



Development of Value-added Food Products From Iron Rich Underutilized Leaves

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ABSTRACT

Purpose - The prevalence of iron deficiency anemia globally is largely the result of low dietary iron intake in daily lives, inadequate to meet the iron requirement especially in infant, children and women. Moreover, there are varieties of underutilized green leaves rich in iron and other essential micronutrients. The purpose of this paper is to analyze the nutritional composition and the acceptability of value-added products prepared from the dehydrated leaves powder of underutilized green leaves. GLVs and green leaves are rich in micronutrients. Therefore, the effort was made to develop iron rich value-added products. Four Products commonly consumed products namely Atta Ladoo, Panjiri, Besan Chilla and Boondi were developed from underutilized dry leaves.

Design/methodology/approach – The nutritional potential and acceptability of dehydrated leaves powder prepared from the under-utilized leaves of cauliflower (*Brassica oleracea*), Drumstick leaf (*Moringa oleifera*), Betel (*Piper betel*), Mint (*Mentha piperita* L.), which are usually discarded and ignored or underutilized were analyzed in the present study. The leaves powder prepared of above-mentioned greens. In selected different recipes with different levels (0, 5, 10 and 15 per cent) of leaves were taken for their iron content. The products incorporated with 5% level of underutilized dried leaves powder were found most acceptable by the panel members among all the four products. Products with level of 10% and 15% of dried leaves powder were relatively less acceptable. Significant differences ($P > 0.01$) were found in the acceptability among all the four iron enriched products.

Originality/Value: Dehydrated greens are concentrated source of micronutrients and can be used in product formulation. Value addition of traditional products with dehydrated greens can be advocated as feasible food-based approach to combat micronutrient deficiencies.

Keywords: Iron, Anemia, Underutilized leaves, Dehydrated, Value added Product, Micronutrient.

INTRODUCTION:

In India, the consumption of green leafy vegetables is very low and is much less than the recommended allowances. Therefore, majority of Indians do not get sufficient vitamins and minerals present in leafy vegetables. Iron and Vitamin A deficiencies are two major nutritional health problems affecting vulnerable groups of population in many developing countries. Anemia is estimated to affect 3.5 billion individuals in developing world and more than 320 million people in India with highest prevalence among women and children, 40-80% pregnant women, 60-70% children and 50% of adolescent girls (**Devadas, 2001**).

Therefore approximately 720 million preschool children with vitamin A deficiency and out of this 4.4 million have xerophthalmia(**WHO, 2001**). Vitamin A deficiency affects many tissues in the body; the most dramatic changes are seen in eyes resulting in tragic consequences of total loss of vision in the early life. **UNICEF (2004)** estimates that VAD is public health concern in 72 countries in Asia and Africa and is known to cause blindness.

It has been emphasized that most appropriate and sustainable approach for correcting nutritional deficiencies is the dietary improvement through a better choice of foods, improved quality and greater variety (**Scrimshaw, 1994**). The diverse agro-climatic conditions never blessed India with vast resources of greeneries, many of which are still under exploited whose nutrient potential have not been adequately studied.

Cauliflower leaves which are generally thrown away as waste are rich of iron and Beta-carotene and can be significantly contribute these nutrients to the diet. **Kumar and Bhavani (2004)** reported that anemia can be prevented and blood hemoglobin levels can be successfully elevated in adolescent girls by incorporating cauliflower leaves in their dietaries. Cauliflower leaves rich source of Beta carotene, iron and calcium but it has higher waste index. Cauliflower leaves are also come in waste products category and thus can be utilized in value added products for treat anemia disease and those people who suffering from micronutrients deficiency.

Drumstick leaves (*Moringa oleifera* Lam) Moringaceae is plant with high nutritional and medicinal value. The leaves are rich in minerals like calcium, potassium, iron etc. and vitamins like Beta-carotene, Ascorbic acid, proteins, flavonoids, phenolic components and other essential phytochemicals. The leaf extracts are used to treat malnutrition and also acts as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. Moringa leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges, and more potassium than bananas, nothing that the protein quality of Moringa leaves rivals that of milk and eggs.

Betel leaves are very popular among rural as well as urban people India and popularly known as 'Paan'. It contains ample amount of medicinal properties. Betel leaf contain some essential oil which may be used as raw material for manufacturing of medicines, mouth freshers, tonics, flavor for foods etc. The leaves anti-carcinogenic properties and very nutritive, are used in drugs of blood cancer. But excess consumption or chewing of betel leaves may lead to oral cancer. Meanwhile, it has great impact on agricultural, economic, industrial and medicinal field. Betel leaf is one of the important commercial crops and most of the rural farmers of India depend on betel cultivation for feeding their family. Export gives a boost to the national economy. Better research, expert technologies, administration, marketing channel expansion will help to increase the value more than that of now.

Mint or pudina leaves is highly valued for its indispensable medical properties and uses. Pudina leaves are a healthy addition to your foods and beverages that render a unique taste and flavor in varied ways like green salads, desserts, chutneys, raitas, smoothies and mint tea. Evidence reveals that mint leaves should be consumed in the form of capsules or pudina leaves extract applied to the skin as a face pack or used as essential oil aromatherapy to reap its wholesome benefits. The many benefits of mint leaves range from alleviating digestive symptoms, improving brain functions, treating the common cold, asthma and even freshens the breath. Mint leaves can be used fresh, dried, as essential oils or in the form of supplements to derive its benefits.

Research has shown that Mint leaves are beneficial for human health as it contains significant amount of micronutrients, vitamins, antioxidants, photochemical and fiber content that may help protect against degenerative disease and micronutrient malnutrition. Many valuable medicinal herbs are becoming rare and precious information regarding their health benefits is lost. Therefore, substitution of herbs in the preparation of value-added food products.

This review studied on the nutritional composition of cauliflower, drumstick, betel and mint leaves powder and its utilization in traditional and instantly prepared food products.

Therefore, in present study the effort was made to use the underutilized green leafy vegetables and leaves such as cauliflower leaves, carrot leaves, beet green leaves, turnip leaves, curry leaves, betel leaves and mint leaves etc., which are mostly not utilized by general mass for human consumption rather used for cattle feed due to lack of awareness about their nutritional value. These leaves are rich in iron, calcium, phosphorus and carotene and have a little amount of fat and protein. As the dried leaves contain higher proportion of nutrient upon moisture evaporation, the present investigation made use of dried powder of underutilized leaves to develop and standardize iron rich value-added products.

MATERIALS AND METHODS:

The study was conducted to develop value added food products using underutilized leaves for solving the condition of anemia and to evaluate its organoleptic characteristics. A list of underutilized plant leaves with rich iron content was prepared using food consumption and exhaustive literature. Four underutilized leaves selected from the list were cauliflower leaves, Drumstick leaves, Betel leaves and Mint leaves. All these leaves were collected vegetable market and farm nearby of Bhopal city. Then the leaves were sun and shade dried and analyzed for their iron content as per the (NIN) by **C. Gopalan**.

Nutritional estimation of fresh leaves

All the selected (iron rich) leaves from cauliflower moringa, beet green, turnip, radish, curry leaves, Betel leaves and mint leaves etc were analyzed for their iron content by NIN by **C. Gopalan**. Iron content of fresh leaves of cauliflower (40.0mg/100gm), Carrot (8.8mg/100gm), Beet green (16.2mg/100gm), Turnip (28.4mg/100gm), Curry leaves (0.93mg/100gm), Drumstick leaves (0.85/100mg), Betel leaves (10.6mg/100gm) and Mint leaves (15.6mg/100gm) were estimated. The cauliflower green leaves had the highest amount of iron among the underutilized leaves collected. Four leaves were selected for the present investigation.

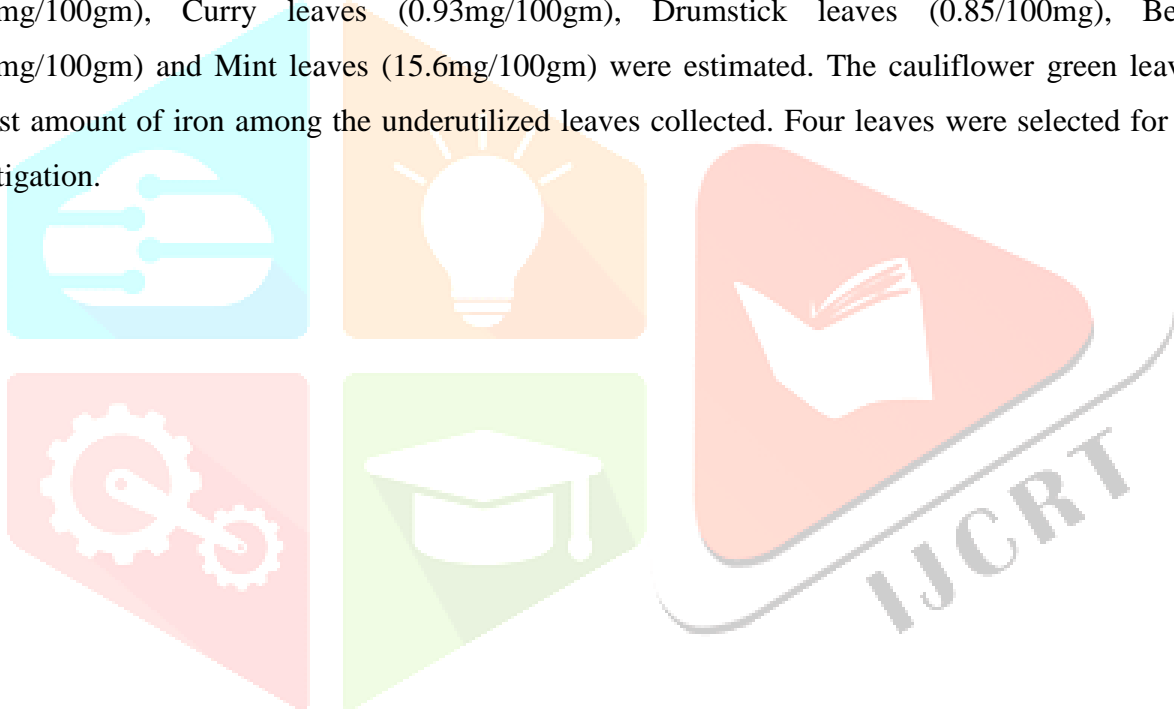


Table 1. Fresh leaves nutrient composition (values are per 100 grams of edible portion)

Leaves	Moisture (gm)	Protein (gm)	Fat (gm)	Fiber (gm)	CHO (gm)	Energy (Kcal)	Ca (mg)	Phosphorus (mg)	Iron (mg)
Beet greens	86.4	3.4	0.8	0.7	6.5	46	380	30	16.2
Betel leaves	85.4	3.1	0.8	2.3	6.1	44	230	40	10.6
Cauliflower Leaves	80.0	5.9	1.3	2.0	7.6	66	626	107	40.0
Drumstick leaves	75.9	6.7	1.7	0.9	12.5	92	440	70	0.85
Mint Leaves	4.9	4.8	0.6	2.0	5.8	48	200	62	156
Mustard leaves	89.8	4.0	0.6	0.8	3.2	34	155	26	16.3
Carrot leaves	76.5	5.1	0.5	1.9	13.1	77	340	110	8.8
Turnip greens	81.9	4.0	1.5	1.0	9.4	67	710	60	28.4
Bengal gram leaves	73.4	7.0	1.4	2.0	14.1	97	340	120	23.8
Cow Pea leaves	89.0	3.4	0.7	1.2	4.1	38	290	58	20.1

Source: NIN, C.Gopalan

Processing of leaves:

Fresh leaves were under shadow for 2 days and sundried for 3,4 days and then the dry leaves were grinded to powders. Four leaves were packed separately in airtight zip lock pouches.

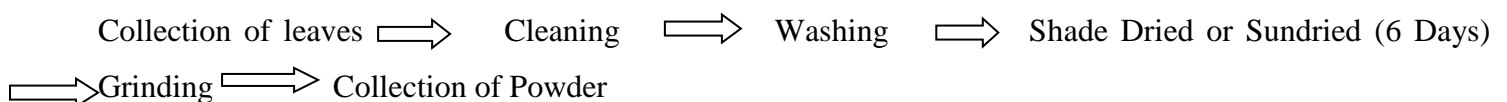


Fig. 1 Selected Fresh leaves

A. Cauliflower leaves B. Drumstick Leaves C. Betel leaves D. Mint Leaves

Fig. 2 Selected Dehydrated leaves Powder

A. Cauliflower B. Drumstick C. Betel D. Mint

Table 2. Details of selected food preparations

Food preparation	Method of cooking used	Consumed as
Atta Ladoo	Roasting	Sweet
Panjiri	Roasting	Sweet
Besan chilla	Sauteing	Main dish for breakfast/Lunch
Boondi	Deep frying	Snack
Mathri	Deep frying	Snack
Chutney	Sauteing	Side dish/relish
Missi Roti	Roasting	Used for breakfast/lunch
Khakhra	Roasting	Used for breakfast
Idli Rava	Steaming	Snack
Upma	Sauteing	Side dish
Dosa	Shallow frying	Main dish for Breakfast/Lunch
Raita	No cooking required	Side dish
Soup	Little cooking required	Side dish

Development of value-added products:

For the development of iron rich value-added products, a list of daily consumed food items was prepared from the magazines and recipe books. Out of them four commonly consumed items were prepared, Atta Ladoo, Panjiri, Besan chilla and Boondi were selected. The standardized recipes for these preparations were taken. The selected product was developed to enrich them with iron using the dry leaf powder incorporated in basic recipe at different levels were coded A (5%), B (10%), C (15%) respectively. Developed preparations were standardized in the laboratory of Home Science, Govt. MLB PG Autonomous college, Bhopal and were evaluated using 9-point hedonic scale.

Standardization of Products

The selected preparations viz. Atta ladoo, Besan chilla and Boondi were standardized in the laboratory for their portion size, cooking characteristics and organoleptic characteristics. Leaf powder was incorporated at 5%, 10% and 15% level. Ingredients used in the preparations were carefully balanced along with a procedure by repeated trial to obtain standard product.

Organoleptic Evaluation of products

Organoleptic evaluation of all recipes containing different levels of leaves mixture was done by panel consisting of 6 judges on the basis of their appearance Flavor, texture and taste. Sensory attributes were scored on a 9-point hedonic scale (Like Extremely 9, Like very much 8, Like moderately 7, Like slightly 6, Neither like or dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike Extremely 1).

Table 3. Hedonic Scale for organoleptic Evaluation

Quality Description	Score
Liked Extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked or disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

RESULTS AND DISCUSSIONS:

Product -1: Atta Ladoo

Atta Ladoo is a traditional sweet snack consumed mostly in Indian families. It is a roasted product with a good texture, appearance and taste. Atta Ladoo- A (with 5% of dried leaf powder) was liked moderately while Atta Ladoo-B (with 10% of dried leaf powder) was liked very much. Atta Ladoo C (containing 15% of dried leaf powder) was liked slightly. A significant ($P>0.01$) difference was found in the color among four variations of ladoo's prepared at different percentages of leaves powder. Atta Ladoo -S was most acceptable and more than 5% of the leaf powder. Texture can be determined both by perception and mouth feel. Texture of Atta Ladoo – A was most accepted among three iron rich developed Atta Ladoo's. A Particular food should have a particular flavor and it should not be overlapping with another products. The standard recipe (8.08) was liked very much while Atta Ladoo- A (7.41) was liked moderately by the panelist. A significant ($P> 0.01$) difference was found between them. Taste further adds towards the acceptability of any food products. Standard (8.33) and Atta Ladoo – A (7.41) were acceptable and the recipes were liked moderately. Overall acceptability score revealed that Atta Ladoo – B was liked very much by the panelist (table 4). these data suggest that incorporation of dried underutilized leaf powder up to 10 % to enrich the Atta Ladoo with iron found acceptable by the judges. Moreover, a significant ($P> 0.01$) difference was found in the overall acceptability of all the developed Atta Ladoo's.

Table 4: Scores for Organoleptic Characteristics of Atta Laddo (Mean \pm S.E.)

Attribute	Atta Ladoo –S	Atta Ladoo – A	Atta Ladoo – B	Atta Ladoo – C
Leaf powder	0%	5%	10%	15%
Appearance	7.5	7.16	7.33	6.83
Color	7.83	7.66	7.66	6.5
Taste	8.33	7.16	7.66	6.5
Texture	8.00	7.66	7.16	6.16
Flavor	7.66	7.16	7.00	6.5
Overall acceptability	8.08	7.41	8.00	6.75

Product -2: Panjiri

Panjiri is one of the traditional Indian Sweet snacks made by wheat atta and some amount of ghee and sugar. Overall acceptability was judged to evaluate the overall sensory quality of the product. Sensory score of standard (S) 8.00, A 7.33, B 7.5, and C were 6.16 and respectively indicating that the product A was liked moderately, B liked moderately and C liked slightly. Significant ($P> 0.01$) Differences were found in all sensory attributes.

Table 5: Scores for Organoleptic Characteristics of Panjiri (Mean ± S.E.)

Attribute	Panjiri –S	Panjiri – A	Panjiri - B	Panjiri –C
Leaf powder	0%	5%	10%	15%
Appearance	8.33	7.5	7.33	6.5
Color	8.00	6.83	7.00	6.33
Taste	7.83	7.33	7.00	6.66
Texture	7.83	7.3	7.00	6.5
Flavor	7.5	7.6	7.33	6.5
Overall acceptability	8.00	7.33	7.5	6.16

Product – 3 Besan chilla

Besan chilla is a delicious and healthy savory Indian pancake recipe made with gram flour, sweet onions, tangy tomatoes, fragrant spices and herbs. Results showed that the standard Chilla was liked moderately however iron enriched Besan Chilla – A was liked very much. Overall Acceptability means score of the standard, A, B and C Besan Chilla were 7.67 respectively. (Table 6). These scores revealed that standard Besan Chilla like moderately, Besan Chilla –A Liked Very Much, Besan Chilla B liked moderately and – C liked slightly. There was significant ($P>0.01$) difference between all variables and Besan Chilla A received highest mean score among three iron enriched Besan Chilla (A, B and C).

Table 6: Scores for Organoleptic Characteristics of Besan Chilla (Mean ± S.E.)

Attribute	Besan Chilla - S	Besan Chilla – A	Besan Chilla – B	Besan Chilla – C
Leaf powder	0%	5%	10%	15%
Appearance	7.66	7.66	7.66	7.00
Color	7.33	7.66	7.33	6.5
Taste	8.16	7.66	7.5	6.33
Texture	7.00	7.5	7.16	6.66
Flavor	7.66	7.83	7.5	6.5
Overall acceptability	7.73	8.13	7.75	6.5

Product – 4 Boondi

Boondi is an Indian snack made from fried chickpea flour, either as a savory snack or sweetened as a dessert. Boondi – A was most accepted in terms of texture color, flavor, taste, and appearance compared to Boondi – B and C (Table 6). Overall acceptability scores (table 6) of standard, A, B and C Boondi were 8,

6.83, 6.33 and 5.16 respectively indicated that the product C was neither liked nor disliked. Significant ($P>0.01$) difference was found among all the sensory variables. Boondi S had the highest mean score.

Table 7 : Scores for Organoleptic Characteristics of Boondi (Mean \pm S.E.)

Attribute	Boondi –S	Boondi – A	Boondi - B	Boondi –C
Leaf powder	0%	5%	10%	15%
Appearance	8.00	7.16	6.16	5.33
Color	7.83	7.16	6.00	5.33
Taste	8.16	6.66	6.33	5.33
Texture	7.66	6.66	6.16	5.16
Flavor	8.00	6.66	6.33	5.16
Overall acceptability	8.00	6.83	6.33	5.16

Sensory evaluation shows that all the Four selected Iron enriched value-added products namely Atta Ladoo, Panjiri, Besan Chilla and Boondi were acceptable by the judges. The mean scores of the all four iron enriched recipes shown that the product A (with 5% of underutilized leaf powder) was most acceptable than product B (with 10% of underutilized leaf powder) and product C (with 15% of underutilized leaf powder). Significant ($P>0.01$) differences among all the four iron enriched products were found.

CONCLUSIONS

All the four-iron rich value-added products namely Atta Ladoo, Panjiri, Besan Chilla and Boondi were most acceptable at 5% level of incorporation of underutilized dried leaves powder. Significant ($P>0.01$) differences were found among all the four products in terms of sensory qualities and acceptability. Dehydration is one of the best methods of preservation of green leaves. Being rich in essential micronutrients the green leaves can be utilized for the purpose of enrichment of nutritional deficient products. These innovative value-added products can supplement iron to a wide range of population with effective utilization of low-cost underutilized leaves. Thus, the development and use of these iron rich value-added products from underutilized and ignored leaves can serve as a dietary approach to prevent iron deficiency anemia in population.

Since iron supplementation programs have had a little reported success in reducing anemia, interest is turning to food-based approaches that have higher potential for achieving longer lasting benefits for the control of iron deficiency. The utilization of underutilized green leaves can be an easy and cheap method.

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