

Original research Article

Utilization of underutilized green leafy vegetables in the development of value added products

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Abstract

The purpose of the research was to assess the nutritional content and proximate composition of three underutilized dried green leafy vegetables: cauliflower, beet, and carrot leaves. Various edible products were made using dried leaf powder like laddu, shakkarpara and nutribar. Cauliflower leaves stand out among the macronutrients with the greatest protein content (21.87 g/100g) followed by carrot leaves (17.06 g/100g). Highest fat content (2.63 g/100g) was found in carrot leaves. Cauliflower leaves showed highest fiber concentration (7.59 g/100g). Carbohydrate content was found highest in carrot leaves (68.36 g/100g). Cauliflower leaves scored highest mineral content (13.52 g/100g). Regarding micronutrients, the iron content of cauliflower leaves was greatest (234.12 mg/100g), followed by that of beetroot leaves (101.37 mg/100g) and carrot leaves (47.6 mg/100g). The highest calcium content was found in carrot leaves (650 mg/100g). The amount of ascorbic acid in beetroot leaves, cauliflower leaves and carrot leaves was 68.34 mg, 45.12 mg and 36.2 mg respectively. After nutrient analysis, sensory analysis was done using various concentrations of dried leaf powder in laddu, shakkarpara and nutribar. Laddus included 5% of dried cauliflower leaf powder scored best in sensory attributes testing. Five percent incorporation of shakkarpara using dried beetroot leaf powder also received the top ratings in comparison to other concentrations. Nutribar with 5% dry cauliflower leaf powder integration regularly received the top sensory ratings.

Keywords: Cauliflower, carrot leaves, beetroot greens, traditional foods, nutribars, proximate composition, sensory analysis

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Introduction

Green leafy vegetables are also known as “Greens” or “Pot herbs”. Globally, these account for 10% of total crop production in which, India ranks second. Being most affordable source of various vital nutrients, green leafy vegetables are indispensable part of vegetarian diets ^[1] ^[2]. Common Indian greens include amaranthus, fenugreek leaves, spinach, bathua, drumstick leaves, mustard leaves, cauliflower leaves and cabbage. Being inexpensive, these are within the reach of the poor population also. Still their consumption is less due to ignorance about their nutritional significance. These are rich in soluble and insoluble dietary fibres, minerals, vitamins and other nutrients ^[3]. According to Mohammed and Sharif (2011) ^[4], these are protective foods as these have low calorie density, therefore good choice for weight control. These are also good sources of vitamin C and phytonutrients, that have vital role in building up immunity (Rahman et al., 2006) ^[5] and significant antioxidant properties and anti - carcinogenic properties (Harborne and Herbert, 1993) ^[6]. Micronutrient deficiency is very common in developing countries like India. These micronutrients have vital role in maintaining tissue function and cellular metabolism. Anaemia is a serious public health problem worldwide particularly in small children, pregnant and nursing mothers. It is due to insufficient diet, poor socioeconomic and educational status, worm infections etc. Lack of knowledge, incorrect beliefs and superstitions further worsen the problem. Increased consumption of green leafy vegetables is linked to improved status of anaemia.

As green leafy vegetables are perishable therefore preservation by drying may of utmost importance to make these available throughout the year. It is now demand of time to search for natural, sustainable and affordable methods to eradicate anemia (Odhav et al., 2007) ^[7]. As minerals cannot be synthesized in our body, therefore these must be achieved from food and water (Mohammed and Sharif, 2011) ^[4]. These are abundantly present in green leafy vegetables. So, this is a need of hour to focus on developing value-

added food products using widely grown and less consumed green leafy vegetables. Using medications or chemicals routinely may have side effects on health; therefore development of iron-rich value-added supplements is the need of hour.

On one side, India is suffering with serious hunger problem, on the other hand, due to poor cold chain infrastructure, the nation wastes 16% of its annual fruit and vegetable production. Therefore, present study was planned with a view to use these discarded leaves in such a way that is advantageous for people.

Objectives

- To create powders from underutilized green leafy vegetables (beetroot, carrot, and cauliflower leaves) by using various drying techniques
- To assess the nutritional value of green leaves powders
- Making value-added products by incorporating green leaves powder
- To calculate the cost, sensory characteristics and nutritional makeup of produced value-added goods

Research Methodology

The goal of the current study was to create calcium and iron-rich products with value addition of traditional recipes using inexpensive, locally available green leafy vegetables that are not often consumed. The study was conducted in the following four phases.

Phase I:

- 1.1 Procuring and processing underutilized green leafy vegetables
- 1.2 Making a powder using underutilized green leafy vegetables
- 1.3 Nutritional evaluation of powdered underutilized green leafy vegetables

Phase II: Development of value added products

- 2.1 Selection of recipes
- 2.2 Standardization of recipes with various levels of incorporation

Phase III: Organoleptic evaluation of developed value added products

Phase IV: Data compilation, interpretation and statistical analysis

Phase-I

1.1 Procurement and processing of Uncommon Green Leafy Vegetables

The 3 underutilized green leafy vegetables were purchased at the local market of Jaipur. These were cauliflower leaves, beetroot leaves and carrot leaves that were added in various ratios.

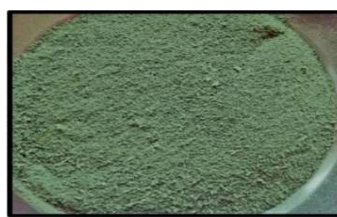
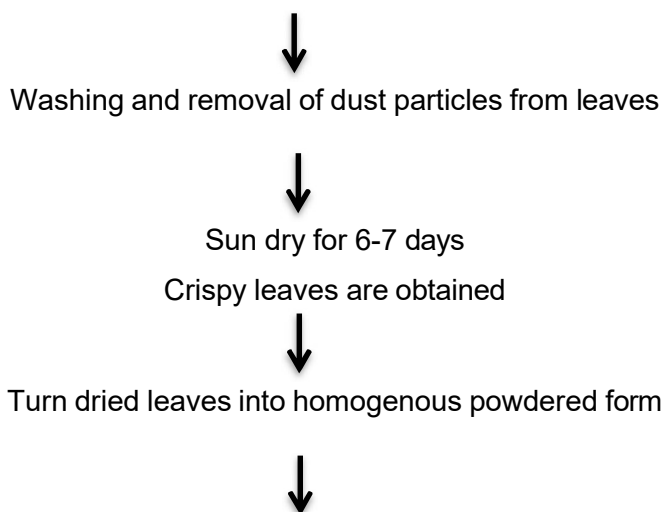
Experimental site: All the work was done in the Nutrition Lab and Biochemistry Lab of SIILAS Campus, Jaipur National University, Jaipur, Rajasthan.

1.2 Making a powder using selected green leafy vegetables

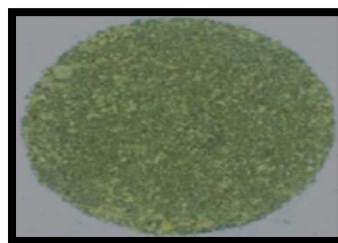
Before washing the leaves, fresh, green, unblemished, non-insect-infested, bruised, discoloured, rotten, and wilting unusual green leafy vegetables were separated.

Vegetables were thoroughly cleaned, rinsed, and diced before being Sun dried in open 6-7 days. Powder was then made and then it was kept in airtight containers for later use.

Extraction of leaves from vegetables



Fresh cauliflower leaves (a), and dried powder (b)



Fresh beetroot leaves (a), and dried powder (b)

Fresh Carrot leaves (a), and Dried Powder



Figure 1: Green leafy vegetables in fresh & in dry powdered form

1.3 Nutritional evaluation of powdered underutilized green leafy vegetables

Powder of Dried underutilized green leafy vegetables was analyzed for macro and micro nutrient content by different methods. Indian Food Composition Tables 2017 ^[9] was referred for validation of results. The standardized methods were as shown below -

Nutrient Content	Analysis Method
Protein	Kjeldhal Method
Fat	Soxhlet Method
Moisture	AOAC, 2019 ^[8]
Carbohydrate	AOAC, 2019
Ash Content	Dry ashing, AOAC, 2019
Iron	AOAC, 2019
Calcium	AOAC, 2019
Vitamin C	2,6 dichlorophenol indophenol method

Table 1: Standardized methods for estimation of nutritive value

Phase-II Development of value added products

2.1 Selection of recipes: The different basic recipes were selected for incorporation of dried green leafy vegetables. The enlisted products were developed -

- Laddoo
- Shakkarpara
- Nutri-Bar

2.2 Standardization of Recipes with various levels of incorporation:

Four distinct treatments, denoted as T1, T2, T3, and T4, were made to find out acceptability of the product. In treatment 1, 5% leaf powder was added with the additional components accounting for the remaining 95%. In treatment 2, the leaf powder was 10% with standard component remaining 90%. In treatment 3, 15% leaf powder was incorporated and standard component was 85% and in treatment 4, this ratio was 20:80 as shown in table 3, 4 and 5 below -

Laddu

	Supplementation Percentage				
Ingredients	Standard	T1 (5%)	T2 (10%)	T3 (15%)	T4 (20%)
Bengal Gram Flour (gm)	100	95	90	85	80
Sugar (gm)	60	60	60	60	60
Ghee (ml)	50	50	50	50	50
CLLP (gm)	0	5	10	15	20

Table 2: Laddu Supplemented with Cauliflower Leaves Powder (CLLP)

	Supplementation Percentage				
Ingredients	Standard	T1 (5%)	T2 (10%)	T3 (15%)	T4 (20%)
Bengal Gram Flour (gm)	100	95	90	85	80
Sugar (gm)	60	60	60	60	60
Ghee (ml)	50	50	50	50	50
BLP (gm)	0	5	10	15	20

Table 3: Laddu Supplemented with Beetroot Leaves Powder (BLP)

Ingredients	Supplementation Percentage				
	Standard	T1 (5%)	T2 (10%)	T3 (15%)	T4 (20%)
Bengal Gram Flour (gm)	100	95	90	85	80
Sugar (gm)	60	60	60	60	60
Ghee (ml)	50	50	50	50	50
CLP (gm)	0	5	10	15	20

Table 4: Laddu Supplemented with Carrot Leaves Powder (CLP)

Similarly shakkarpara and nutribar samples were prepared using different concentrations of green leafy powder.

Phase-III

Organoleptic evaluation of developed value added products: By completing sensory assessment, the acceptability of the created recipes under research was determined. First of all tasting panel was selected using sensory threshold test ^[10]. After that acceptability was assessed using 9 point hedonic scale test and composite scoring test ^[11].

Phase-IV

Data compilation, interpretation and statistical analysis: In order to determine the statistically significant differences between various features, the acquired data was tabulated and statistically evaluated using mean, standard deviation and student's 't' test ^[12].

Results and discussion

The present study was conducted on development of value added food products out of underutilized, green leafy vegetables. The results of the study are discussed here in following heads.

1. Nutrient composition of dehydrated underutilized green leafy vegetables

Proximate composition

Three varieties of dry leafy vegetables, including cauliflower leaves (*Brassica oleraceabotrytis*), beetroot leaves (*Beta vulgaris*), and carrot leaves (*Daucus carota* subsp.) were evaluated for their nutritional value. The measured values for different macro

nutrients per 100 grams of each vegetable are shown in the table 5 and micronutrients have shown in table 6.

	Dry leafy Vegetables		
Nutrient Content	Cauliflower Leaves (<i>Brassica Oleraceabotrytis</i>)	Beetroot Leaves (<i>Beta vulgaris</i>)	Carrot leaves (<i>Daucus carota</i> subsp.)
Moisture (gm/100gm)	13.37	12.80	8.5
Protein (g/100 g)	21.87	12.43	17.06
Fat (g/100g)	2.13	1.72	2.63
Fibre (g/100gm)	7.59	4.54	3.33
Carbohydrate (gm/100gm)	42.04	54.04	68.36
Ash (gm/100gm)	13.52	10.47	10.5

Table 5: Proximate composition of underutilized dehydrated green leafy vegetables

	Dry leafy Vegetables		
Micro-Nutrient Content	Cauliflower Leaves (<i>Brassica Oleraceabotrytis</i>)	Beetroot Leaves (<i>Beta Vulgaris</i>)	Carrot leaves (<i>Daucus carota</i> subsp.)
Iron (mg/100 g)	234.12	101.37	47.6
Calcium (mg/100 g)	620.62	370.70	650
Ascorbic Acid (mg/100g)	45.12	68.34	36.2

Table 6: Micronutrient content of underutilized dehydrated green leafy vegetables

2. Acceptability scores of the developed products

2.1 Sensory scores of laddu with incorporation of dried cauliflower leaves powder:

The data on acceptability scores of developed laddu is revealed in table 7. The variant with 5% incorporation has the greatest scores for sensory qualities among the variations with various incorporation percentages percent incorporation level for all sensory characters' colour (8.06), texture (7.86), flavour (7.73), taste (8.00), appearance (7.86) and overall acceptability (7.73). , excluding the standard variation. It performs better than Variations III, IV, and V because they have greater incorporation rates. As a result, given the available information, Variation II is the suggested option.

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.60	8.46	8.40	8.26	8.33	8.46
II	5	8.06	7.86	7.73	8.00	7.86	7.73
III	10	7.40	7.13	7.46	7.13	7.26	7.20
IV	15	6.93	7.00	7.13	7.00	6.93	6.86
V	20	6.15	6.40	6.20	6.53	6.26	6.20

Table 7: Sensory scores of Laddu with incorporation of Dried Cauliflower leaves at various Percentage

2.2 Sensory scores of Laddu with incorporation of Dried Beetroot leaves Powder:

Sensory scores obtained by various variations of incorporated Laddu are presented in Table No 8. It is evident from the table that the best scores were obtained to Laddu with the variation III. i.e., 10 percent incorporation level for all sensory characters like colour (7.86), texture (7.80), flavour (7.80), taste (8.00), appearance (7.40) and overall acceptability (7.73).

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.60	8.46	8.40	8.26	8.33	8.46
II	5	8.06	7.86	7.32	8.00	7.06	7.20
III	10	8.06	7.80	7.80	8.00	7.40	7.73
IV	15	7.86	7.73	7.80	7.80	7.40	7.73
V	20	7.00	7.20	7.00	7.13	6.86	7.06

Table 8: Sensory scores of Laddu with incorporation of Dried Beetroot leaves at various percentage

2.3 Sensory scores of Laddu with incorporation of Dried Carrot leaves Powder

Sensory scores obtained by various variations of incorporated Laddu are presented in table 9. The greatest mean values for each sensory characteristic was found in variation II (5% incorporation): (8.40, 8.40, 8.26, 8.26, 8.46, 8.33).

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.60	8.46	8.40	8.26	8.33	8.46
II	5	8.40	8.40	8.26	8.26	8.46	8.33
III	10	7.86	7.80	7.66	7.86	8.00	7.66
IV	15	7.33	7.46	7.26	7.33	7.26	7.13
V	20	6.73	7.00	6.93	6.93	6.93	6.40

Table 9: Sensory scores of Laddu with incorporation of Dried Carrot laves at various Percentage

2.4 Sensory scores of Shakkarpara with incorporation of Dried Cauliflower leaves

Powder: The variation with the greatest ratings among those with various incorporation percentages is variant II, which incorporates 5% CCLP. It reaches the mean values for the following sensory characteristics Variation II (5% incorporation): (7.66, 7.53, 7.53, 7.86, 7.66, 7.73) as shown in table 10.

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.6	8.26	8.13	8.13	8.13	8.13
II	5	7.66	7.53	7.53	7.86	7.66	7.73
III	10	7.13	7.26	7.06	7.06	7.06	7.33
IV	15	6.73	6.86	6.93	6.86	6.80	7.06
V	20	6.00	6.00	6.33	6.13	5.60	6.13

Table 10: Sensory scores of Shakkarpara with incorporation of dried cauliflower leaves at various percentage

2.5 Sensory scores of shakkarpara with incorporation of dried beetroot leaves

powder: The variation having 5% of fresh carrot leaves in it, version II, had the highest sensory ratings. High marks were given for its color (8.14), texture (7.95), flavor (7.95), taste (8.23), look (8.00), and general acceptance (8.04). In every sensory characteristic, Variation II consistently performs better than Variations III, IV, and V. It receives better ratings for its look, flavor, texture, acceptability overall, and color. Based on the

information given, Variation II with 5% incorporation is the suggested option as shown in table 11.

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.6	8.26	8.13	8.13	8.13	8.13
II	5	8.14	7.95	7.95	8.23	8.00	8.04
III	10	7.95	7.80	7.76	7.90	7.85	7.90
IV	15	7.76	7.61	7.57	7.71	7.66	7.76
V	20	6.73	7.00	6.93	6.93	6.93	6.40

Table 11: Sensory scores of shakkarpara with incorporation of dried beetroot leaves powder at various percentages

2.6 Sensory Scores of Shakkarpara with incorporation of Dried Carrot leaves Powder:

Excluding the standard variation, Variation II with 5% incorporation is the best variation among the possibilities with various incorporation percentages. High mean values are routinely attained for sensory qualities. The results for Variation II's color (8.40), texture (8.40), flavor (8.26), taste (8.26), look (8.46), and general acceptance (8.33) are remarkable. Variation II continues to perform better across all sensory qualities when compared to Variations III, IV, and V (Table 12).

Variations		Mean value of sensory score					
No.	Incorporation %	Colour	Texture	Flavour	Taste	Appearance	Overall acceptability
I	Standard	8.6	8.26	8.13	8.13	8.13	8.13
II	5	7.5	7.92	7.33	7.3	7.6	7.5
III	10	7.33	7.00	7.00	7.00	7.33	7.3
IV	15	6.73	7.00	6.93	6.93	6.93	6.40
V	20	6.5	6.33	6.66	6.5	6.5	6.16

Table 12: Sensory scores of shakkarpara with incorporation of dried carrot leaves at various percentages

2.7 Sensory scores of Nutribar with incorporation of Dried Cauliflower leaves Powder:

Based on the presented data, Variation II with 5% incorporation comes out as the best option among the variants with various incorporation percentages. The majority of the sensory qualities are met by Variation II with the highest mean values. The color

(7.5), texture (7.92), flavour (7.33), taste (7.3), look (7.6), and overall acceptability (7.5) all obtain quite good rankings. Variation II typically outperforms Variations III, IV, and V in terms of sensory ratings as depicted in figure.

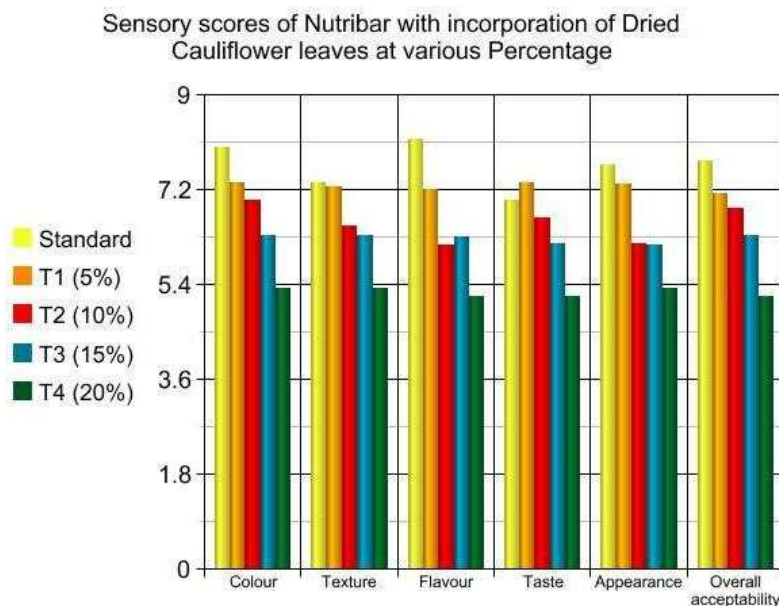


Figure 2: Sensory scores of Nutribar with incorporation of dried cauliflower leaves at various percentages

2.8 Sensory scores of Nutribar with incorporation of dried beetroot leaves powder:

Among the variations with different incorporation percentages, Variation II with 5% incorporation emerges as the best option based on the provided data. Variation II consistently achieves high mean values for most sensory attributes. It receives notable scores for color (7.66), texture (7.66), flavor (7.66), taste (7.5), appearance (7.83), and overall acceptability (8.13). When compared to Variations III, IV, and V, Variation II consistently outperforms them in terms of sensory scores. Therefore, based on the given data, Variation II (5% incorporation) is the recommended choice (Figure 3).

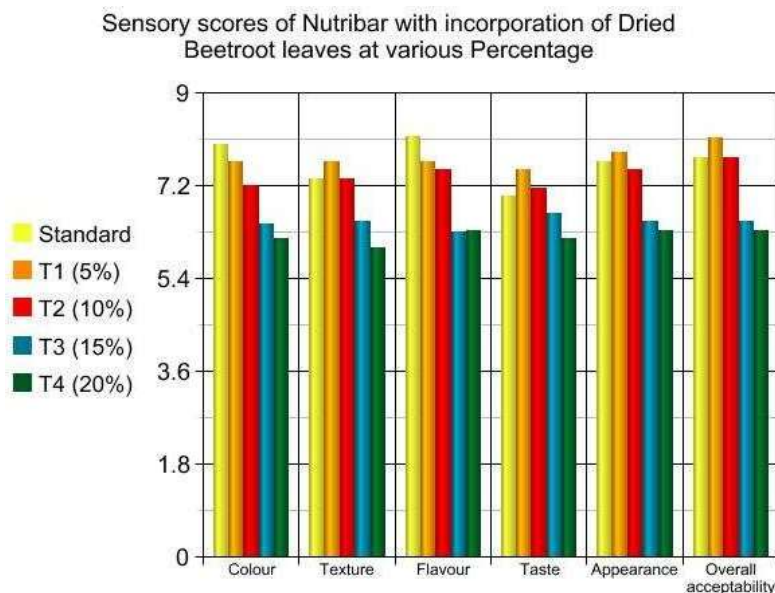


Figure 3: Sensory scores of Nutribar with incorporation of dried beetroot leaves at various percentage

2.9 Sensory scores of Nutribar with incorporation of dried carrot leaves powder:

As presented in figure 3, among the variations with different incorporation percentages, variation II(5% variation) yields the highest sensory scores based on the provided data. Variation II with 5% incorporation is the best option based on sensory scores. It exhibits appealing characteristics, including a colour score of 7.16, texture score of 7.26, flavour score of 6.66, taste score of 6.83, appearance score of 7.16, and overall acceptability score of 7.13. These qualities make Variation II the recommended choice for optimal sensory experience.

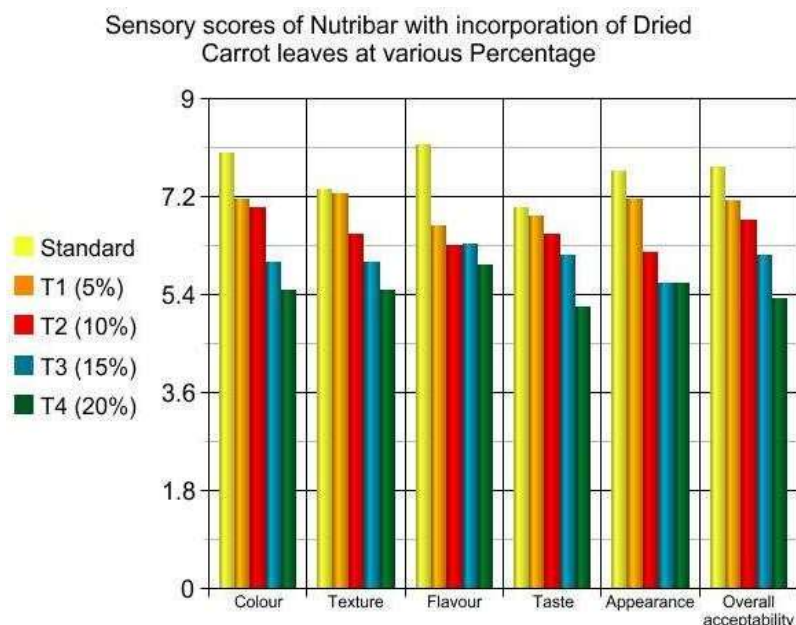


Figure 4: Sensory scores of Nutribar with incorporation of dried carrot leaves at various percentage

Conclusion

The purpose of the research was to assess the nutritional content and proximate composition of three underutilized dried green leafy vegetables: cauliflower, beet, and carrot leaves. The objective was to evaluate their potential as dietary supplements in food items. In order to investigate the sensory attributes of these goods, versions of Laddu, Shakkarpara, and Nutribar were created using various amounts of dried leaf powder.

Cauliflower leaves stand out among the macronutrients with the greatest protein content (21.87 g/100g), whereas carrot leaves also showed high protein content (17.06 g/100g). Among the three vegetables, carrot leaves have the largest fat content (2.63 g/100g). Cauliflower leaves had the greatest concentration of fiber (7.59 g/100g), which suggests they may be a useful source of dietary fiber. Among the three vegetables, carrot leaves have the most carbohydrate content (68.36 g/100g). Cauliflower leaves have the highest mineral content when compared to ash levels (13.52 g/100g).

Regarding micronutrients, the iron content of cauliflower leaves is greatest (234.12 mg/100g), followed by that of beetroot leaves (101.37 mg/100g), and carrot leaves (47.6 mg/100g). The highest calcium content is found in carrot leaves (650 mg/100g), while the lowest calcium content is found in beetroot leaves (370.70 mg/100g). The amount of

ascorbic acid in beetroot leaves (68.34 mg/100g), cauliflower leaves (45.12 mg/100g), and carrot leaves (36.2 mg/100g) is the greatest.

The research went on to construct versions of Laddu, Shakkarpara and Nutribar with varying amounts of dry leaf powder integration based on the nutritional content analysis. For each modification, sensory ratings were gathered in order to evaluate the goods' acceptability.

The variety of laddus that included 5% of dried cauliflower leaf powder scored best for all sensory attributes— color, texture, flavor, taste, appearance and overall acceptability. This version outperformed Variations III, IV, and V, which all had greater incorporation rates. As a result, it was advised that Variation II with 5% incorporation be chosen. The variant with 5% dried beetroot leaf powder integration (variant III) in Shakkarpara also received the top ratings for its sensory properties. In terms of color, texture, flavor, taste, appearance, and overall acceptability, it did better than Variations II, IV, and V. For Nutribar, Variation II with 5% dry cauliflower leaf powder integration regularly received the top sensory ratings. It was superior than Variations III, IV, and V in terms of look, flavor, texture, and acceptance in general.

In conclusion, the research showed that adding dried green leafy vegetables to food items may improve their nutritional content and sensory aspects. Examples of these vegetables are cauliflower leaves, beetroot leaves, and carrot leaves. In terms of sensory evaluation, the versions that included 5% dry leaf powder consistently outperformed the others. As a result, Variation II with 5% integration was suggested as the best option for the evaluated food items' sensory experience. These results demonstrate the possibility for using unusual green leafy vegetables that have been dried as nutrient additions in a variety of culinary applications.

References

1. Grivetti LE, Ogle BM. Value of traditional foods in meeting macro- and micro nutrient needs: the wild plant connection. *Nutr. Res. Review.* 2000; 13(1): 31- 46. doi: 10.1079/095442200108728990
2. Ogle BM, Tuyet HT, Duyet HN, Xuan Dung HN. Food, feed or medicine: the multiple functions of edible wild plants in Vietnam. *Economic Botany.* 2003; 57: 103- 117
3. Asaolu SS, Adefemi OS, Oyakilome IG, Ajibulu KE, Asaolu MF. Proximate and mineral composition of Nigerian green leafy vegetables. *Journal of Food Res.* 2012; 1(3): 214- 218

4. Mohammad MI, Sharif N. Mineral composition of some leafy vegetables consumed in Kano, Nigeria. *Nigerian Journal of Basic and Applied Sciences*. 2011; 19(2): 208 – 212
5. Rahman I, Kode A, Biswas SK. Assay for quantitative determination of glutathione and glutathione disulfide levels using enzymatic recycling method. *Nature Protocols*. 2006; 1: 3159- 3165
6. Harborne JB, Herbert B. *Phytochemical Dictionary. A Handbook of Bioactive Compounds from Plants*. Taylor & Francis, Inc., London, 1993
7. Odhav B, Beekrum S, Akula Us, Bajinath H. Preliminary assessment of nutritional value of traditional leafy vegetables in Kwazulu Natal, South Africa. 2007; 20(5): 430- 435
8. A.O.A.C. (2019). *Official methods of analysis*. Association of Official analytical chemist., 14th Edn. Washington, DC. 95, pp.61 – 133
9. Longvah T, Ananthan R, Bhaskarachary K, Venkaiah K. *Indian Food Composition Tables*. National Institute of Nutrition, ICMR, Hyderabad, 2017
10. Swaminathan M. *Essentials of Food & Nutrition*. Ganesh Publishers, Madras, 1977.
11. Sriakshmi B. *Food Science*. New Age International (P) LTD., New Delhi, 1999
12. Panse VG, Sukhadev PV. *Statistical Methods for Agricultural workers*. Indian Council of Agricultural Research Publication, 1985; 87 – 89.