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Nutritional evaluation of some leafy vegetable used by the tribal and rural people of south Odisha, India

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ABSTRACT

Leafy vegetables are good source of nutrients. The paper deals with the nutrient analyses of twenty seven leafy vegetables of South Odisha, India, most of which are less used or used at the time of food scarcity. The nutritive value such as crude protein, total sugar, total lipid, vitamin B_1 and vitamin C of the selected leafy vegetables were analysed. Among the less consumed leafy vegetables Murraya koenigii, Tamarindus indicus, Cleome viscosa, Alternanthera sessilis, and Senna tora showed nearly 5% or more protein content. Murraya koenigii (18.7%) showed the highest total sugar content followed by Tamarindus indicus (18.1%), Corchorus aestuans (15%) while Tamarindus indicus showed the highest fat content (0.002%). Out of the selected leafy vegetables eighteen plant species showed no vitamin B_1 content and eight showed no vitamin C content. Tamarindus indicus contains the highest vitamin B_1 content followed by Bambusa bambos while Moringa oleifera showed the highest vitamin C content followed by Cleome viscosa. Some of these underutilised leaves may be useful as food and medicine that are required in small quantities to cure some of the diseases the tribal and rural poor suffer from.

Key words: Crude protein, fat, leafy vegetable, South Odisha, total sugar, vitamin B_1, vitamin C,

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INTRODUCTION

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]. They 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 [2]. Green leafy vegetables have long been recognized as most abundant sources of protein and vitamins [3, 4]. An antioxidant vitamin like ascorbic acid is important in human food since they function as an anticancer agent [5]. Many leafy vegetables especially, amaranth 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 South Odisha because these leafy vegetable can provide appreciable amount of nutrients in comparison to other fruit and seed plants. The forest dwellers collect and use various forest plants as leafy vegetables. Leafy vegetables are easily collected by the poor tribal and rural people free from the environment and thus inexpensive, but are a good source of nutrients.

Attempts have been made by some researchers from different parts of the world on compositional evaluation and functional properties of various types of edible plants [6, 7, 8, 9, 10, 11, 12]. In India, some researchers also enumerated nutritional evaluation of various types of edible plants [13, 14, 15, 6, 17, 18, 19]. However, work on nutritional exploration of less known natural leafy vegetable plants available in Odisha is scanty. Therefore, an attempt has been made to determine the nutrient content of some of the selected leafy vegetable plants of South Odisha. The present study was conducted to evaluate the nutritional value of 27 less known leafy vegetables commonly consumed in South Odisha.

MATERIALS AND METHODS

Sample preparation

Out of 30 districts, South Odisha consists of 7 districts. [20]. Reported 106 leafy vegetable plants from South Odisha. Out of these, selected leafy vegetable plants that include leaf and green stems, were collected in different seasons as per their availability. Fresh leaf samples of 25 leafy vegetable plants, emerging culms of two bamboos (*karada*) and the stem of *Caralluma adscendens* were collected from different places of South Odisha.

The samples collected for nutritional analysis are: *Achyranthes aspera* L., *Alternanthera sessilis* (L.) R. Br. Ex DC., *Amaranthus gangeticus* L., *Amaranthus spinosus* L., *Amaranthus viridis* L., *Bambusa bambos* (L.) Voss, *Bauhinia purpurea* L., *Boerhavia diffusa* L. *Caralluma adscendens* (Roxb.) R. Br., *Celosia argentea* L., *Cleome viscosa* L., *Coccinia grandis* (L.) Voigt, *Commelina benghalensis* L., *Corchorus aestuans* L., *Dendrocalamus strictus* (Roxb.) Nees, *Flacourtia indica* (Burm.f.) Merr., *Glinus oppositifolius* (L.) DC., *Ipomoea acquatica* Forssk., *Leucas aspera* (Willd.) Link., *Marselia minuta* L., *Moringa oleifera* Lam., *Murraya koenigii* (L.) Spreng., *Premna latifolia* Roxb., *Senna tora* (L.) Roxb., *Melothria heterophylla* (Lour.) Cogn., *Tamarindus indicus* L. and *Tridax procumbens* (L.) L. For each sample about one gram of fresh leaf sample was taken and washed thoroughly with distilled water for analysis.

Chemical analysis

Moisture content of the selected fresh leaf sample were determined by keeping the sample in hot air oven at 70 ^{0}C for a constant weight and expressed in percentage. Crude protein content of the fresh leaf samples were determined by following Bradford method. For extraction of total sugar Anthrone-Suphuric acid reagent test was applied [21]. For extraction of total lipid, Chloroform: Methanol mixture (2:1 vol) test was applied [21]. Visual titration method based on reduction of 2, 6-dichlorophenol indophenols dye was adopted for estimation of ascorbic acid (Vitamin C) content [21]. Spectrofluorometric method using oxidising agent potassium ferricyanide was adopted for quantitative determination of thiamine (Vitamin B_1) content of selected fresh leaf sample [21].

Statistical calculation

Three determinations were carried out for each analysis. The mean value and standard deviation were calculated using statistical software.

RESULTS

Plant species selected for nutritional evaluation are listed with botanical name, Odia name and the estimated value of various nutritional compounds observed in 27 different leafy vegetables are shown in Table 1.

Moisture content

From the experimental result, it is observed that all the selected fresh leaf samples analyzed registered much moisture with a maximum of 93% in *Ipomoea aquatica* and minimum of 64% in *Murraya koenigii.* The moisture content analysed showed that *Alternanthera sessilis* and *Bambusa bambos* contain 75.6%; *Cleome viscosa*, and *Tridax procumbens* 69.6%; *Leucas aspera* and *Bauhinia purpurea* 78.3%; *Amaranthus viridis* and *Glinus oppositifolius* contain 80.6%. However, *Amaranthus gangeticus* (86%), *Amaranthus spinosus* (85.3%), *Senna tora* (85%), *Boerhavia diffusa* (83%), *Caralluma adscendens* (80%), *Celosia argentea* (87.3%), *Corchorus aestuans* (80.3%) and *Flacourtia indica* (82%) are richer in moisture content than the other species with values 78.3% in *Premna latifolia*, 78% in *Coccinia grandis*, 77.6% in *Dendrocalamus strictus*,76.3% in *Melothria heterophylla* and 75% in *Achyranthes aspera*.

Crude protein

All the selected plants showed high amount of crude protein with *Moringa oleifera* (66.2 mg $g^{-1)}$ having the highest value and *Tridax procumbens* (8.2 mg g^{-1}) has the lowest value. *Murraya koenigii, Tamarindus indicus, Cleome viscosa, Alternanthera sessilis,* and *Senna tora* showed nearly 50 mg g^{-1} (5%) or more protein content (Table 1). *Amaranthus spinosus, Ipomoea aquatica, Dendrocalamus strictus, Melothria heterophylla, Amaranthus viridis,*

Leucas aspera, Glinus oppositifolius, Celosia argentea, Commelina benghalensis, Boerhavia diffusa, Bambusa bambos, Marselia minuta, Achyranthes aspera, Caralluma adscendens, Coccinia grandis and *Premna latifolia* exhibited protein content between 20 and 40 mg g^{-1}. Less than 20 mg g^{-1} crude protein content was showed by *Amaranthus gangeticus* (Table 1).

Table 1. Crude protein, total sugar, fat and vitamin B_1 and C content of some of the selected leafy vegetables of south Odisha
(Values are mean ± standard deviation, n = 3)

Plant Name	Odia name	Moisture (%)	Crude Protein (mg g^{-1})	Total Sugar (mg g^{-1})	Fat (Total lipid) (mg g^{-1})	Vit B_1 (mg g^{-1})	Vit C (mg g^{-1})
Achyranthes aspera	*Apamaranga*	75.0 ±25.0	33.00 ±0.50	60.83 ±1.04	0.009 ±0.004	Nil	Nil
Alternanthera sessilis	*Madaranga*	75.6 ±24.3	49.83 ±0.76	115.50 ±0.50	0.009 ±0.005	Nil	0.163 ±0.03
Amaranthus gangeticus	*Lalkhada*	86.0 ±14.0	9.33 ±1.04	35.17 ±0.76	0.001 ±0. 0006	0.0002 ±0.0001	0.973 ±0.02
Amaranthus spinosus	*Kantamarisha*	85.3 ±14.6	28.67 ±1.53	69.35 ±0.77	0.004 ±0.001	Nil	0.316 ±0.01
Amaranthus viridis	*Leutia*	80.6 ±19.3	28.33 ±1.53	20.47 ±0.45	0.007 ±0.002	Nil	Nil
Bambusa bambos	*Kantabaunsa*	75.6 ±24.3	39.33 ±1.04	56.31 ±0.60	0.011 ±0.001	0.0016 ±0.0001	0.046 ±0.02
Bauhinia purpurea	*Barada*	78.3 ±21.6	35.40 ±0.66	92.00 ±0.30	0.004 ±0.003	Nil	Nil
Boerhavia diffusa	*Atikapudi-sago*	83.0 ±17.0	44.28 ±0.29	74.55 ±0.42	0.008 ±0.002	Nil	0.270 ±0.01
Caralluma adscendens	*Hada-sinkula*	80.0 ±20.0	32.94 ±0.82	71.17 ±0.76	0.007 ±0.004	Nil	0.403 ±0.01
Celosia argentea	*Gudugudia-saga*	87.3 ±12.6	20.17 ±1.26	58.55 ±0.51	0.007 ±0.001	Nil	Nil
Cleome viscosa	*Bana-sorish*	69.6 ±30.3	54.33 ±1.53	81.33 ±1.53	0.015 ±0.005	Nil	2.023 ±0.01
Coccinia grandis	*Bana-kundri*	78.0 ±22.0	30.40 ±0.79	58.16 ±1.03	0.005 ±0.002	Nil	0.160 ±0.02
Commelina benghalensis	*Kaniseera*	92.6 ±73.3	20.97 ±0.54	23.53 ±0.45	0.004 ±0.002	Nil	Nil
Corchorus aestuans	*Bana-kadali*	80.3 ±19.6	26.23 ±0.75	150.64 ±0.31	0.005 ±0.004	Nil	0.920 ±0.01
Dendrocalamus stictus	*Saliabaunsa*	22.3 ±7.7	29.17 ±1.26	65.30 ±0.26	0.009 ±0.004	0.0011 ±0.0001	Nil
Flacourtia indica	*Kanteikoli*	82.0 ±18.0	31.33 ±0.76	54.59 ±1.38	0.004 ±0.003	Nil	0.386 ±0.03
Glinus oppositifolius	*Pita-saga*	80.6 ±19.3	25.83 ±1.90	129.89 ±0.79	0.006 ±0.004	0.0015 ±0.0001	0.353 ±0.01
Ipomoea aquatica	*Kalamba-saga*	93.3 ±6.6	28.67 ±1.61	31.03 ±0.61	0.005 ±0.002	0.0005 ±0.0001	0.343 ±0.03
Leucas aspera	*Gayasa*	21.6 ±7.8	26.17 ±1.26	57.32 ±1.50	0.002 ±0.001	Nil	0.296 ±0.01
Marselia minuta	*Sunusunia-sago*	86.6 ±13.3	36.67 ±1.53	45.15 ±0.79	0.014 ±0.002	Nil	Nil
Melothria heterophylla	*Kainchikakudi*	76.33 ±23.6	28.42 ±0.39	64.40 ±0.36	0.006 ±0.002	Nil	0.296 ±0.01
Moringa oleifera	*Sajana*	76.0 ±24.0	66.17 ±1.04	125.50 ±0.50	0.013 ±0.004	0.0007 ±0.0001	2.166 ±0.15
Murraya koenigii	*Mersinga*	64.0 ±36.0	61.17 ±0.76	187.56 ±0.51	0.007 ±0.004	0.0006 ±0.0001	0.060 ±0.02
Premna latifolia	*Gandhana*	78.3 ±21.6	30.58 ±0.38	135.17 ±0.76	0.007 ±0.002	Nil	0.363 ±0.03
Senna tora (Cassia tora)	*Chakunda*	85.0 ±15.0	49.17 ±1.04	54.67 ±1.53	0.013 ±0.005	0.0008 ±0.0001	0.790 ±0.03
Tamarindus indicus	*Tentuli*	70.6 ±29.6	56.33 ±1.53	181.29 ±0.62	0.020 ±0.001	0.0022 ±0.0001	0.046 ±0.01
Tridax procumbns	*Bisalyakarani*	76.0 ±24.0	18.00 ±0.51	18.00 ±0.51	0.003 ±0.002	Nil	Nil

Total sugar

Among the 27 leafy vegetable studied, *Murraya koenigii* (187.6 mg g^{-1}, 18.7%) registered the highest total sugar content and the lowest value was shown by *Tridax procumbens* (18.0 mg g^{-1}). Among the leafy vegetable analyzed, *Tamarindus indicus* (181.3 mg g^{-1}), *Corchorus aestuans* (150.6 mg g^{-1}), *Premna latifolia* (135.2 mg g^{-1}), *Glinus oppositifolius* (129.9 mg g^{1}), *Moringa oleifera* (125.5 mg g^{-1}) *Alternanthera sessilis* (115.5 mg g^{-1}) are with high

total sugar content compared to *Bauhinia purpurea* (92.0 mg g^{-1}), *Cleome viscosa* (81.3 mg g^{-1}), *Boerhavia diffusa* (74.5 mg g^{-1}), *Caralluma adscendens* (71.2 mg g^{-1}), *Amaranthus spinosus* (69.3 mg g^{-1}), *Dendrocalamus strictus* (65.30 mg g^{-1}), *Melothria heterophylla* (64.4 mg g^{-1}), *Achyranthes aspera* (60.8 mg g^{-1}), *Celosia argentea* (58.5 mg g^{-1}), *Coccinia grandis* (58.16 mg g^{-1}), *Leucas aspera* (57.3 mg g^{-1}), *Bambusa bambos* (56.3 mg g^{-1}), *Senna tora* (54.7 mg g^{1}), *Flacourtia indica* (54.6 mg g^{-1}). Much lower sugar content was shown by *Marselia minuta* (45.1 mg g^{-1}), *Amaranthus gangeticus* (35.2 mg g^{-1}), *Ipomoea aquatica* (31.0 mg g^{-1}), *Commelina benghalensis* (23.5 mg g^{-1}) and *Amaranthus viridis* (20.5 mg g^{-1}).

Fat

Among the leafy vegetable studied, *Tamarindus indicus* showed the highest fat content (0.020 mg g^{-1}) while *Amaranthus gangeticus* exhibited the lowest fat content (0.001 mg g^{-1}). *Cleome viscosa* (0.015 mg g^{-1}), *Marselia minuta* (0.014 mg g^{-1}), *Moringa oleifera* (0.013 mg g^{-1}), *Bambusa bambos* (0.011 mg g^{-1}) showed higher total lipid content compared to *Alternanthera sessilis*, *Achyranthes aspera*, *Dendrocalamus stictus* (0.009 mg g^{-1}), *Boerhavia diffusa* (0.008 mg g^{-1}), *Amaranthus viridis*, *Celosia argentea*, *Premna latifolia*, *Murraya koenigii* and *Caralluma adscendens* (0.007 mg g^{-1}). Leafy vegetable *Glinus oppositifolius* and *Melothria heterophylla* (0.006 mg g^{-1}), *Corchorus aestuans*, *Ipomoea aquatica* (0.005 mg g^{1}), *Amaranthus spinosus*, *Commelina benghalensis*, *Flacourtia indica* and *Bauhinia purpurea* (0.004 mg g^{-1}), *Tridax procumbens* (0.003 mg g^{-1}), *Leucas aspera* (0.002 mg g^{-1}) reported to be contained low fat value in comparison to other selected leafy vegetable.

Vitamins

All the selected leafy vegetable plants had their vitamin B_1 content as the lowest of all the bulk nutrients considered. However, *Tamarindus indicus* showed the highest (0.0024 mg g^{-1}) vitamin B_1 content and lowest value was reported in *Amaranthus gangeticus* (0.0002 mg g^{-1}). Among the selected plants, *Bambusa bambos* (0.0016 mg g^{-1}), *Glinus oppositifolius* (0.0015 mg g^{-1}) and *Dendrocalamus strictus* (0.0011 mg g^{-1}) are with high vitamin B_1 content in comparison to *Senna tora* (0.0008 mg g^{-1}), *Moringa oleifera* (0.0007 mg g^{-1}), *Murraya koenigii* (0.0006 mg g^{-1}) and *Amaranthus gangeticus* (0.0002 mg g^{-1}).

The green leafy vegetables are rich in ascorbic acid. The highest value was shown by *Moringa oleifera* (2.166 mg g^{-1}) and lowest value by *Tamarindus indicus* (0.0467 mg g^{-1}). However, *Cleome viscosa* (2.023 mg g^{-1}), *Amaranthus gangeticus* (0.973 mg g^{-1}) ,*Corchorus aestuans* (0.920 mg g^{-1}), *Senna tora* (0.790 mg g^{-1}), *Bambusa bambos* (0.046 mg g^{-1}), *Flacourtia indica* (0.386 mg g^{-1}), *Caralluma adscendens* (0.403 mg g^{-1}), *Glinus oppositifolius* (0.353 mg g^{-1}), *Ipomoea aquatica* (0.343 mg g^{-1}), *Premna latifolia* (0.363 mg g^{-1}), *Amaranthus spinosus* (0.316 mg g^{-1}) are richer in vitamin C than the others with values of 0.296 mg g^{-1} in *Melothria heterophylla* and *Leucas aspera*, 0.270 mg g^{-1} in *Boerhavia diffusa*, 0.163 mg g^{-1} in *Alternanthera sessilis* and 0.160 mg g^{-1} in *Coccinia grandis*.

DISCUSSION

The results obtained in this study show a close agreement with those found in literature [22, 9, 12].

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 *Ipomoea aquatica* 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 *Moringa oleifera* 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 *Moringa oleifera* is a non conventional food with substantial nutritional value [24]. For all age group, leaves of *Moringa oleifera* serve as a valuable source of nutrient [25]. Fresh leaf of *Moringa oleifera* contains at least twice more proteins than milk and half the protein of eggs [26, 27]. It was also reported that 30 g of drumstick leaf powder can cover one third of the daily allowance for protein [27].

The leaves of *Murraya koenigii* 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].

All the selected leafy vegetables studied, highest fat content was shown by *Tamarindus indicus* that plays a very important role in the human body help in brain function, joint mobilization and even energy production [29]. They also help the body to absorb fat-soluble vitamins such as vitamins A and E [30].

The result of vitamin analysis showed that the leafy vegetables are rich in vitamin B_1 and C. The green leafy vegetables are rich in ascorbic acid as revealed by the highest value recorded in the leaf of *Moringa oleifera,* which indicate that they are vital for body performance [31]. Vitamin C is a powerful antioxidant essential for healthy formation of bone and teeth [5]. It had been reported that the vitamin C content in *Moringa oleifera* leaf is 6-7 times more than the amount of vitamin C in orange juice. The most notable feature is that the cooked leaf of *Moringa oleifera* contains more vitamin C content [32, 33]. It was also reported that 30 g of *Moringa oleifera* leaf powder can cover one third of the needs in vitamin C [27]. Similarly, the leafy vegetable, *Tamarindus indicus* showed the highest vitamin B_1 content suggested that it plays a very important role in nutrient metabolism involved in metabolising glucose in the body [10].

From the present study, it is reported that the some leafy vegetable are consumed by the tribal and rural people of South Odisha regularly as per their availability while some are consumed at times.

Plant species like *Caralluma adscendens, Leucas aspera, Cleome viscosa, Celosia argentea, Melothria heterophylla, Corchorus aestuans, Coccinia grandis,* are used at the time of food scarcity because these edible leafy vegetable plants are nutritionally rich and can supplement nutritional requirement of humans and livestock, especially in terms of vitamins, proteins, carbohydrates and fats while *Glinus oppositifolius, Senna tora, Premna latifolia* and *Flacourtia indica* are consumed during their availability. They play an important source of food for tribal and rural people of south Odisha to meet their food need especially in the period of food crisis

These leafy vegetable meet the nutritional requirement of the poor people as well act as medicinal plant for various ailments. For example, in the present study, *Alternanthera sessilis*, taken as leafy vegetable, increases the flow of bile in the intestine stimulates lactation in nourishing mother and helps in the treatment of leucorrhoea [34]. *Commelina benghalensis,* taken as food, is also helpful to relief constipation and rheumatic pain [16]. *Ipomoea aquatica* acts as a blood purifier and cure gonorrhoea [34]. *Marsilea minuta,* a native leafy vegetable plant of South 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]. *Boerhavia diffusa*, a leafy vegetable, is taken internally for curing asthma and cough [37]. The leaves of *Senna tora* pounded with egg albumin are applied externally as a plaster on bone fracture [38]. *Celosia argentea* leaf is used in case of diarrhoea, dysentery and acute abdominal pain [39]. *Tamarindus indicus* 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 [40]. 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 [41].

CONCLUSION

On the basis of detailed chemical analysis and observations, it can be concluded that all the edible leafy vegetable plants of South Odisha contain appreciable amount of nutrients which are readily available. 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 fat contents of these vegetables are not enough to satisfy the recommended dietary allowances. They therefore 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. 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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