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Nutritional and mineral analysis of chamkora (*Colocasia esculenta*) and tarota (*Cassia tora*) wild indigenous green leafy vegetables

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Abstract
In the present research work carried out efforts have been made to evaluate chamkora (*Colocasia esculenta*) and tarota (*Cassia tora*) for nutritional and mineral profile. The nutritional evaluation revealed that the fat content was observed in chamkora leaves i.e. (0.74 %) and that for tarota is (0.37%). The crude fibre reported in chamkora was 2.10% and 2.83%. Highest calcium content was observed in chamkora (5.2 mg/100g) than tarota viz., (3.31 mg/100g). Phosphorus content was observed in tarota leaves i.e. (3.44 mg/100g) whereas chamkora leaves was observed as (2.92 mg/100g). Iron content was observed in chamkora leaves (0.57 mg/100g) than tarota leaves (0.38 mg/100g) which was higher than tarota leaves.

Keywords: Nutritional and mineral, indigenous green leafy vegetables, chamkora

Introduction
Green leafy vegetables (GLVs) are crucial to the food supply since they contain enough vitamins and minerals for humans. Ascorbic acid, carotenoids, riboflavin, folic acid, and minerals including calcium, magnesium, and phosphorus are all abundant in these. There are a variety of neglected green vegetables with enticing nutritional value found in nature that can satiate an expanding population. The majority of them are adaptable, sturdy, and responsive to unfavourable weather conditions. Unused goods are becoming more important today as a technique to increase the nutritional supply per person. One of the main causes of a vitamin A and iron deficiency is a high dietary intake of GLVs (Akubugwo, 2007) [3].

The biochemical and nutritional aspects of wild edible vegetables are crucial because they are the best sources of proteins, amino acids, carbohydrates, fibre, vitamins, minerals, and bioactive compounds, all of which are vital for health and actively prevent a variety of diseases, such as cancer, diabetes, coronary heart disease, etc (Saikia & Deka, 2013) [14], (Aregheore, 2012) [5].

Taro, which is included in the genus *Colocasia*, is an aroid (Aracaceae) plant. For its underground corms, it is widely grown around the world (Njintang *et al*., 2007) [13]. The taro plant grows best in soil with a pH of 5.5–5.6, a high humidity level, 1000 mm of annual rainfall, and an ideal temperature range of 21–27 °C (Anonymus, 1999) [4]. India and other Southeast Asian countries with wet tropical rainforests are where taro is native. According to several scholars, it is impossible to pinpoint the origin of taro to a single location (Lebot, 1999) [11]. Africa produces the most of the world's taro, followed by Asia, Oceania, and then Asia. China, Japan, the Philippines, and Thailand are the top producers in Asia, while Papua New Guinea, Samoa, the Solomon Islands, Tonga, and Fiji are the top producers in Oceania (FAO, 1999) [7].

A semi-wild annual herb known as *Cassia tora* Linn. (Caesalpinaceae) is widely cultivated throughout south-east Asia, including India, Northern Australia, and the Americas. This plant species is well known for having potential in conventional medical treatments for a range of problems and illnesses, from minor coughs to diabetes and hypertension. Recent scientific research has revealed the phytochemical and biological potential of this substance. The therapeutic value of C. tora has been established due to its antibacterial, antioxidative, antihypertensive, antidiabetic, and antimutagenic properties, to name a few. This essay provides a thorough analysis of *Cassia tora* L.'s phytochemical and biological properties (Sarwa *et al*., 2012) [15].

Materials and Methods

Physical properties of GLVs and yield

The physical properties of leaves such as length, width and thickness were determined by using a digital vernier calliper. The weight of leaves determined by stacking 10 leaves and colour was visually determined.

Yield of fresh leaves was determined in percentage by calculating the weight of edible portion and waste portion.

Proximate and mineral composition

Estimation of moisture

It was worked out by weighing 5g sample accurately and subjecting to oven drying at 105 °C for 4-6 hrs. Oven dried samples were cooled in desiccator and weighed. The drying was repeated until the constant weights were obtained. The resultant loss in weight was calculated as per cent moisture content. (A.O.A.C., 2000).

$$\text{Moisture (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Total weight of sample}} \times 100$$

Estimation of crude fat

5 g of ground sample was weighed accurately in thimble and extracted with petroleum ether (60-80 °C) in K plus Soxhlet apparatus for 6-8 h. The resultant ether extract was evaporated and crude fat was calculated (A.O.A.C., 2000).

$$\text{Crude fat (\%)} = \frac{\text{Final weight of flask} - \text{Empty weight of flask}}{\text{Weight of sample}} \text{x } 100$$

Estimation of crude protein

Protein content was determined by Micro-kjeldhal method using 200 mg of sample by digesting the same with concentrated sulfuric acid containing 1 g of catalyst mixture for 2-3 h at 100°C. Then it was distilled with 40% NaOH and liberated ammonia was trapped in 4% Boric acid and then it was titrated against 0.1N HCl using mixed indicator (Methyl red: Bromocrysol green1: 5) Then % Nitrogen was calculated by formula and % protein was estimated in sample by multiplying with factor 6.25 (A.O.A.C., 2000).

$$\text{\% N} = \frac{\text{(Sample-blank)} \times \text{Normality of Hcl} \times \text{vol. made for distillation} \times 0.014 \times 100}{\text{Aliquot taken for distillation (ml)} \times \text{weight of sample (g)}}$$

% Protein = % N × 6.25

Estimation of total ash

5 g of finely ground sample was weighed in silica crucible and ignited on low flame. Then it was transferred to muffle furnace and heated at 550 °C for 5-6 h for complete oxidation of organic matter and resultant ash content was calculated (A.O.A.C., 2000).

$$\text{Total ash (\%)} = \frac{\text{Weight of crucible with ash} - \text{Weight of empty crucible}}{\text{Weight of sample (g)}} \text{x } 100$$

Determination of carbohydrate content

The sample was accurately weighed (0.5 g) in the test tube and kept for a few minutes in ice water bath followed by the addition of cold H_2SO_4 (72 per cent) with gentle agitation. The viscous paste was combined with distilled water to get final acid concentration of 2 N. This was then refluxed to attain complete hydrolysis at 980C for 3-4 hours. Phenol-H_2SO_4 process estimated the sugar amount using glucose as standard. On spectrophotometer the orange yellow colour was read at 480 nm. The calibrated curve measured the sugar concentration in hydrolysate and quantified the percentage of total sugar in the sample (Ranganna, 2011).

Estimation of crude fibre

About 2-5 g of moisture and fat free sample was weighed into 500 ml beaker and 200 ml boiling 0.25 N (1.25w/v) Sulfuric acid was added. The mixture was boiled for 30 min keeping the volume constant by addition of water at frequent intervals. At the end of this period the mixture was filtered through a filter paper and residue was washed with hot water till it becomes free from acid. The material then transferred to the same beaker and 200ml of boiling 0.313N NaOH solution was added. After boiling for 30 min the mixture was filtered through filter paper. The residue was washed with hot water till free from alkali followed with some alcohol. It was then transferred to crucible, dried overnight at 80-100 °C and weighed. The crucible was heated in muffle furnace at 550-600 °C for 2-3 h and cooled and weighed again. The difference in weights represents the wt of crude fiber. (A.O.A.C., 2000).

Analysis of minerals

Mineral content of vegetables was estimated by method given by Ranganna, (2011).

Estimation of phosphorous

Spectrophotometric method was used to determine phosphorus content. With dry ashing, 5 ml of ash solution was collected. In ash solution 5 mL of molybdate reagent was added and mixed. Then 2 ml of a solution of aminonaphthol sulphonic acid was mixed and made volume up to 50 ml. Instead of sample a separate blank was prepared using water. The solutions were expected to stand for 10 minutes and colour was measured at 650 nm by setting the blank transmission to 100 per cent.

$$\text{Phosphorous (mg/100g)} = \frac{\text{Mg of phosphorous in aliquot x total volume of x 100 taken for Estimation ash solution}}{\text{Ml of ash solution taken for estimation x weight of sample}}$$

Estimation of calcium

Calcium was measured with titrimetric method. Aliquot of 25 ml of mineral solution was taken and dissolve in distilled water to make 150 ml final volume. In this solution, add 2-3 drops of methyl red indicator. Strong ammonia has been applied to neutralize the solution that converts pink to gold. The mixture was then permitted to heat for a few minutes, adding 10 ml of ammonium oxalate. Mixture was boiled again for 2 minutes, adding glacial acetic acid until the colour becomes pink. The mixture was held aside in a warm position (overnight) and the supernatant was evaluated with a drop of ammonium oxalate as precipitate settled to verify precipitation was achieved.

Precipitate was filtered with filter paper with Whatman No.4, then washed with warm distilled water. The precipitate was transferred to a beaker by making a hole in the filter paper centre and twice giving H_2SO_4 washings (2 N, 5ml). The solution was then heated to 70˚C and titrated to 1 N/100 $KMnO_4$. Titration endpoint was persistent pink colour. A blank was run at the same time.

1 ml of 0.01N $KMnO_4$ = 0.2004 mg calcium

Estimation of iron

Iron content of vegetables was determined by using a-a, dipyridyl method AOAC (1990). Accurately take 10 ml of wet digested wild vegetables sample solution into volumetric flask of 25 ml capacity by pipetting in triplicate. Hydroxylamine hydrochloride solution (1 ml), acetate buffer solution (5 ml) and a-a, dipyridyl solution (2 ml) were added into each volumetric flask. By using distilled water made up the volume to 25 ml and mix the content. The developed color intensity was read in spetronic 20 at 510 nm. Iron content of the digested wild vegetables sample solution was read from the standard curve of known iron concentration.

Standard curve preparation

Take 0.0, 0.5, 1.0, 1.5, 2.0, 3.0 and 4.0 ml of standard solution of iron in to a series of 25 ml volumetric flasks and add to each of them flask accurately 0.2 ml of concentrated hydrochloride solution. Dilute each sample with distilled water to exactly 10 ml, then add chemicals in the same way as for the sample, Plot the quantity of iron in mg against the spectrophotometric absorbance (I.C.M.R., 1990).

$$\text{Iron content} = \frac{\text{Quantity of Fe in aliquot (Calibration curve)}}{\text{Aliquot of ash solution taken}} \times \frac{\text{Total volume of ash solution}}{\text{Wt. of the sample}} \times 100$$

Estimation of copper and zinc

By using Atomic Absorption Spectrophotometer (AAS) from the department of Soil Science and Agricultural Chemistry, College of Agriculture, VNMKV, Parbhani examined the copper, manganese and zinc.

Results and Discussions

Physical properties of fresh green leafy vegetables

The physical properties of wild vegetables chamkora and tarot were studied and average values were tabulated in table 1.

Table 1: Physical properties of fresh green leafy vegetables (GLV)

Physical parameter	Chamkora	Tarota
Colour	Green	Dark green
Length (mm)	300	45
Width (mm)	160	12.7
Thickness (mm)	1.25	1.78
Wt/10 leaves (g)	40	7

*Each value is average of three determinations.

The data presented in table 1 showed the physical properties of wild vegetables. The color of chamkora and tarota leaves were green and dark green. The length of chamkora and tarota leaves were 300 and 45 mm respectively. The width of chamkora and tarota leaves were 160 and 12.7 mm respectively. The thickness of chamkora and tarota leaves were 1.25, and 1.78 mm respectively. The weight of chamkora and tarota leaves per 10 pieces of leaves were 40 and 7 g respectively. The similar results were obtained with Agarwal *et al*., (2013) [1] with respect to morphological characteristics of green leafy vegetables.

Yield of fresh green leafy vegetables

The dried indigenous vegetables were grinded to get powder and per cent yield of dehydrated indigenous vegetables powder is summarized in table 2.

Table 2: Yield of fresh green leafy vegetables

Parameter	Total weight (g)	Total weight of waste (g)	Total weight edible part (g)	Percent yield (%)
Chamkora	1000g	360	640	64
Tarota	1000g	470	530	53

*Each value is average of three determinations

The data presented in table 2 showed the per cent yield of chamkora and tarota leaves. It was observed that percent yield of chamkora (1 kg) was 64 % and that from tarota was observed as 53 %.

Proximate composition of green leafy vegetables

Proximate composition generally shows the nutritional quality of food product. It is important to know the proximate composition of green leafy vegetables leaves to judge its nutritional quality. The results obtained were presented in Table 3.

Table 3: Proximate composition of fresh green leafy vegetables

Green leafy vegetables	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Fibre (%)	Carbohydrates (%)
Chamkora	87.88	0.74	2.10	0.74	2.10	5.50
Tarota	85.68	0.37	3.61	0.80	2.83	5.83

*Each value is average of three determinations

The data obtained from table 3 showed the proximate composition of fresh green leafy vegetables. The highest moisture content was observed in chamkora leaves i.e (87.88 %) whereas tarota leaves has about (85.68%). The presence of high moisture in leafy vegetables makes them available for microbial growth and development which results in the spoilage of green leafy vegetables. Drying of leafy vegetable results in decreasing moisture content of leaves to large extent therefore making them unavailable for microbial growth and hence shelf life of dried products gets increased.

The fat content was observed in chamkora leaves i.e. (0.74 %) and that for tarota is (0.37%). The amount of protein present in fresh green leafy vegetables leaves showed that the plant can form a part of human diet. Highest protein content was observed in tarota leaves (3.61 %) than chamkora leaves i.e., (2.10 %).

The carbohydrate offers energy in the form of calories. Highest carbohydrate content was observed in tarota leaves i.e. (5.83 %) than chamkora leaves. The carbohydrate content observed in chamkora leaves was (5.50 %).

The ash is an inorganic content which gets after complete burning of any food commodity. The ash content gives the mineral content of the food products. The tarota leaves contained high amount of ash i.e. (0.8 %). Ash content in chamkora leaves was found to be (0.74%).

The similar result was obtained by research finding of Funke (2011) [8] who stated that nutritional composition of cooked amaranth leaves processed by different methods. Ahmad *et al*. (2015) [2] also concluded that the nutritional value and biologically active components of fenugreek leaves appreciated by medical science. The results of proximate composition of Amarathus Spinosus were similar to results obtained by Kadbhane *et al*., (2019) [10] who studied proximate composition of Amarathus Spinosus powder.

Mineral composition of fresh green leafy vegetables

Mineral content of green leafy vegetable leaves is essential in justifying its nutritional quality. Phosphorous, calcium, iron,

copper and zinc were studied in present research work. The results related to mineral content of green leafy vegetable leaves are presented in Table 4.

Table 4: Mineral composition of fresh green leafy vegetables

Green leafy vegetables	Calcium (mg/100g)	Phosphorous (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)	Copper (mg/100g)
Chamkora	5.20	2.92	0.57	2.23	1.01
Tarota	3.31	3.44	0.38	1.17	0.56

The mineral analysis of fresh green leafy vegetables from table 4 revealed various major and trace elements like calcium, phosphorous, iron, zinc, copper. Hightest calcium content was observed in chamkora (5.2 mg/100g) than tarota *viz*., (3.31 mg/100g). The results of calcium content suggests that the leaves may have greater physiological significance to cure diseases related to bone system.

Highest phosphorus content was observed in tarota leaves i.e. (3.44 mg/100g) whereas chamkora leaves was observed as (2.92 mg/100g). The phosphorus helps in bone formation, energy metabolism and metabolism of nucleic acid (Murray *et al*., 2003) [12].

The body uses iron to make hemoglobin, a protein in red blood cells that carries oxygen from the lungs to all parts of the body, and myoglobin, a protein that provides oxygen to muscles. (Chandra, 1990) [6]. Highest iron content was observed in chamkora leaves (0.57 mg/100g) than tarota leaves (0.38 mg/100g).

The copper contents of chamkora and tarota are 1.01 and 0.567 mg/100g respectively.

The results of minerals content of green leafy vegetables were found to be similar with the research finding of Golaszewska and Wierzbowska (2017) [9].

Conclusion

The present research work carried out focused on proximate composition of green leafy vegetables chamkora and tarota (*Cassia tora*). The chamkora (*Colocasia esculenta*) leaves were found higher in fat content whereas tarota leaves were higher in protein and fibre content. In all the mineral content chamkora leaves were found superior over tarota leaves.

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