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Digera muricata (Kondhra) leaves incorporated as a healthy and nutritional traditional product soup

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Abstract
Digera muricata (Kondhra) leaves rich in fat (1.01mg/100gm), protein (2.48mg/100gm) and iron (15.80mg/100gm) were supplemented in vegetable soup with four levels *viz*; 2.5gm, 5gm, 7.5gm and a control and subjected to sensory evaluation on a nine-point hedonic scale with different characteristics like color, appearance, flavor, texture and taste followed by overall acceptability score through a panel of ten experts and well qualified in the subject as judges. Karl Pearson's coefficient of correlation was used to estimate interrelationship between different characteristics and Kendall's coefficient of concordance for the agreement between different judges. Majority of the correlations were highly significant and Kendall's coefficient of concordance W (W=0.731) has shown a significant stage of agreement between judges in judging the product. Further, for estimating the Physicochemical properties the samples were tested in four replicates and ANOVA suggested a highly significant value between different levels of *Digera muricata* (Kondhra) leaves supplementation (p<0.05). The supplementation of 7.5gm of *Digera muricata* (Kondhra) leaves was found to be most acceptable.

Keywords: *Digera muricata*, correlations, concordance, physicochemical

1. Introduction
Today more and more people are leaning towards healthy meals that are not only appealing to taste but are also good for our body. In that essence, naturally grown vegetables are long being appraised for aroma, taste, flavour and nutritional effects; even though research on this is virtually scarce. *Digera muricata* (*Kondhra*) leaves that grows as a weed on roadside and in every agricultural field of India, *Digera muricata* (Kondhra) leaves is a wild edible green leafy vegetable which belongs to the Amaranthacae family and is also known to be an important medicinal herb. During rainy season, this plant produces fairly large hairy leaves with flowers intriguing white mixed with pink or carmine red, making them easily recognizable in a natural habitat.

The consumption of *Digera muricata* (*Kondhra*) *leaves is* very limited in elite societies being neither prized in urban cuisine nor commercially exploited as food. Intense scientific exploration on the wild edible vegetable is thus highly needed not just to reduce gap between our traditional practice and contemporary life style but also to add necessary information regarding edibility of the vegetable. The effort to raise awareness may leave a permanent mark on economic activities as edible wild vegetables are retailed with lower prices in market than the cultivated vegetable due to their unique aroma and texture.

Vegetable soups dates to ancient history. Vegetable soup is the primary liquid food, which is generally served as warm or hot, and which is made from or prepared from combining green leafy vegetables as primary ingredients with water, stock and some thickening agents and fall under heterogenous category of foods. Hot soups are characterized by boiling solid ingredients such as green leafy vegetables, tomatoes mushrooms and roots as a main ingredient in liquids until the flavors are extracted. Basic ingredients in addition to vegetables can include vegetable stock, cream, water, pasta and noodles, vegetable oil, seasonings, salt and pepper etc. Vegetable soup is served as a starter or appetizer dish and also referred to as winter soup and country soup, is a traditional staple food and common dish during the months of December – January.

There are so many studies on soup but a few studies are available on fresh leaves vegetable soup. This study is intended to fill the gap by exploring the finding related to wild edible green

leafy vegetable soup. The aim of the study was to explore a formula of better wild edible green leafy vegetable soup, the impact of fresh soup on the content and specification of soup as a complete food.

2. Review of Related Literature

Vegetable soup is very popular in modern society. It is a one of the top foods which people like so much with another fast-food item. It is an important part of modern daily life style and is convenient to eat and fulfilling the consumers social requirements. (Goel *et al*., 2011) [3] Prepared vegetable soup with addition of gudmar leaves, bitter gourd fruit and fenugreek seeds mixture. The results found that elements increase sensory significantly with increasing nutritional advantages.

Usually there are two types of soups available *viz*. thick and clear soups. (Gupta *et al*., 2017) [4] Prepared soup with addition of kachnar leaves at different levels. The results clarified that soup were acceptable at different levels.

3. Materials and Methods

3.1 Raw material

Digera muricata (*Kondhra*) fresh leaves were collected from the agricultural fields of BPSMV University, Khanpur kalan, Sonipat (Haryana) and also from different sources including vegetable markets as per the requirements.

3.2 Chemicals

For the experiment the researcher approached for necessary analytical findings for testing in a laboratory of National and International repute to get best possible results on sample analysis and other experimental framework.

All chemicals used during investigation were of AR (Analytical Reagent) grade and obtained from standard suppliers. The testing of product was carried out at Referral laboratory of ICAR - National Dairy Research Institute, NDRI, Karnal.

3.3 Equipment's

All the equipment's used for the testing of the fresh leaves developed products are of high quality and standards.

3.4 Development and preparation of value-added food products

Wild edible green leafy vegetable under study was selected for value addition to traditional routine foods on the basis of easy availability and suitable for the particular recipe. The recipes selected were based on the methods of processing *viz*., fermentation, boiling, pan baking, shallow and deep fat frying. The main ingredient of the selected recipe was substituted with underutilized foods in varying levels (proportion) or incorporated additionally according to suitability to improve the nutritional quality in terms of energy, protein, iron and β-carotene.

Different value-added food products were developed by incorporating *Digera muricata* (*Kondhra*) fresh leaves by using various cooking methods by giving different treatments at different levels. The detailed method of preparation of product under study and the various proportions of materials and leaves used for the development of traditional product are as follows:

Table 1: *Digera muricata* (Kondhra) Soup

Ingredients	1	2	3	4
Tomatoes	100gm	97.5gm	95gm	92.5gm
Water	100gm	100gm	100gm	100gm
Salt, black pepper & cumin seeds	1gm	1gm	1gm	1gm
Cow ghee	1gm	1gm	1gm	1gm
Kondhra fresh green leaves	---	2.5gm	5gm	7.5gm

Process: Put sliced tomatoes in a pressure cooker, close the lid and keep it for boiling for 10 minutes and keep them for cooling. Then take a blender or grinder, grind the tomatoes in it. Take a pan add ghee, cumin seeds, salt and black pepper and put the pureed tomatoes in the pan. Boil it for some time. Healthy and yummy *Kondhra* soup is ready to serve. This procedure is followed with all the four treatments combinations as given in the above Table 1. The developed product has been shown in figure 2.

Fig 1: *Digera muricata* (Kondhra) leaves plant

Fig 2: *Digera muricata* (Kondhra) soup

Type 1: Control 100%
Type 2: 97.5% Tomatoes + 2.5% Kondhra fresh leaves
Type 3: 95% Tomatoes + 5% Kondhra fresh leaves
Type 4: 92.5% Tomatoes + 7.5% Kondhra fresh green leaves

3.5 Sensory Evaluation

The perception of food product is a combination of different senses that contribute to the sensory quality. These include characteristics like appearance, colour, texture, taste, aroma and overall acceptability of the product.

3.6 Development of score card
A 9-point Hedonic scale score card was developed to assess the organoleptic characteristics mainly based on the appearance and colour, taste, texture, aroma and overall acceptability for this value-added food product developed.

3.7 Selection of sensory panel
Ten judge's experts in quality testing, possessing good health and interested in sensory evaluation were selected from Department of Foods and Nutrition, B.P.S. Institute of Higher learning, BPSMV, Sonipat and to be evaluated individually. All the panel judges were females.

3.8 Sample presentation for sensory evaluation by judges
Before the presentation of the coded product, each product was placed in a sensory evaluation chamber with saline water to rinse the mouth. The selected panels were made to sit comfortably in the chamber and requested to score for different sensory characters according to their importance in evaluating the acceptability of the product on the score card (9-point hedonic scale). The evaluation scores for different characteristics were subjected to further statistical analysis.

3.9 Statistical Analysis
The obtained data was statistically analysed for analysis of variance (ANOVA), Karl Pearson's coefficient of correlation, Kendall's coefficient of concordance and Physicochemical properties to determine significant difference. Data has been analyzed using the IBM SPSS software, version 25 at the 5% level of significance ($\alpha = 0.05$).

3.10 Proximate Analysis
Parameters of the proximate analysis (crude fat and protein) was estimated by standard method of (AOAC, 2019) [1] of *Digera muricata* (*Kondhra*) leaves and as well as of the developed soup was analysed.

3.11 Total minerals
The most important total mineral Iron (Fe) was estimated by standard method of (AOAC, 2019) [1] by Inductively Coupled Plasma Mass Spectrometry (ICP -MS).

4. Results and Discussions
4.1 Physico chemical analysis of *Digera muricata* (*Kondhra*) leaves

Table 2: Proximate Analysis and Total Mineral content of sample *Digera muricata* (Kondhra) leaves

Protein (mg/100gm)	Fat (mg/100gm)	Iron (mg/100gm)
2.48	1.01	15.80

The table 2 shows that the estimate of protein level was 2.48mg/100gm and fat content only 1.01mg/100gm.
In the total mineral a very vital components that is Iron was estimated to be 15.80mg/100gm.
The above analysis indicated that the results in table 2, are well comparable with the estimates reported by (Neha *et al*. 2013; Rekha Vijayvergia., 2013).
As reported earlier, one of the major value-added products developed by the researcher on the basis of the use of *Digera muricata* (*Kondhra*) green leaves as main ingredient was Soup.

4.2 Soup
The soup was prepared with main ingredients of *Digera muricata* (*Kondhra*) leaves, tomatoes and the process of preparation was as per methodology discussed above. As per requirement and taste the ghee, cumin seeds, salt and black pepper were also added. When the product was ready it was subjected to sensory evaluation for its acceptance and it is worth mentioning here that the soup was prepared by taking four levels of *Digera muricata* (*Kondhra*) leaves that is control (0) level, 2.5gm, 5gm, 7.5gm giving four independent samples of value-added products.

4.3 Sensory evaluation
The standard technique was adopted to evaluate the product for its acceptance and a 9 - point hedonic scale was used to study various parameters namely: colour, appearance, flavour, texture and taste for all the four products as prepared above. Well qualified, experienced having good knowledge of tasting the product, ten judges were selected for the proper sensory evaluation of the products. It is worth mentioning their all the judges were females from the Institute of higher learning, BPSMV University, Khanpur Kalan, Sonipat. In other words, it could be mention that there was a homogenous group of judges involved in the sensory evaluation of the products. The acceptance scores were recorded by the judges on a well-tested score card.

4.4 Assessment of Quality
The scores given by judges on 9 – point hedonic scale, the overall acceptability was measured on the basis of total mean scores for all the four products as mentioned below:

Table 3: Overall mean sensory scores of the soup

Judges	Control	2.5	5	7.5
1	8.8	8.8	9	9
2	7	8	7.4	7.4
3	6.8	7	8	8.4
4	8.2	8.6	9	9
5	8.2	8.2	9	9
6	6.6	7	8	7.8
7	7.2	7.6	7.6	8
8	7.4	8	8	8.8
9	7.6	8.2	8.2	8.4
10	8	7.8	8.2	8.6
Mean scores	7.58	7.92	8.24	8.44

4.5 Correlation Analysis
The sensory evaluation was based on five parameters namely colour, appearance, flavour, texture and taste. In order to establish interrelationship between all these parameters correlation analysis was also carried out and inter correlations with the use of Karl Pearson's Coefficient of Correlation (r) was calculated as per formula given below:

$$r = \frac{\sum(X-\overline{X})(Y-\overline{Y})}{\sqrt{\sum(X-\overline{X})^2}\sqrt{(Y-\overline{Y})^2}}$$

Where, $\overline{X}$ = mean of X variable
$\overline{Y}$ = mean of Y variable

The results obtained for all possible inter correlations have been summarised in the form of a CORRELATION MATRIX for each product namely control, 2.5gm, 5gm,7.5gm *Digera muricata* (*Kondhra*) concentrations of green leaves in the product in the study that is SOUP.

Table 4: (A.B.C.D.) Correlation matrix for various characteristics of Digera muricata soup

4 (A).

Soup control	Colour	Appearance	Flavour	Texture	Taste
Colour	1				
Appearance	0.218	1			
Flavour	0.463	0.805**	1		
Texture	0.775**	0.433	0.602	1	
Taste	0.554	0.237	0.634*	0.674*	1
Mean Scores	7.6	7.7	7.6	7.8	7.2

4 (B).

Soup 2.5gm	Colour	Appearance	Flavour	Texture	Taste
Colour	1				
Appearance	0.916**	1			
Flavour	0.801**	0.836**	1		
Texture	0.345	0.368	0.553	1	
Taste	0.133	0.19	0.523	0.860**	1
Mean scores	7.8	7.9	8.1	8	7.8

4 (C).

Soup 5gm	Colour	Appearance	Flavour	Texture	Taste
Colour	1				
Appearance	0.655*	1			
Flavour	0.800**	0.553	1		
Texture	0.304	0.512	0.674*	1	
Taste	0.816**	0.458	0.904**	0.447	1
Mean scores	8.6	8.2	8.4	8.5	8.5

4 (D).

Soup 7.5gm	Colour	Appearance	Flavour	Texture	Taste
Colour	1				
Appearance	0.507	1			
Flavour	0.883**	0.512	1		
Texture	0.393	0.892**	0.573	1	
Taste	0.498	0.602	0.602	0.758*	1
Mean scores	8.1	8.3	8.3	8.4	8.1

4A. Control

It is evident from the correlation analysis carried out in correlation matrix Table 4A. that there exists a significant correlation between colour and texture 0.775 ($p< 0.05$), appearance and flavour 0.805 ($p< 0.05$), flavour and taste 0.634 ($p< 0.05$) and texture and taste 0.674 ($p< 0.05$). The analysis indicated that the significant correlation coefficients are good measures of studying the respective relationship between parameters under study. These all-correlation coefficients are positive.

4B. 2.5gm

The correlation matrix in Table 4B. indicates that there exists a very high intensity of relationship between colour and appearance and so also colour and flavour. The estimates of correlation coefficient are 0.916 ($p< 0.01$) and 0.80 ($p< 0.01$) respectively. Further it is interesting to note that flavour is having a good relationship r= 0.836 ($p< 0.01$), on the other hand the flavour is having non- significant correlations between texture and taste. The analysis further suggested that texture and taste are also showing good dependence on each other with correlation coefficient of 0.860 ($p< 0.01$).

4C. 5gm

It is evident from the Table 4C that the correlation analysis has proved a very good and significant relationship between colour and appearance 0.655 ($p< 0.05$), colour and flavour 0.800 ($p< 0.01$) and colour and taste 0.816 ($p< 0.01$), however there appears to be a poor relationship between colour and texture. Furthermore, for this product the relationship between flavour and texture 0.674 ($p< 0.05$) and flavour and taste 0.904 ($p< 0.01$) are equally important. The analysis further suggested that texture and taste were not so significantly related because of liquid form of the product.

4D. 7.5gm

The correlation analysis in Table 4D. for 7.5gm concentrations have shown significant correlation for colour and flavour 0.883 ($p< 0.01$), appearance and texture 0.892 ($p< 0.01$) and texture and taste 0.758 ($p< 0.05$). Rest of the analysis is self-explanatory in the respective table.

Concordance Analysis

The sensory evaluation of the product namely soup based on four levels of *Digera muricata* (*Kondhra*) leaves in green form that is 0, 2.5, 5, 7.5gm was carried out with the selection of 10 expert judges (all females) and the necessary analysis has been reported in the above tables. (Moroney, M.J., 1963) [5].

However, it is also necessary to verify that how close are these judges in giving the judgement of 9-point hedonic scale, further analysis was carried out to test the Null Hypotheses (H0):

Null Hypotheses (H0): There is no agreement among the judges.

Alternate Hypotheses (H1): All the judges are in full agreement.

To test above hypotheses Kendall's Coefficient of Concordance 'W' was calculated as under:

$$W = \frac{12S}{m^2(n^3 - n)}.$$

Where m = products, n = judges, S = sum of squares. (Moroney, M.J., 1963) [5].
The significance of the concordance coefficient (W) was tested by use of Chi-square test (χ^2). From the above formula the estimated value of W was found to be:

W = 0.731 and Chi-square (χ^2) = 21.923.

The Kendall's Coefficient of Concordance W was found to be highly significant ($p < 0.01$) and hence the NULL Hypotheses was rejected. It indicates that there exists a good agreement between all the judges selected for the sensory evaluation of the product under study as it evident from the Chi-square test.
The physicochemical properties of soup prepared corresponding to 4 treatment combinations namely control, 2.5gm, 5gm, 7.5gm addition of *Digera muricata* (*Kondhra*) leaves were subjected to laboratory analysis as per methodology adopted above in 4 replicates for each parameter. Thus, the statistical analysis corresponding to data generated in a table with four replicates and four treatments was carried out according to Two-way analysis of variance (ANOVA). The statistical model was: (George W. Snecdecor., 1989) [2].

$yij = \mu + \alpha i + \beta j + €ij$ ---------- I

where; yij= value of observation corresponding i^{th} row and j^{th} column
μ = overall mean
αi = effect of i^{th} replicate, i = 1 to 4
βj = effect of j^{th} replicate, j = 1 to 4.
€ij = random error

The analysis of variance results as per model above are discussed below in respect of:
1. Crude Fat (mg/100gm)
2. Crude Protein (mg/100gm)
3. Iron (mg/100gm)

The results of analysis carried out for crude fat, crude protein and iron content in food as per model stated above are summarised below in Table 5 (A, B).

Table 5: The results of analysis carried out for crude fat, crude protein and iron content in food as per model stated above are summarised below

5 (A).

Anova	**For**	**Protein**			**Fat**		
Source of variation	**Df**	**Ms**	**F**	**Cd**	**Ms**	**F**	**Cd**
Rows	3	0.00267	2.1818	0.055	0.023823	1.634739	0.193
Columns	3	0.01067	8.72727		1.02589	70.397	
Error	9	0.00122			0.014573		
Total	15						

5 (B).

Anova	**For**	**Iron**					
Source of variation	Df	Ms	F	Cd			
Rows	3	0.00316	137.727	0.024			
Columns	3	13.1876	57.5e+4				
Error	9	2.3e-05					
Total	15						

C.D: Critical Difference (5%)

5. A. Protein
Protein plays a vital role in the consumption of any food item and it was proper to analyse the protein content in soup prepared by the use of 3 levels i.e.; 2.5gm, 5gm and 7.5gm. It is suggested that the analysis proved that the hypotheses of no effect is being rejected and hence the protein content in three levels of supplementation are not having the same effect (F = 8.73, 3 & 9 d.f.: $p<0.05$). It could be safety inferred that the protein is quite effective in soup with the addition of *Digera muricata* (*Kondhra*) leaves at different levels.

5. A. Fat
Fat is an important component in any product and so also for soup. Accordingly, the ANOVA analysis was carried out for fat content in soup after the supplementation of 3 levels of *Digera muricata* (*Kondhra*) green leaves that is, 2.5gm, 5gm, 7.5gm. These levels differ significantly as shown by the analysis and hence it could be safely concluded that the effect of these 3 levels is not of the same order in the product prepared as soup (F = 70.4, 3 & 9 d.f.: $p<0.05$).

5. B. Iron
The basic purpose of the iron supplementation through *Digera muricata* (*Kondhra*) leaves in the product taken as soup is to increase the Fe level. However, the analysis of variance has suggested that all the 3 levels namely 2.5gm, 5gm and 7.5gm differ significantly. ($p < 0.05$). The replicates effects are also found to be significant.

5. Conclusion
Wild edible green leafy vegetable under study was selected for value addition to traditional routine foods on the basis of easy availability and suitable for the particular recipe. The recipes selected were based on the methods of processing *viz*., fermentation, boiling, pan baking, shallow and deep fat frying. The main ingredient of the selected recipe was substituted with underutilized foods in varying levels (proportion) or incorporated additionally according to suitability to improve the nutritional quality in terms of energy, protein, iron and β-carotene. The sensory evaluation of the product i.e., Soup has given a notion that the supplementation of 7.5gm of *Digera muricata* (*Kondhra*) leaves is well acceptable.

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