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A study on nutritional value of some leafy vegetables of Bhubaneswar, Odisha, India

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ABSTRACT

Humans established relations with food for their existence on earth. In various parts of the world, different types of vegetation are used as food material. To overcome the crises in food, the alternative source of food may be the direct product of plants which can be consumed in raw condition. Considering the growing need to identify the alternative sources, most of the people are consuming leafy vegetables as major food source. To see the nutritional importance of leafy vegetables, most are cultivating now a days for both as food and their livelihood. A small work was conceptualized and undergone by the BSc final year students of the Biotechnology department, NIIS Institute of Information Science and Management, Bhubaneswar. The present study evaluated the moisture content, total protein and total carbohydrate content in common leafy vegetables used in Odisha. Total protein was estimated by Lowry method, while total carbohydrate and free amino acid content by anthrone method and spectrophotometric method. The result showed highest protein contained in *Spinacia oleracea* (103.98 ± 2.34 µg/mg) followed by *Moringa olerifera* (99.86 ± 2.32 µg/mg), *Centella asiatica* (95.53 ± 2.78 µg/mg). The highest carbohydrate content was observed in the leaf of *Amaranthus viridis* (116.26 ± 2.33 µg/mg of plant tissue) followed by *Ipomoea aquatica* with carbohydrate content (82.35 ± 1.55 µg/mg), *Basella alba* with carbohydrate content (50.46 ± 2.23 µg/mg), and highest moisture content was recorded in the leaves of (89.57 ± 18.44%) followed by *Spinacia oleracea* (89.32 ± 19.12%), and lowest in *Bauhinia purpurea* (30.45 ± 15.55%). The study's finding confirmed that wild leafy vegetables are having potential nutritional value and these can be cultivated for commercialization purpose. The cultivation of these leafy vegetable plays a significant role in their livelihood and sustainability. As per the data reported, more than one million people of this region suffer from malnutrition so

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present study is an approach to overcome the health issue of people of this region in a sustainable manner.

Key words: Nutrition; vegetable; Carbohydrate; Protein

Introduction

Consumption of green vegetables is a major source of vitamins and micro-nutrients for People using only vegetarian diets rich in carbohydrates. In rural settlements where vegetable cultivation is not practiced and market supplies are not organized, local inhabitants depend on indigenous vegetables, both cultivated in kitchen gardens and wild, for enriching the diversity of food. Knowledge on such foods is part of traditional knowledge which is largely transmitted through each and every Households. Many surveys have concluded that many villages people have the proper knowledge of both wild and cultivated species of vegetables. Most of the popular vegetables that we know of are recent introductions in our kitchens. Indians have been eating wild vegetables for thousands of years, but unfortunately, we lost the track somewhere at the dawn of modern times. Tribals and rural Indians still value these wild vegetables. The use of wild plants as food is an integral part of the culture and tradition of many indigenous communities around the world.

Nature has provided different life forms on which humans survive on Earth. Primitive humans ate all types of fruits, Leaves and roots of plants collecting from wild, before he learnt to grow useful plants. Living out of nature, human selected plants those are edible and identified plants those are unsuitable for consumption. The hunter-gatherers subsequently discovered that by planting seeds, plants could be grown that would give them food. People in many developing countries depend on wild resources including wild edible plants to meet their food need especially in period of food crisis. Vegetables are the fresh and edible portions of herbaceous plants, which can be eaten raw or cooked [1]. In many tropical countries, rural people traditionally harvest wide range of leafy vegetables, roots, tubers, fruits from wild because of its taste, cultural uses, as food supplements or to tide over food shortage. Labeled as famine or hunger food, wild plants have been recognised to have potential to meet household food and income security [2 & 3].

Leafy vegetables are valued mainly for their high carbohydrate, vitamin and mineral contents. Vegetables may be edible roots, stems, leaves, fruits or seeds. Each group contributes to diet in its own way [4]. Green leafy vegetables have long been recognized as most abundant sources of protein and vitamins [5 & 6]. An Antioxidant vitamin like ascorbic acid is important in human food since they function as an anticancer agent [7]. Many leafy vegetables notably, Amaranthus, spinach, Moringa, Ipomea, Corella, Neem, Bauhinia and others species have been cultivated and consumed for centuries across Indian subcontinent on account of its food and medicinal properties. Many leafy vegetables especially, amaranths and spinach have attained commercial status and its cultivation is wide spread in India. Because of their low production cost and high yield, leafy vegetables are considered to be one of the cheapest vegetables in the market and it could be rightly described as ‘poor man’s vegetables’. Leafy vegetables are considered as primary food class and regular ingredient in the diet of tribal people of Odisha because this leafy vegetable can provide appreciable amount of nutrients in comparison to other fruit and seed plants.

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A large section of the rural population meets their nutritional requirement through unconventional means, by consuming various wild plants. Now a days, many rural people started cultivation of wild leafy vegetables and that is our main reason of studying this topic as we want to distinguish the proximate value of some wild and cultivated species found in and around Bhubaneswar, Odisha. Our topic is mainly focused on the nutritional value like Protein, Carbohydrate and moisture content of different leafy vegetables which are consumed by the people of Bhubaneswar, Odisha.

Materials and Methods

Plant material:

For the present study, 10 individuals of wild and cultivated leafy vegetables were collected from in and around of Bhubaneswar. Most of the wild leafy vegetables were collected from Deras, Chandaka wild life, Bhubaneswar and rest cultivated were taken from Iginia, Kolathia and Khandagiri, Bhubaneswar. Details of the species are provided below.

Table-1: Details of the samples collected for present study

Sl No.	Type	Location	Species Name	Vernacular/ Odia Name	Family
1	Wild	Deras	*Centella asiatica*	Thalkudi Saaga	Apiaceae
2	Wild	Chandaka	*Crotalaria pallida*	Crotalaria Saaga	Fabaceae
3	Wild	Deras	*Bauhinia purpurea*	Kanchana/ Barudi Saaga	Fabaceae
4	Cultivated	Khandagiri	*Moringa oleifera*	Sajana Saaga	Moringaceae
5	Cultivated	Iginia	*Coriandrum sativum*	Dhania Saaga	Apiaceae
6	Cultivated	Kolathia	*Ipomoea aquatica*	Kalama Saaga	Convolvulaceae
7	Cultivated	Iginia	*Basella alba*	Poi Saaga	Basallaceae
8	Cultivated	Iginia	*Spinacia oleracea*	Palanga Saaga	Amaranthaceae
9	Cultivated	Iginia	*Cucurbita maxima*	Kakharu Saaga	Cucrbitaceae
10	Cultivated	Iginia	*Amaranthus viridis*	Khada Saaga	Amaranthaceae

Processing of Plant:

Individual samples are collected in two different zip lock for taking the fresh weight and another for protein extraction. Then fresh weight taken samples are kept in a hot air oven at 70° C for 24-48 hrs to read the dry weight. Other zip lock samples are immediately taken for protein extraction by using standard protocol.

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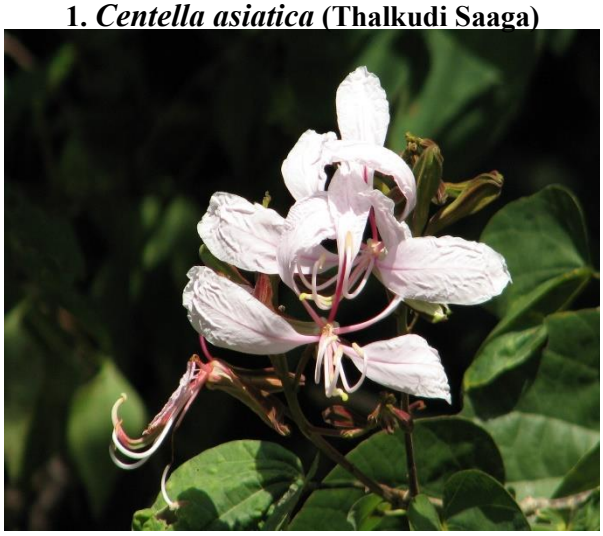
1. ***Centella asiatica*** **(Thalkudi Saaga)**

2. ***Crotalaria pallida*** **(Suni Saaga)**



3. ***Bauhinia purpurea*** **(Barudi Saaga)**

4. ***Moringa oleifera*** **(Sajana Saaga)**

5. ***Coriandrum sativum*** **(Dhania Saaga)**

6. ***Ipomoea aquatica*** **(Kalama Saaga)**

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7. *Basella alba* (Poi Saaga)

8. *Spinacia oleracea* (Palanga Saaga)

9. *Cucurbita maxima* (Kakharu Saaga)

10. *Amaranthus viridis* (Khada Saaga)

Fig-1: Photographs of species taken for the study

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Fig-2: Photographs of field work and wild samples collection

Equipment used in this study:

The instruments used in this study were given below

a. Weighing Balance
b. Vertex
c. Spectrophotometer
d. Water bath
e. Centrifuge
f. Hot Air oven
g. Micropipette

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d. Weighing Balance | c. Vertex | b. Spectrophotometer

e. Water-Bath | a. Centrifuge | f. Hot Air Oven

g. Micropipette

Fig-3: Photographs of equipments used in our work

Nutritional value

i. Moisture content:

All 10 individual samples were collected and taken the fresh weight of all individuals. The moisture content of the leaf samples were determined by keeping the sample in hot air oven at 70°

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C for a constant weight. After taking the dry weight of all individuals, the moisture content was measured by using the below formula and it is calculated in percentage.

Moisture content (%) = [(Wet weight- Dry weight)/ Wet weight] ×100

ii. Carbohydrate estimation:

A. Carbohydrate extract

- Plant extracts were prepared as described by Yemm & Willis (1954). 100 mg of dried leaves were extracted with 10 ml of 80% (v/v) ethanol by keeping it in water bath at 60-70° C for 20 mins with shaking at 2 mins intervals and cooled it to room temperature. Then centrifuged the sample at 4000 rpm for 10 mins and the supernatant was collected into a new 50ml tube. The extraction procedure was repeated for three times with 80% (v/v) ethanol and collected the supernatants.

B. Preparation of reagent.

(i) Anthrone was prepared as described by Trevelyan & Harrison (1952) by dissolving 0.2 g. of anthrone in 100 ml. of conc. H_2SO_4. This reagent was prepared fresh each time prior to use. The reagent was allowed to stand for 30-40 min. with occasional shaking until it was perfectly clear.

(ii) Glucose stock solution: 200µg glucose per mL distilled water.

Procedure:

1. Pipette out into a series of test tubes different volumes of glucose solution from the supplied stock solution (200µg /ml) and make up the volume to 1 mL with distilled water.
2. Consider tube 1 as blank and tubes 2 through 9 for construction of a standard curve.
3. To each tube add 5 mL of the anthrone reagent (supplied) and mix well by vertexing.
4. Cool the tubes.
5. Cover the tubes with marbles/ Caps on top and incubate at 90° C for 20 minutes or Boiling water bath for 10 minutes.
6. Cool to room temperature and measure the optical density at 620 nm against a blank.
7. Prepare a standard curve of absorbance vs. µg glucose.

iii. Protein estimation:

A. Protein extract

- 1-1.5g of individual leaves were weighed and taken in a chilled mortar and pestle harvested from test plants. Added 1ml of protein extraction buffer (Tris-Cl:10mM; EDTA: 10mM; β-Mercaptoethanol: 5mM; PMSF: 0.1 mg/ml) per gram of leaf in a cold mortar and pestle and grinded the tissue in the until a thick paste is produced. Then, the paste was collected in a 1.5ml micro centrifuge tube and centrifuged for 20 minutes at 12000 rpm at 4°C.
- Finally, the supernatant was transferred to another new 1.5 ml micro centrifuge tube and kept in 4°C refrigerator.

B. Preparation of reagent

i. Alkaline sodium carbonate solution:

2% of Na_2CO_3 was dissolved in 0.1 normal of NaOH. 20gm of Na2CO3 and 4gm of NaOH dissolved in 1000ml of distilled water. 0.5% copper sulphate solution. 0.5gm copper sulphate

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was dissolved in 100 ml of distilled water. 1% sodium potassium tartarate solution. 1gm sodium potassium tartarate was dissolved in 100 ml of distilled water.

ii. Folin –ciocaltece phenol reagent:

It was diluted 3 times before use. Its composition is sodium. Molybdate and sodium tungstate in phosphoric acid and sulphuric acid.

iii. Standard protein Bovine Serum Albumin (BSA) solution (1mg/ml):

10 mg of BSA was dissolved in 10 ml of distilled water. Before use the stock solution was diluted to 2 time (1ml of stock solution + 1ml of distilled water). the concentration of BSA is 500 µg/ml.

iv. Alkaline burette reagent:

It was prepared just before use. To 100 of alkaline sodium carbonate solution 2ml of copper sulphate and 2ml of sodium potassium tartarate solution was added to it and mixed thoroughly.

Procedure:

The tubes were cleaned and dried properly.

1. Pipette out the different concentration of standard glucose solution was taken in to test tubes marked as a 1,1', 2, 2', 3, 3', 4, 4', 5, 5' like this respectively.
2. The volume was made up to 0.5 ml by adding distilled water.
3. Simultaneously in blank test tubes 0.5ml of distilled water and 0.5ml of folin-ciocalteu phenol reagent and 5ml of biuret reagent was taken.
4. The test tubes were mixed thoroughly and allow to stand for 30min at room temp.
5. Then the absorbance was taken at 620 nm.
6. A standard graph was prepared by taking concentration of BSA (µg/ml).

Result

Moisture content:

From the result, it is observed that all the selected fresh leaf samples analyzed registered much moisture with a maximum of 89.57% in *Basella alba* and minimum of 30.45% in *Bauhinia purpurea.* The moisture content analysed showed that *Spinacia oleracea, Ipomea aquatica, Amaranthus viridis, Coriandrum sativum, Centella asiatica, Cucurbita maxima, Moringa oleifera, Crotalaria pallida* are resulted 89.32%, 88.63%, 87.93%, 84.67%, 78.73%, 76.84%, 75.96%, 52.92% respectively.

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Fig-4: Photographs of Sample processing and taking dry weight for moisture content

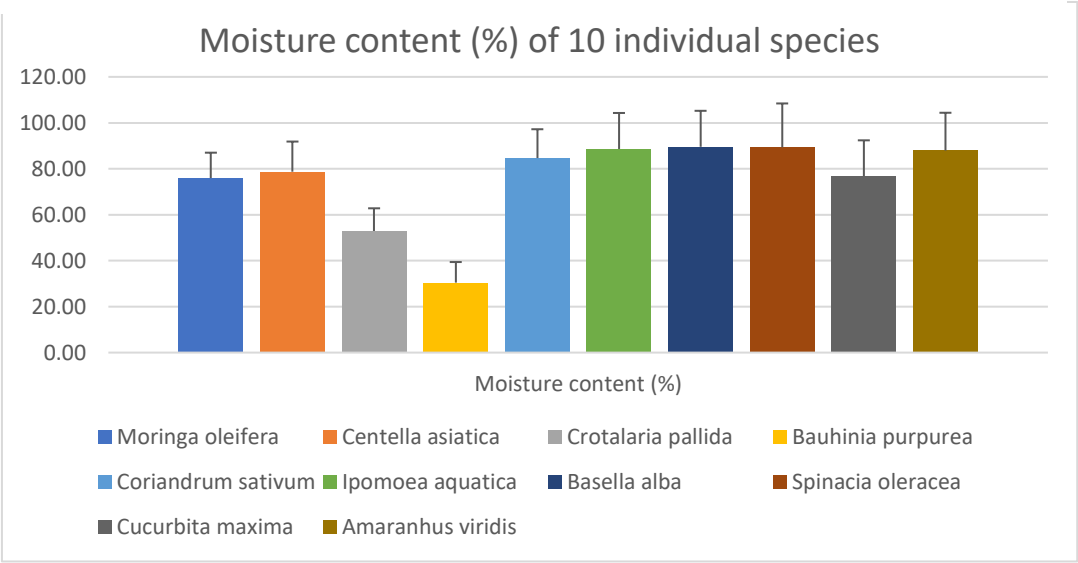

Fig-5: Histogram of moisture content of 10 Samples

Carbohydrate estimation:

Among the 10 leafy vegetables studied, *Spinacia oleracea* (327.55±10.77 µg/ml) resulted the highest total sugar content and the lowest value was shown by *Ipomoea aquatica* (68.78±2.42 µg/ml). Among the other leafy vegetables analyzed, *Moringa oleifera* (134.62±2.39 µg/ml) followed by *Basella alba* (130.47±9.89 µg/ml), *Coriandrum sativum* (118.78±3.23 µg/ml), *Bauhinia purpurea* (101.85 ±2.91 µg/ml), *Centella asiatica* (96.62 ±3.12 µg/ml), *Amaranthus viridis* (89.55±10.97 µg/ml), *Cucurbita maxima* (77.24±9.59 µg/ml), *Crotalaria pallida* (76.32±3.07 µg/ml) were shown good quantity of total sugar.

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Fig-6: Lab work for Total sugar estimation

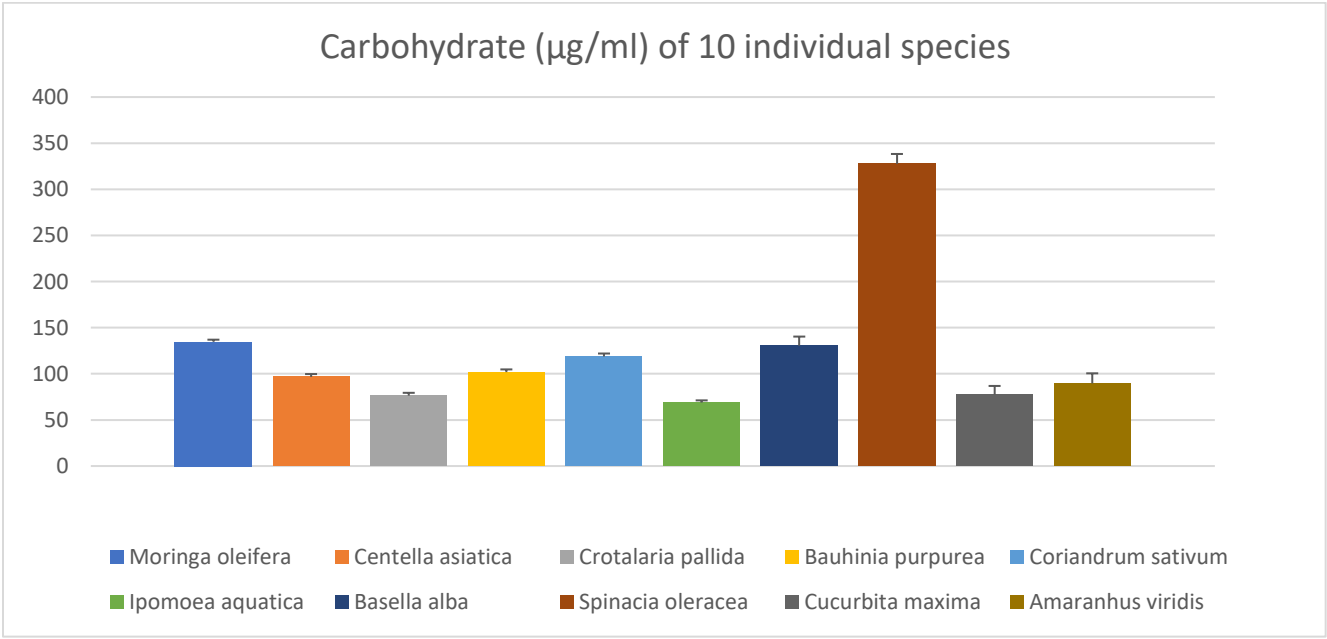

Fig-7: Histogram for Total sugar estimation

Protein estimation:

All the samples showed adequate amount of protein and cultivated species were shown more significant as compare to wild species. Highest and lowest value of protein were found in *Spinacia oleracea* (300.21±7.56 µg/ml) and *Bauhinia purpurea* (62.21 ±4.35 µg/ml) respectively. In rest 8

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species, the protein values were 287.27±6.10 µg/ml, 267.27±9.09 µg/ml, 229.39±6.66 µg/ml, 177.27±5.55 µg/ml, 173.51±7.47 µg/ml, 168.68±5.84 µg/ml, 85.98±5.44 µg/ml and 81.39±7.25 µg/ml in *Amaranthus viridis*, *Basella alba*, *Cucurbita maxima*, *Coriandrum sativum*, *Moringa oleifera*, *Ipomoea aquatica*, *Centella asiatica*, *Crotalaria pallida* respectively.

Fig-8: Lab work for Protein estimation

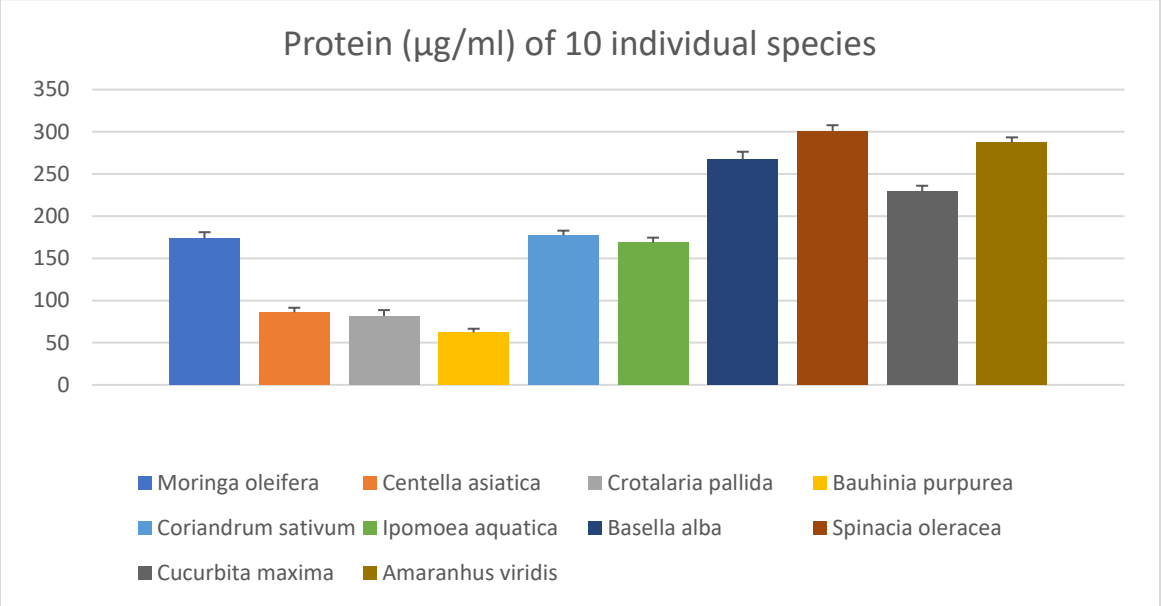

Fig-9: Histogram for Protein estimation

Discussion

Some of the differences in the nutritional values compared to others may be due to factors such as climate, species, and nature of soil, growing conditions, application of natural or artificial manure and the period of analysis. All the selected leafy vegetables have high percentage of moisture content. However, leaf of *Basella alba* showed the highest moisture content. These leafy vegetables provide required amount of moisture to the humans as water is the most important nutrient and the most abundant substance in the human body. In addition, water is needed to separate (by a process called hydrolysis) a phosphate group from adenosine triphosphate (ATP) or guanosine triphosphate (GTP) to get energy [2]. The high moisture content of vegetables makes them to aid the digestion of food. Their life span is very short because the high moisture facilitates bacterial action resulting into spoilage [10].

All the selected leafy vegetables reported in this study contain high amount of crude protein. However, leaf of *Spinacia oleracea* contains highest crude protein which indicates that the vegetables can be used for building and repairing of body tissue, regulation of body process and formation of enzyme and hormones. Proteins also aid in the formation of antibodies that enable the body to fight infection. Protein serves as a major energy supplier [23]. It had been reported that *Spinacia oleracea* is a non conventional food with substantial nutritional value [24]. For all age

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group, leaves of *Moringa oleifera* serve as a valuable source of nutrient [25]. Fresh leaf of *Spinacia oleracea* contains at least twice more proteins than milk and half the protein of eggs [26, 27].
The leaves of *Spinacia oleracea* also stand to be the highest estimated total sugar content followed by other selected leafy vegetable studied which indicate that it plays a key role in central metabolic pathway of the body. They also provide stored form of energy as glycogen in liver and muscles [28].
Spinacia oleracea and *Moringa oleifera,* taken as food, is also helpful to relief constipation and rheumatic pain [16]. *Ipomoea aquatica* acts as a blood purifier and cure gonorrhoea [34]. *Amaranthus viridis,* a common leafy vegetable plant of Odisha, important for human nutrition, act as a growth promoter and helps in maintenance and repair of body tissue [35]. Leafy vegetable *Bauhinia purpurea* is used in the treatment of diarrhoea [36]. *Centella asiatica*, a leafy vegetable, is taken internally for curing asthma and cough and brain development [34]. The leaves of *Basella alba* pounded with egg albumin are applied externally as a plaster on bone fracture [36]. *Crotalaria pallida* leaf is used in case of diarrhoea, dysentery and acute abdominal pain [37]. *Coriandrum sativum* is used as leafy vegetable; the decoction of leaf is given to children as an antihelmentic [39]. In *Moringa oleifera*, the leaf powder is used as a dietary supplement for pregnant and lactation women to increase milk production and expel intestinal worms [33]. Traditionally, fresh and dried *Moringa oleifera* leaves treat different ailments such as anaemia, abnormal blood pressure, headache, chest congestion, glandular swelling, sprain, joint pain, pimples and psoriasis [38].

Conclusion

In this study the analysis and observation noted and concluded that all the edible leafy vegetable plants collected from in and around Bhubaneswar, Odisha contain adequate amount of nutrients which are readily available in market and also in wild. Hence, they could be consumed to supplement the scarce or non-available sources of nutrients to the tribal and poor rural people. The carbohydrate, protein and moisture contents of these leafy vegetables are not enough to satisfy the recommended dietary allowances. Therefore, these cannot be considered a total substitute for the staple food we consume daily but rather they can be used as sources of additional organic nutrients in our daily meals. The loss or lack of these organic nutrients in the diet of human can be taken care of by generous consumption of green leafy vegetables because of their invaluable health benefits. As the study is a preliminary and few numbers of sample are taken from study, so the study can be considered as a reference study for future elaborate study which can give a compact idea on the proximate analysis of all the leafy vegetables used in India. The leafy vegetables also have medicinal values not restrict to treat disease but also improve overall health due to their vitamin and other nutrient content. Consumption of these leafy vegetable could provide several health benefits and are recommended for pharmacological use.

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Author contribution

Dr. Subrat Kumar Kar conceptualized the study, designed the entire experiment, and wrote the paper. Sumit Mandal, Subrat Kumar Behera, Snigdha Rani Sundaray, Sushree S. Priyadarshinee, Sradhanjali Panda, Subhashree Dash, Abhinabh Nayak carried out the laboratory work and contributed equally. Dr. Sanjay Kumar Pattanaik helped to wrote the paper and represented as a co-corresponding author.

Declarations

The authors declare no conflict of interest.

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