporating green leafy vegetables and reported the range of in vitro iron bioavailability in various standardized mungbean recipes from 2.9 to 7.9 per cent. Kaur and Bajwa (2003) studied effect of green leafy vegetables on the quality attributes of vegetable impregnated paneer. The leafy vegetables (coriander and mint) were blended (steam or water) prior to impregnation in paneer and then evaluated for sensory scores by using nine point hedonic scale. The study revealed that steam blanched coriander in paneer received higher scores for colour (7.67) compared to water blanched (7.17) and unblanched (6.08). Colour influence on appearance of paneer, the unblanched samples receiving significantly lower scores than blanched. The coriander-impregnated paneer with unblanched leaves had comparatively stronger coriander flavour which was contributed to higher flavour profile (8.50). The overall acceptability was found to be highest for the samples prepared by incorporating steam blanched coriander (7.32). However, texture was not affected by incorporation of coriander. Similarly, paneer with steam blanched mint leaves received higher scores for all sensory attributes compared to water blanched and unblanched.

Kulkarni (2003) developed number of value added food products using underutilized leafy vegetables. The nutrients such as protein, iron, β-carotene and ascorbic acid ranged from 2.43 g (ground nut chutney with chakramuni leaves) to 15.71 g (barnyard millet upma with drumstick leaves), 1.40 mg (groundnut chutney with chakramuni leaves) to 12.94 mg (little millet dosa with chakramuni leaves), 15.63 µg (groundnut chutney with chakramuni leaves) to 2338.09 µg (drumstick chapathi with soybean) and 0.40 mg (coconut chutney) to 946.80 mg (both variations of turdal bhaji with chakramuni and chandanabatta leaves) per serving, respectively. Singh and Awasthi (2003) calculated nutrient composition of the products namely, biscuits, murukku, mathri and namakpare incorporated by kachnar, drumstick, colocasia and curry leaves. The protein, iron and β-carotene contents of the products ranged from 11.6 to 23.8 g /100 g, 2.16 to 5.62 mg /100 g and 819.2 to 3017.75 µg /100 g, respectively. Sadana and Hira (2004) evaluated the nutrient content of saags prepared from unconventional leaves namely kail, Palampur dark green, Chinese sarson no.1 and Palampur light green. Nutritional evaluation of prepared recipes revealed that these greens were rich sources of calcium, iron, β-carotene and ascorbic acid.

Jemima and Bhavani (2004) reported that the porial prepared with cauliflower leaves provided 16.4, 262.9 and 13.85 mg /100 g of iron, calcium and vitamin C, respectively, whereas, fresh cauliflower leaves had 25.1 mg of iron, 260 mg of calcium and 29 mg of ascorbic acid per 100 g. Punia et al. (2004) investigated the nutrient composition of amaranth (Amaranthus tricolor) and kondhara (Digaria arvensis) leaves incorporated products. Puri and paranthas were prepared with amaranthus leaves. Bengalgram dhali, greengram dhali, raiitha and sag were prepared with kondhara leaves. Protein, fat, minerals, crude fibre, carbohydrates and energy contents of the products varied from 11.48 to 30.44, 7.25 to 28.77, 2.64 to 21.33, 0.25 to 5.75, 38.56 to 70.72 g/100 g and 367 to 33 kcal/100g on dry weight basis. Calcium, iron, ascorbic acid and β-carotene contents of products were 127.30 to 3350, 1.50 to 4.10, 5.41 to 60.83 mg/100 g and about 1710 to 10557 µg/100 g on dry weight basis, respectively. Singh et al. (2004) studied the nutritional evaluation of products prepared from dried spinach leaves and estimated that, the moisture and protein contents of cake, biscuits, pakora, vada, namakpara and kumura ranged from 1.43 to 40.87 per cent and 9.61 to 16.62 per cent, respectively. Ascorbic acid content was higher in products prepared from fresh spinach as compared to that prepared from dried powder. β-carotene content was found to be highest in namakpara prepared from dried leaves. Total iron content of spinach products ranged from 4.10 to 15.00 mg /100 g on dry weight basis. Ionizable iron and in vitro iron (% of total iron) was reported to be maximum in biscuits. The investigation revealed that the products developed with the spinach contained appreciable amounts of iron and β-carotene.

Lakshmi and Radhapiya (2004) studied the nutritive value of fresh and dried drumstick leaves which were found
to be rich sources of iron, calcium and total carotene. They reported that protein content was maximum in kurmura (12.25%) and minimum in biscuit (7.42%). Ascorbic acid and β-carotene contents of biscuit, cake, namakpara, kurmura ranged from 2.21 to 4.29 mg and 2.04 to 4.98 mg, respectively. Total iron content was highest in cake (9.90 mg) and ionizable iron was found to be higher in biscuit (2.63 mg). Das et al. (2005) determined the in vitro availability of iron from common foods stuffs of plant origin. The samples were analyzed spectrophotometrically using derivative spectroscopy for total and in vitro available iron (ionizable iron). Though rice had lowest total iron content (0.61 ± 0.09 mg/100g), the per cent ionizable iron was highest (29.50 ± 4.75%) as compared to all other cereals and millets tested and also compared to some of the whole pulses analyzed. Similarly, maize with comparatively lower total iron content (2.73 ± 0.14 mg/100g), had a higher per cent ionizable iron (25.30 ± 1.46%). The whole pulses were found to contain total iron ranging from 4.40 ± 0.30 mg/100g in blackgram to 6.36 ± 0.55 mg/100g in rajmah, but except Bengal gram (white) (21.71 ± 0.53%), pea (35.66 ± 4.44%) and rajmah (24.05 ± 1.42%), others showed very low ionizable iron (3.41 ± 0.22-6.53 ± 1.31%).

Singh and Kawatra (2006) studied the ionizable iron content of products viz., pakora, vada, namakpara, kurmura biscuit and cake prepared with addition of fresh and dried powder of amaranthus leaves. Ionizable iron content of products ranged from 1.3 in kurmura to 2.9 mg/100g in biscuit prepared from dried leaves. Ionizable iron expressed as per cent of total iron was highest in biscuit (57.4%) followed by cake (27.5%) and namakpara prepared with dried and fresh amaranthus leaves (25 and 23.7%, respectively), pakora with fresh leaves (19.3%), kurmura with dried leaves (16.1%), vada (16.2%) and kurmura with fresh leaves (22.4%). Pandey et al. (2006) studied the nutritional evaluation of leafy vegetable parantha. The moisture content of different paranthas varied significantly and ranged from 30.50 to 39.85 per cent. The paranthas prepared from different leaves varied significantly for protein content. Protein content was found to be highest in bathua parantha (28.36%) followed by palak parantha (24.19%) and chaulai parantha (22.52%). Total mineral content of Bathua parantha, chaulai parantha and palak parantha were found to be 2.69, 4.22 and 1.29 per cent, respectively. The carbohydrate and energy content of bathua, chaulai and palak parantha were found to be 50.91, 50.96, 52.61 and 373, 347 and 359 Kcal, respectively.

Nande et al. (2007) evaluated the nutritive value of the recipes prepared from spinach and betel leaves. The data revealed that betel leaves recipes had higher content of all nutrients but there was no significant difference between them. Among all the recipes prepared, coconut burfi, cutlet and muthia with spinach and betel leaves showed highest content of protein (11.29 and 11.49 g, respectively), carotene (1081.21 and 1114.05 µg, respectively), folic acid (61.18 and 51.87 µg, respectively) and iron (4.07 and 5.80 mg/100g,
respectively). Nambiar and Parnami (2007) conducted a study to standardize and organoleptically evaluate freshly blanched leaves of the drumstick tree (Moringa oleifera) incorporated into three recipes commonly consumed in India: mung (Phaseolus aureus), kabuli channa (Cicer arietinum) and desi channa (Cicer arietinum). One serving of each of these recipes (30 g raw weight of pulses) could incorporate a maximum of 20 g of fresh drumstick leaves. All three recipes were found to be acceptable by the panel of judges, with an overall composite score ranging from 3.06–3.53 (on a scale of 1 to 5). The drumstick leaf recipes were micronutrient rich and each serving could provide 3955 µg β-carotene (665 retinol equivalents or RE), 46 mg ascorbic acid and 1.6 mg iron. Meal planners typically use a benchmark of one third of the RDA, and these recipes could achieve 24, 341, 15 and 496 per cent of that level for adult women in energy, vitamin C, iron and β-carotene, respectively. Even if only one sixth of the β-carotene is considered as bioavailable for vitamin A (RE), these recipes would still meet 82.5 per cent to 83.3 per cent of the RDA for adult women. Nalwade et al. (2008) estimated the bioavailability of iron and calcium from 14 leafy vegetables. The per cent bioavailability of iron was highest in tandulga (62.47%) followed by paatar (54.95%). Ghol had the minimum amount of bioavailable iron (4.99%) and other vegetables like sarate, drumstick, wavdinga pan, cheel, kunjeer, raigira, kantemath, chopardamath, tarwata, beet greens and pokla leaves had 33.07, 30.74, 30.64, 27.28, 22.55, 16.67, 12.20, 10.43, 8.24, 7.15 and 5.37 per cent bioavailable iron, respectively.

Kaur and Kochhar (2009) developed commonly consumed food preparations by separately incorporating fresh and dry carrot greens, applying different cooking methods. Levels of incorporation of fresh carrot greens in different food preparations ranged 40 to 80 per cent whereas powder of dry carrot greens was added in different preparations at 7, 8 and 9 per cent levels. Organoleptic evaluation of all food preparations were conducted by a panel of ten judges using Hopkin’s seven point scale. In fresh carrot greens incorporated food preparations, the maximum and most acceptable level (80%) of incorporation of under exploited carrot greens was in saag and minimum (40%) in puri and kadhi. In dry carrot greens incorporated food preparations, the most and best level (9%) of incorporation of greens was in mathri and minimum (7%) in matrey. Among all the fresh carrot greens incorporated food preparations, gulabjamun scored highest (6.96 + 0.27) overall acceptability scores while laddoo scored minimum (5.52 + 0.68). In dry carrot greens incorporated food preparations, laddoo scored highest (6.31 + 0.28) and laddoo scored minimum (5.98 + 0.69) overall acceptability scores. Karva et al. (2010) revealed the post harvest processing of green leafy vegetables for iron security. The five commonly consumed leafy vegetables (GLVs) of Dharwad city viz., rajagira, kiraksali, fenugreek, spinach and shepu, were selected for the study. Dehydration protocol was assessed employing different pre–treatments (blanching, sulphitation and blanching + sulphitation, untreated) prior to dehydration in sun, shade, hot air oven and microwave oven. Among all selected GLVs, rajagira showed highest iron content of 222.52 mg/100g followed by kiraksali (54.59 mg/100g). Verma and Jain (2012) estimated fortification of mathri with fresh and dehydrated vegetables and assessment of nutritional quality. Levels of incorporation of fresh greens (spinach, mint and carrot) in mathri were 8 per cent whereas powder of dry green vegetables (spinach, mint, carrot and lotus stem) was added in mathri at 7 per cent. Result showed that the fresh vegetables mathri showed the highest overall acceptability (7.8±0.199) attributes and the score fell in the range of like very much. Nutritional analysis showed that protein and iron content of dried vegetables mathri i.e. 7.44g and 5.37mg was higher as compared to fresh vegetables mathri.

Conclusion:

Various products prepared by the combination of greens are rich sources of essential macro and micro nutrients. Consumption of these foods in daily diets can help in combating micronutrient deficiencies.

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