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Development of Iron Rich Value Added Products from Underutilized Leaves: A Dietary Approach to Prevent Iron Deficiency Anaemia

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ABSTRACT

The high prevalence of iron deficiency anaemia globally is largely the result of low dietary iron intake, inadequate to meet iron requirement especially in infant, children and women. Moreover, there are varieties of underutilized green leafy vegetables rich in iron and other essential micronutrients. Therefore, the effort was made to develop iron rich value added products. Four commonly consumed products namely Chakali, Namakpara, Bhujia and Tarts were developed from the underutilized dry leaves. Cauliflower, carrot, beet green, turnip, and curry leaves were taken at 5%, 10% and 15% 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 a 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.

Key words: *Iron, Anaemia, Underutilized leaves, Value Addition.*

INTRODUCTION

The commonly observed public health concern that affects mostly infant, children and women both in developing and developed countries is anaemia. The primary cause of anaemia is rarely found in isolation rather it is more frequently associated with a number of other causes such as malaria, parasitic infection, nutritional deficiencies and low level of haemoglobin etc[1]. Nutritional anaemia is defined as a condition that results from the inability of the erythropoietic tissue to maintain a normal haemoglobin concentration on account of inadequate supply of one or more nutrients leading to reduction in circulated haemoglobin. Anaemia is a pathologic deficiency in oxygen-carrying haemoglobin in red blood cells[2]. It impairs health and well-being mostly in women and increases the risk of maternal and neonatal adverse outcomes.

Anaemia affects half a billion women of reproductive age worldwide. WHO estimates suggest that over 1/3rd of the world's population suffer from anaemia mostly iron deficiency anaemia.

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In 2011, 29% (496 million) of non-pregnant women and 38% (32.4 million) of pregnant women aged 15-49 years were anaemic. The prevalence of anaemia was highest in south Asia and central and west Africa.[3] In developing countries every second pregnant woman and about 40% of preschool children are estimated to be anemic. India continues to be among the countries with very high prevalence of anaemia to a tune of 70-80% in children, 70% in pregnant women and 24% in adult man.[4] In many developing countries, iron deficiency anaemia is aggravated by worm infections, malaria and other infections, malaria and other infectious diseases such as HIV and tuberculosis. The major health consequences include poor pregnancy outcome, impaired physical and cognitive development, increased risk of morbidity in children and reduced work productivity in adults. Anaemia contributes to 20% of all maternal deaths.[5]

While the causes of anaemia are variable it is estimated that the half of cases are due to iron deficiency.[3] Iron is an essential mineral critical for motor and cognitive development. Children and pregnant women are especially vulnerable to the consequences of iron deficiency. Low haemoglobin concentration (anaemia) affects 43% of children in 5 years of age and 38% of pregnant women globally. Anaemia during pregnancy increases the risk of maternal and perinatal mortality and low birth weight. Maternal and neonatal deaths are a major cause of mortality, together causing between 2.5 million and 3.4 million deaths worldwide. WHO recommends iron and folic acid supplements for reducing anaemia and improving iron status among women of reproductive age. Flour fortification with iron and folic acid is globally recognized as one of the most effective and low-cost micronutrient interventions.[6] India being second in vegetables and fruits production hardly process 2% of the produce and 30-40% is being wasted due to lack of processing and prevention.[7] The country can effectively use the underutilized produce with high iron content for potential fortification with flour in order to develop some value added products to prevent iron deficiency anaemia.

Therefore, in the present study the efforts was made to use the underutilized green leafy vegetables such as cauliflower leaves, carrot leaves, beet green leaves, turnip leaves and curry 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 than fresh leaves because of concentration of the nutrient upon moisture evaporation[8], the present investigation made use of dried powder of underutilized leaves to develop and standardize iron rich value added products.

MATERIAL AND METHODS

The study was conducted to develop products using underutilized leaves for solving the condition of anaemia and to evaluate its organoleptic characteristics. A list of underutilized plant leaves with rich iron content was prepared using food consumption[9] and exhaustive literature. Five underutilized leaves selected from the list were cauliflower leaves, carrot leaves, beet leaves, turnip leaves and curry leaves. All these five leaves were collected from vegetable market of Jaipur city. Then the leaves were dried in shade and analyzed for their iron content as per the standardized procedure.[10] Analyses were done in the laboratory of department of Home Science, M.J.R.P University.

Preparation of Sample

Sample (1g) was taken in a digestion tube. To this 5 ml nitric acid was added and kept overnight. It was then digested next day in per chloric acid (5 ml) by heating till clear solution obtained. The solution then diluted to 100 ml with distilled water and was used for the determination of iron.

Analysis of Iron Content

All the selected (iron rich) leaves from cauliflower, carrot, beet green, turnip and curry leaves were analyzed for their iron

content by spectrophotometer method (Sharma, 2007). Iron contents of dried leaves of cauliflower (71.45mg/100gm), carrot (73.6mg/100gm), beet green (83.6mg/100gm), turnip (83.25mg/100gm) and curry leaves (10 mg/100gm) were estimated. The beet green leaves had the highest amount of iron among the five underutilized leaves collected. The carrot leaves also showed an appreciable amount of iron. As these leaves are available only in the winter season, the cauliflower leaves and beet leaves available throughout the year in the market were selected for the present investigation.

Processing of Leaves

Fresh leaves were dried under shadow for 2 days at 22° C and then the dry leaves were grinded to powders. Both leaves were packed separately in airtight zip lock pouches.

Development of Products

For the value added iron rich product development, a list of daily consumed food items was prepared from the magazines and recipes books. Out of them four commonly consumed preparations, Chakli, Namakpara, Bhujia and Tarts were selected. The standardized recipes for these preparations were taken.[11] 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, M.J.R.P University, Jaipur and were evaluated using 9 point hedonic scale.

Standardization of Products

The selected preparations *viz.* Chakli, Namakpara, Bhujia, and Tarts 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.

Sensory Evaluation of Products

Iron enriched value added products were served to the selected group of 15 panel members for evaluation of their sensory attributes. Organoleptic evaluation of standard and iron enriched products was done using 9 point hedonic scale (table 1). Experiments were carried out in triplicate. One way Analysis of Variance (ANOVA) was performed[12] using standard statistical package (SPSS 20.0) and the significance of difference was defined at $P<0.01$.

Table 1: Hedonic Scale for Organoleptic Evaluation

Quality description	Score
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

RESULTS AND DISCUSSIONS

Product-1: Chakali

Chakali is a snack consumed mostly in India. It is an extruded product with a good texture and appearance; colours adds to the qualities of food whether it is acceptable or refutable by the consumers. Chakali-A (with 5% of dried leaf powder) was liked moderately while Chakali-B (with 10% of dried leaf powder) was liked slightly. Chakali-C (containing 15% of dried leaf powder) was neither liked nor disliked. A significant ($P>0.01$) difference was found in the colour among four chakalis prepared at different percentages of leaves powder. Chakali-A was most acceptable and more than 5% of the leaf powder made the recipe unacceptable due to dark colour. Texture can be determined both by perception and mouth feel. Texture of Chakali-A was most accepted among three developed iron rich chakalis. A significant ($P>0.01$) difference was found in texture among all the chakalis. A particular food should have a particular flavor and it should not be overlapping with another products. The Standard (8.40 ± 0.21) was liked very much while chakali-A (7.40 ± 0.30) 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 (8.40± 0.18) and Chakali-A (7.40 ± 0.33) were acceptable and the recipes were liked very much. Overall acceptability score revealed that Chakali-A was liked moderately by the panelist (table 2). These data suggest that incorporation of dried underutilized leaf powder up to 5 % to enrich the chakali with iron found acceptable by the judges. Moreover, a significant (P> 0.01) difference was found in the overall acceptability of all the developed chakalis.

Table 2: Scores for Organoleptic Characteristics of Chakali (Mean ± S.E)

Attribute	Chakali-S	Chakali-A	Chakali-B	Chakali-C
Leaf powder	**0%**	**5%**	**10%**	**15%**
Colour	8.50 ± 0.16	7.60 ± 0.27	6.40 ± 0.27	5.40 ± 0.45
Texture	7.93 ± 0.29	7.73 ± 0.29	6.13 ± 0.25	5.20 ± 0.44
Flavour	8.40 ± 0.21	7.40 ± 0.21	5.86 ± 0.30	5.00 ± 0.40
Taste	8.40 ± 0.18	7.40 ± 0.33	5.93 ± 0.28	4.33 ± 0.42
Appearance	8.26 ± 0.20	7.53 ± 0.33	5.80 ± 0.40	4.46 ± 0.46
Overall acceptability	8.46 ± 0.19	7.73 ± 0.28	6.20 ± 0.32	5.13 ± 0.45

Product-2: Namakpara

Namakpara is one of the traditional Indian snacks made by the Bengal gram flour and some amount of oil and spices. Overall acceptability was judged to evaluate the overall sensory quality of the product. The mean acceptability score (table 3) of standard (S), A, B, and C were 8.26 ± 0.15, 7.4 ± 0.28, 5.8 ± 0.36 and 4.3 ± 0.32 respectively indicating that the product A was liked moderately, B neither liked nor disliked and C disliked slightly. Significant (P>0.01) differences were found in all sensory attributes.

Table 3: Scores for Organoleptic Characteristics of Namakpara (Mean ± S.E)

Attribute	Namakpara-S	Namakpara-A	Namakpara-B	Namakpara-C
Leaf powder	**0%**	**5%**	**10%**	**15%**
Colour	8.33 ± 0.22	7.33 ± 0.31	5.66 ± 0.3	4.43 ± 0.45
Texture	8.26 ± 0.15	7.66 ± 0.28	5.80 ± 0.32	5.00 ± 0.40
Flavour	8.46 ± 0.19	7.20 ± 0.34	5.53 ± 0.46	4.33 ± 0.37
Taste	8.20 ± 0.19	7.40 ± 0.42	5.26 ± 0.43	3.93 ± 0.31
Appearance	8.26 ± 0.22	6.93 ± 0.35	5.40 ± 0.43	4.06 ± 0.31
Overall acceptability	8.26 ± 0.15	7.4 ± 0.28	5.8 ± 0.36	4.3 ± 0.32

Product-3: Bhujia

Bhujia is a traditional snack and widely used by almost all the people. It is an appetizer and consumable of all age group. Results showed that the standard bhujia was liked extremely however iron enriched bhujia-A was liked very much. Overall acceptability means score of the standard, A, B and C bhujia were 8.66 ± 0.12, 7.60 ± 0.21, 6.60 ± 0.23, and 4.93 ± 0.36 respectively (table 4). These scores revealed that standard bhujia liked extremely, bhujia-A liked very much, bhujia-B liked moderately, and bhujia-C neither liked nor disliked. There were significant (P>0.01) difference between all variables and bhujia A received highest mean score among three iron enriched bhujia (A, B and C).

Table 4: Scores for Organoleptic Characteristics of Bhujia (Mean ± S.E)

Attribute	Bhujia-S	Bhujia-A	Bhujia-B	Bhujia-C
Leaf powder	**0%**	**5%**	**10%**	**15%**
Colour	8.73 ± 0.11	7.20 ± 0.27	6.26 ± 0.35	4.80 ± 0.44
Texture	8.13 ± 0.21	7.33 ± 0.26	6.46± 0.34	5.06± 0.45
Flavour	8.33 ± 0.15	6.66 ± 0.45	6.13 ± 0.43	5.40 ± 0.34
Taste	8.53 ± 0.21	7.66 ± 0.37	6.20 ± 0.43	4.60 ± 0.44
Appearance	8.73 ± 0.11	7.33 ± 0.45	6.53 ± 0.40	4.73 ± 0.47
Overall acceptability	8.66 ± 0.12	7.60 ± 0.21	6.60 ± 0.23	4.9 ± 0.36

Product-4: Tarts

Tarts are baked dish containing of filling over pastry base with an open top covered with pastry. Tart-A was most accepted in terms of texture colour, flavor, taste and appearance compared to tart-B and C (Table 5). Overall acceptability scores (table 4) of standard, A, B and C tart were 8.5± 0.24, 8.00± 0.20, 7.5 ± 0.38 and 5.5± 0.27 respectively indicated that the product were extremely liked, liked very much, liked moderately while product C was neither liked nor disliked. Significant (P>0.01) difference was found among all the sensory variables. Tart A had highest mean score.

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

Attribute	Tarts-S	Tarts-A	Tarts-B	Tarts-C
Leaf powder	**0%**	**5%**	**10%**	**15%**
Colour	8.7 ± 0.15	8.20± 0.17	7.46 ± 0.27	6.13± 0.43
Texture	8.46 ± 0.21	8.26± 0.20	7.86± 0.25	6.46± 0.45
Flavour	8.33 ± 0.22	7.66 ± 0.25	6.73 ± 0.28	4.80 ± 0.36
Taste	8.33 ± 0.18	7.60 ± 0.27	6.53 ± 0.33	4.53 ± 0.38
Appearance	8.73 ± 0.15	8.73 ± 0.11	8.46 ± 0.23	8.00 ± 0.33
Overall acceptability	8.46 ± 024	8.06 ± 0.20	7.66 ± 0.38	5.46 ± 0.27

Sensory evaluation revealed that all the four iron enriched value added products namely Chakli, Namakpara, Bhujia and Tarts 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 Chakali, Namakpara, Bhujia and Tarts 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. 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 leaves can serve as a dietary approach to prevent iron deficiency anaemia.

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