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A Comprehensive Review of Indigenous Green Leafy Vegetables in West Bengal: Nutrient Profile, Antinutritional Factors, and Health Benefits

Supratim Biswas* **and Lakshmishri Roy**

Department of Food Technology, Techno Main Salt Lake, Kolkata, India

Corresponding author: Supratim Biswas, Department of Food Technology, Techno Main Salt Lake, Kolkata, India, E-mail: supratimft@gmail.com

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Abstract

This review focuses on the nutritional and anti-nutritional parameters, as well as the medicinal importance, of six native green leafy vegetables from West Bengal: Thankuni, Bathua, Kulekhara, Moringa, Kalmi and Jute Mallow. Each plant exhibited unique nutrient profiles, highlighting their individual nutritional importance. Variations in composition and nutritional content were observed among the selected vegetables. Thankuni and Moringa stood out for their high iron content, while Bathua had high levels of ascorbic acid and total phenolic content. Kulekhara exhibited high folic acid and flavonoid content, while Kalmi contained high β-carotenoid content, and Jute Mallow had high flavonoid content. Antinutritional factors varied, with Bathua showing high levels of phytic acid and tannin content, Moringa containing significant levels of oxalic acid, and Kalmi having notable saponin content. These findings highlight the diverse nutritional profiles of the selected green leafy vegetables, emphasizing their potential as important sources of essential nutrients.

Keywords: Green leafy vegetables; Nutritional content; Vitamins; Minerals; Dietary fibre; Indigenous plants; Antinutritional factors; Thankuni; Bathua; Kulekhara; Moringa; Kalmi; Jute mallow; Medicinal properties; Nutrient analysis

Introduction

Centella asiatica commonly called Gotu Kola/Thankuni (in West Bengal) or pennywort is an herbaceous, frost-tender perennial plant in the flowering plant family *Apiaceae*. It is native to India and other parts of Asia, such as China, Sri Lanka, Nepal and Madagascar, and has been utilized in folk medicine in different countries [1]. *Centella asiatica* possesses components that have beneficial properties. The ethno-pharmacological reports provide information on *Centella asiatica* medicinal properties, such as its ability to improve venous insufficiency. *Chenopodium album* (L.) of the family *Chenopodiaceae* (Goosefoot family) belongs to the genus *Chenopodium*. It is also known as fat-hen, Bathua (in WB), vastukah, chakvit. This weedy plant has various medicinal applications. It is a polymorphous, mealy-white, erect herb that is 3.5 m in height and found at an altitude of 4,700 m. The herb is a common weed during summer and winter in waste places and in the field of wheat, barley, mustard and gram, and reduces their yield [2]. Kulekhara or, *Hygrophila auriculata* belongs to the Acathaceae family. *Hygrophilla auriculata* has several common names in different languages. In Bengali, it is called Kulekhara [3]. It is a spiny bush and is common throughout India. Though the whole plant has been used medicinally, the root and leaves are used more. Anciently, it has been found effective in treating skin diseases, dropsy and sleeplessness. It is found effective in renal stones too, where lower potencies have been proven more beneficial. The plant is used as a demulcent, aphrodisiac, diuretic, urinary tonic and hepatoprotective substance. The aerial parts and the roots are used in herbal preparations [4]. *Moringa oleifera* Lam (*Moringaceae*) is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses and high nutritional value. Different parts of this plant contain a profile of important minerals and are a good source of protein, vitamins, β-carotene, amino acids and various phenolics [5]. Water spinach (*Ipomoea aqua ica* Forsk) is a vascular semi-aquatic plant native to tropics and subtropics that grow wild and sometime cultivated in Southeast Asia, India and Southern China. Water spinach is an herbaceous perennial plant belonging to the family *Convolvulaceae* [6]. *Corchorus olitorius* (jute) is a pantropical plant that is native to African and Asian countries. The green leaves of the plant are consumed as mucilaginous (slimy) soup in many African cooking traditions. These green leaves have also found usage in folk medicine as treatments for various ailments and diseases [7,8].

However, limited research has been conducted on the nutritional and anti-nutritional properties of these indigenous plants [9-15]. Understanding the nutritional value and potential anti-nutritional factors in these green leaves is essential for promoting their consumption and exploring their potential applications. This review paper focuses on investigating the nutritional and anti-nutritional parameters of six native green leafy vegetables from West Bengal: Thankuni (*Centella asia ica*), Bethua (*Chenopodium album*), Kulekhara (*Hygrophila auriculata*), Moringa (*Moringa oleifera*), Kalmi (*Ipomoea aqua ica*), and Jute Mallow (*Corchorus olitorius*) **(Table 1)**.

Table 1: Common and local names of selected locally available green leafy vegetables.

Botanical Name	Family	Common English name	Local West Bengal name	Cultivation	Uses
Centella asiatica	*Apiaceae*	Asiatic Pennywort	Thankuni	Grows in wet, damp areas near water sources	Used in traditional medicine for its neuroprotective and cognitive-enhancing effects
Chenopodium album	*Amaranthaceae*	Lamb's Quarters	Lamb's Quarters	Grows in a variety of soils and climates	Consumed as a vegetable and used in traditional medicine for its anti-inflammatory properties
Hygrophila auriculata	*Acanthaceae*	Marsh Barbel	Kulekhara	Grows in wetlands and damp areas	Used in traditional medicine for its anti-inflammatory and analgesic properties.
Moringa oleifera	*Moringaceae*	Drumstick Tree	Shojne	Grows in a variety of soils and climates	Consumed as a vegetable and used in traditional medicine for its antioxidant properties
Ipomoea aquatica	*Convolvulaceae*	Water Spinach	Kalmi	Grows in water or in damp soil	Consumed as a vegetable and used in traditional medicine for its anti-inflammatory properties
Corchorus olitorius	*Malvaceae*	Jute Mallow	Nalita	Grows in tropical and subtropical regions	Consumed as a vegetable and used in traditional medicine for its anti-inflammatory properties

Results and Discussion

Green leafy vegetables can provide several vital nutrients required for human health. This study aimed to investigate the nutritional and anti-nutritional parameters and medicinal importance of six native green leafy vegetables from West Bengal: Thankuni (*Centella asiatica*), Bathua (*Chenopodium album*), Kulekhara (*Hygrophila auriculata*), Moringa (*Moringa oleifera*), Kalmi *(Ipomoea aquatica*) and Jute Mallow (*Corchorus olitorius*). Each plant exhibited unique nutrient profiles, highlighting their individual nutritional importance [16-25]. Based on the review, it is evident that each of the six native green leafy vegetables from West Bengal, namely Thankuni, Bathua, Kulekhara, Moringa, Kalmi and Jute, possess unique nutritional compositions.

The selected green leafy vegetables showed variations in their composition and nutritional content **(Table 2)**. Thankuni had a moderate moisture content (13.10% ± 1.07%), high ash content (16.55% ± 0.45%), low lipid content (1.20% ± 0.10%), high crude fibre content (17.00% ± 1.87%), moderate protein content (8.35% ± 1.28%) and a high carbohydrate content (43.81% ± 0.70%). Bathua had low moisture content (5.06%), high ash content (21%), high protein content (28.69%) and moderate carbohydrate content (40.84%). Kulekhara had high moisture content (32.74%), moderate ash content (16.69%), moderate protein content (9.12 g/100 g) and moderate carbohydrate content (19.98 g/100 g). Moringa exhibited moderate moisture content (14.8% ± 0.2%), low ash content (3.8% ± 0.2%), high lipid content (17.3% ± 0.2%), high crude fibre content (24.2% ± 0.9%), high protein content (50.4% ± 0.2%) and moderate carbohydrate content [26-35]. Kalmi had high moisture content (69.11% ± 0.72%), moderate ash content (16.37% ± 0.67%), low lipid

content (2.19% ± 0.08%), low crude fibre content (7.44% ± 0.27%), low protein content (13.82% ± 0.08%) and low carbohydrate content (10.51% ± 0.08%). Jute had high moisture content (84.49% ± 1.76%), moderate ash content (12.40% ± 1.44%), high lipid content (6.64% ± 1.46%), high crude fibre content (20.86% ± 3.30%), moderate protein content (29.18% ± 0.47%) and high carbohydrate content (27.88% ± 3.76%).

Table 2: Proximate composition of the selected green leafy vegetables (%).

Leaves	Moisture	Ash	Lipid	Crude fibre	Protein	Carbohydrate
Thankuni	13.10 ± 1.07	16.55 ± 0.45	1.20 ± 0.10	17.00 ± 1.87	8.35 ± 1.28	43.81 ± 0.70
Bathua	5.06%	21%	-	-	28.69%	40.84%
Kulekhara	32.74 Value expressed as % wet weight	16.69 Value expressed as % dry weight	-	-	9.12 (g/100 g)	19.98 g/100 g
Moringa	14.8 ± 0.2	3.8 ± 0.2	-	17.3 ± 0.2	24.2 ± 0.9	50.4 ± 0.2
Kalmi	69.11 ± 0.72	16.37 ± 0.67	2.19 ± 0.08	7.44 ± 0.27	13.82 ± 0.08	10.51 ± 0.08
Jute	84.49 ± 1.76	12.40 ± 1.44	6.64 ± 1.46	20.86 ± 3.30	29.18 ± 0.47	27.88 ± 3.76

In terms of mineral content **(Table 3),** Thankuni and Moringa stood out for their high iron content (50.4 ± 15.8 mg/100 g and 25.14 ± 1.13 mg/100 g, respectively). Bathua had low mineral content, while Kulekhara showed moderate levels of various minerals. Kalmi exhibited high levels of sodium (4,771.5 ± 180.0 mg/100 g) and Jute had a high potassium content (283 mg/kg) [36-45].

Table 3: Mineral contents of the selected green leafy vegetables of WB (mg/100 g).

Leaves	Iron (mg/100 g)	Zinc	Copper	Manganese	Sodium	Potassium	Calcium	Magnesium
Thankuni	50.4 ± 15.8	14.7 ± 1.0	2.8 ± 2.4	25.2–90.1	1,798.2 ± 77.1	4,771.5 ± 180.0	1,583.3 ± 307.9	411.4 ± 60.2
Bathua	1.2	50	0.04	0.9	0.3	3.65	3.85	112.17
Kulekhara	12.03	0.44	4.87	-	56.1	266	70.22 mg/100 g	-
Moringa	25.14 ± 1.13	2.04 ± 0.85	0.45 ± 0.05	7.21 ± 1.03	133.11 ± 20.09	1.75 ± 0.02	1.48 ± 0.01	301.11 ± 2.08
Kalmi	6,925 ± 3.12		6.338 ± 0.004	2,390 ± 6.38	0.840 ± 0.004	4.406 ± 0.001	18 mg/100 g	12,121 ± 3.21
Jute Mallow	4.147 mg/kg	0.701 mg/kg	0.059 mg/kg	0.013 mg/kg	21.8 mg/kg	283 mg/kg	33.3 mg/kg	183 mg/kg

The nutritional parameters varied among the vegetables **(Table 4).** Thankuni and Moringa contained significant amounts of ascorbic acid (36.7-96.7 mg/100 g and 6.60 ± 0.01 mg/g, respectively). Bathua had high levels of ascorbic acid (377.65 mg/100 g) and total phenolic content (74.12 mg GAE/g dry extract). Kulekhara exhibited high folic acid content (<1.0 µg/100 g) and flavonoid content (3.59 mg quercetin/g of dry matter). Kalmi contained high β-carotenoid content (5.85 µg/ml) and Jute had high lavonoid content (39.93 mg/100 g) [46-55].

Table 4: Nutritional parameters of selected green leafy vegetables (GAE- Gallic Acid Equivalent, QE-Quercetin Equivalent).

Leaves	Ascorbic acid (mg/100 g)	Antioxidant activity (%)	Total Phenolic content (mg GAE/ g dry extract)	β-Carotenoid (mg/100 g)	Folic acid content µg /100 gm	Flavonoid content (mg quercetin/g of dry matter)
Thankuni	36.7-96.7	75-86	3.42 ± 0.030-8.32 ± 0.105	31.8-72.7	-	111.8–260.6 mg/100 g FW
Bethua	377.65	74.12	0.94	24.64	-	42.74 (µg CE/mg extract)
Kulekhara	60.32	-	20.83 (mg GAE/g)	4.4	<1.0	3.59 (mg QE/g)
Moringa	6.60 ± 0.01 (mg/g)	41.40 ± 8.66	45.81 ± 0.02 (mg/g)	92.38 ± 0.11 (mg/g)	41 µg	27 ± 0.03 (mg/g)
Kalmi	95.86 ± 12.60 mg/g	64.81	77.06 ± 0.70	5.85 µg/ml	0.174 ± 0.006 mg/100 g	6.61 ± 0.42
Jute Mallow	53-80	44.5-46.2	1.85 ± 1.00 mg/g	39.93	0.03 mg/L	4.09 ± 1.00

The antinutritional factors also varied among the vegetables. Bathua contained high levels of phytic acid (268.33 mg/100 g) and tannin content (203.91 mg GAE/100 g) [56-60]. Moringa had significant levels of oxalic acid (334.33 ± 0.67 mg/100 g) and Kalmi had notable saponin content (2.53% ± 0.02%) **(Table 5)**.

Table 5: Antinutritional factors present in the selected leaves (mg/100 gm) (TAE-Tannic Acid Equivalents, GAE- Gallic Acid Equivalents).

Leaves	Phytic acid content (mg/100 g)	Tannin content (mg/100 g)	Oxalic acid content (mg/100 g)	Saponin content (mg/100 g)
Thankuni	-	1.11 ± 0.02	-	8.20%
Bathua	268.33	203.91 mg GAE/100 g	-	0.46 (g/100 g DM)
Kulekhara	-	42.5 mg TAE/g dry weight	-	-
Moringa	10.58 ± 0.01	8.19 ± 0.01	334.33 ± 0.67	64-81 g/kg of dry weight
Kalmi	6.09% ± 0.02%	0.04% ± 0.00%	1.31% ± 0.02%	2.53% ± 0.02%
Jute Mallow	5.633	0.243	0.287	2.43

Overall, these findings highlight the diverse nutritional profiles of the selected green leafy vegetables, emphasising their potential as sources of essential nutrients.

Conclusion

The selected green leafy vegetables, including Thankuni, Bathua, Kulekhara, Moringa, Kalmi and Jute Mallow, exhibited variations in their proximate composition, mineral content, nutritional parameters and anti-nutritional factors. These variations provide insights into their potential as sources of nutrients and bioactive compounds. Thankuni and Jute Mallow stood out as potential sources of iron and other minerals. Bathua exhibited relatively higher zinc content, while Kulekhara had a higher copper content. Moringa exhibited the highest protein content and varied bioactive compounds, such as ascorbic acid, β-carotenoids and phenolic compounds. Kalmi exhibited very high iron and magnesium content, as well as diverse bioactive compounds. These findings suggest that each vegetable has its unique nutritional profile and health-promoting potential. It's important to note that the nutritional composition can be influenced by various factors, including cultivation practices, environmental conditions, and sample variability. Therefore, further studies and larger sample sizes are needed to validate these findings and provide more comprehensive information about the nutritional composition and health benefits of these vegetables.

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