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Estimation of Total Carbohydrate Content in Some Wild Edible Plants of Kangchup Chingkhong, Senapati District, Manipur, North East India

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Abstract

This study was conducted from March to December, 2024 at the laboratory of the Institutional Biotech Hub, Lilong Haoreibi College, Thoubal, Manipur, aimed to estimate the total carbohydrate content of selected wild edible plants (WEPs) collected from the Kangchup Chingkhong area of Senapati District, Manipur. In this study, 32 plant parts from 21 species including trees, shrubs, herbs, and creepers were analyzed using the anthrone method for carbohydrate estimation. The results revealed substantial variation in carbohydrate content across different plant types and organs. Among trees, *Wendlandia grandis* flowers had the highest carbohydrate concentration (25.59±0.27 mg g^{-1} dry weight), followed by *Acacia pennata* leaves (21.28±1.98 mg g^{-1}) among shrubs. High carbohydrate levels were also observed in *Alpinia officinarum* leaves (17.40±0.93 mg g^{1}) and *Paederia foetida* leaves (16.74±0.45 mg g^{-1}), representing herbs and creepers, respectively. These findings highlighted the nutritional potential of WEPs and supported their inclusion in food-based strategies for enhancing dietary diversity and food security. The study advocated for the preservation of ethnobotanical knowledge and recommends further research on seasonal variability, nutrient bioavailability, and other macronutrients to maximize the benefits of these underutilized resources.

Keywords: Wild edible plant, carbohydrate, Manipur, nutritional profiling

1. Introduction

The Northeastern region of India, particularly the state of Manipur, lies within the Indo-Burma biodiversity hotspot—one of the most ecologically rich and threatened areas globally. This region is celebrated for its remarkable diversity of wild edible plants (WEPs), which have supported the food systems and cultural practices of indigenous communities for generations (Konsam et al., 2016; Leisembi et al., 2024). These plants are deeply integrated into the local way of life, playing a vital role in food and nutritional security by serving as reliable sources of energy and essential micronutrients, especially during times of agricultural scarcity or economic stress (Mahapatra et al., 2012; Satter et al., 2016; Talang et al., 2023; Lalmuanpuii et al., 2024; Kikim et al., 2025).

In rural and tribal areas, WEPs form an integral part of traditional diets, contributing not only to caloric intake but also providing dietary fiber, antioxidants, and bioactive compounds with therapeutic potential (Handique, 2003; Sajem and Gosai, 2006; Rymbai et al., 2023). Their availability in forests and community lands makes them accessible to economically disadvantaged households, enhancing both food diversity and nutritional adequacy.

Carbohydrates are the primary source of dietary energy and are essential for various physiological and metabolic functions (Slavin and Lloyd, 2012; Anonymous, 2017). In subsistence communities with limited access to market foods, energy requirements are predominantly met through plant-based diets (Longvah et al., 2017; Aryal et al., 2018). Several studies have demonstrated that many WEPs have carbohydrate concentrations that rival or even surpass those of cultivated crops. This is particularly evident in storage organs like rhizomes and tubers, as well as photosynthetic parts like leaves and flowers (Bharucha and Pretty, 2010; Beluhan and Ranogajec, 2011; Touthang et al., 2019).

Despite their significant role in local food systems, many WEPs remain underutilized and under-researched. This is largely due to the absence of comprehensive scientific documentation of their nutritional and biochemical properties (Leisembi et al., 2024; Kikim et al., 2024). Understanding the carbohydrate composition of these plantsis critical for promoting their inclusion in regional food security programs, nutrition policy frameworks, and biodiversity conservation strategies (N'Guessan et al., 2009; Padulosi et al., 2013; Hunter et al., 2019).

In recent years, both regional and national initiatives have sought to assess the nutritional potential of WEPs, particularly in ecologically fragile and nutritionally vulnerable zones such as Northeast India (Konsam et al., 2016; Bhatia et al., 2018). These efforts are not only aimed at improving nutritional outcomes but also at building climate-resilient food systems. WEPs, by virtue of their ecological adaptability, are increasingly recognized as key components in the development of sustainable and diversified food systems (Padulosi et al., 2013; Hazarika et al., 2022; Lalrinhlua et al., 2022; Talang et al., 2023; Kikim et al., 2024).

Moreover, these plants support traditional healing systems and local economies while reinforcing cultural identity. Ethnobotanical studies stress the urgency of documenting indigenous knowledge to prevent both biodiversity loss and cultural erosion (Sajem and Gosai, 2006; Uprety et al., 2012; Ghorbani et al., 2012).

The advancement of biochemical analysis methods, such as the phenol-sulfuric acid and anthrone assays, has significantly enhanced the speed and accuracy of carbohydrate quantification in plant samples (Dubois et al., 1956; Albalasmeh et al., 2013). These techniques are now standard in profiling wild and underutilized plants (Konsam et al., 2016).

This study evaluated the total carbohydrate content of selected wild edible plants from the KangchupChingkhong region in Senapati District, Manipur. The findings aimed to highlight the nutritional relevance of these species and advocate for their greater recognition in food security strategies, public health nutrition, and conservation planning.

2. Materials and Methods

This study was conducted from March to December 2024 at the laboratory of Institutional Biotech Hub, LilongHaoreibi College, Lilong, Thoubal, Manipur.

2.1. Reagents

1. Anthrone reagent (0.1% anthrone dissolved in concentrated sulphuric acid)

2. Concentrated sulphuric acid (H_2SO_4)

3. Carbohydrate standard (glucose or other carbohydrate)

4. Distilled water

2.2. Sample collection and preparation

Various parts of 30 plant species were collected from Kangchup Chingkhong area, Senapati district of Manipur. After collecting, the plant samples were cleaned by using tap water followed by double distilled water to remove all the dust and oven dried at 60°C. The dried samples were ground to powder by using a grinder. 100 mg of each sample was taken in a mortar and pestle and to it, approximately 10 ml of 80% ethanol was added and kept pasting until a clear plant solution was observed. Then the solutions were centrifuged at 4000 rpm for 12 min and the final supernatants were collected in respective tubes.

2.3. Preparation of anthrone reagent

The anthrone reagent was prepared by dissolving 0.1 g of anthrone in 100 ml of concentrated sulfuric acid.

2.4. Reaction setup

An aliquot (usually 1 ml) of the carbohydrate extract was pipetted into a clean test tube. To this, 4 ml of the anthrone reagent was added. The solution was mixed thoroughly using a vortex mixer, and the test tube was heated in a boiling water bath at 100°C for 10–15 min. During this heating step, the blue-green color developed, indicating the presence of carbohydrates. After heating, the reaction mixture was cooled to room temperature. The absorbance of the solution was measured at 620 nm using a spectrophotometer or colorimeter. The intensity of the blue-green color was directly proportional to the carbohydrate concentration in the sample.

2.5. Standard curve

A standard curve was prepared using known concentrations of glucose as carbohydrate standard. These standards were subjected to the same reaction procedure. Absorbance values were plotted against the concentration of the standard solutions to create a calibration curve. The carbohydrate concentration in the plant sample was determined by comparing its absorbance value with the standard curve. The result was expressed as mg of carbohydrate g^{-1} of fresh or dry plant weight, depending on the experimental design.

2.6. Statistical analysis

All the experimental measurements were performed in triplicates and expressed as the mean±standard deviations. The magnitude of the means, standard curve, standard errors, and standard deviations were calculated using MS Excel 2019 software.

3. Results and Discussion

In this study, 32 plant parts belonging to 21 plant species were used as carbohydrate sources. The parts were categorized into four types: trees, Shrubs, Herbs, and Creepers. The total protein content was expressed as mg g^{-1} of the sample's dry weight.

3.1. Total carbohydrate content among the tree

The data pertaining to total protein content among the tree species has been depicted in Table 1. The highest carbohydrate concentration was found in *Wendlandia grandis* flower (25.59±0.27 mg g^{-1} of dry weight) followed by *Parkia timoriana* fruit pulp, *Clerodendrum colebrookianum* stem, *C. colebrookianum* and *Dysoxylum excelsum* leaves with a total carbohydrate content of 20.84±1.39, 16.35±1.98, 15.78±1.11 and 14.43±1.36 mg g^{-1} of dry weight, respectively.

Table 1: Total Carbohydrate content among the trees

Sl. No.	Plant sample	Local name	Family	Plant part	Carbohydrate concentration (mg g^{-1} of dry weight)
1.	*Clerodendrum colebrookianum*	Kuthapangouba	Verbenaceae	Stem	16.35±1.98
				Leaves	15.78±1.11
2.	*Dysoxylum excelsum*	Ujao	Mileaceae	Flower	5.06±0.62
				Leaves	14.43±1.36
				Stem	9.74±0.50
3.	*Parkia timoriana*	Yongchak	Fabaceae	Fruit pulp	20.84±1.39
				Seed	11.34±0.87
4.	*Leucaena leucocephala*	Chigonglei	Mimosaceae	Fruit pulp	5.54±0.20
				Seed	11.99±0.70
5.	*Wendlandia grandis*	Pheija	Rubiaceae	Flower	25.59±0.27
6.	*Albizia myriophylla*	Yangli	Fabaceae	Bark	7.67±0.15

*The data represented were means of 3 replications

The lowest carbohydrate concentration was recorded in *C. colebrookianum* flower (5.06±0.62mg g^{-1} of dry weight) followed by *Leucaena leucocephala* fruit pulp (5.54±0.20 mg g^{-1} of dry weight), *Albizia myriophylla* bark (7.67±0.15 mg g^{-1} of dry weight), *Dysoxylum excelsum* stem (9.74±0.50 mg g^{-1} of dry weight), *P. timoriana* seed (11.34±0.87 mg g^{-1} of dry weight) and *L. leucocephala* seed (11.99±0.70 mg g^{-1} of dry weight).

The high carbohydrate levels in leaves and stems of *A. pennata* and *Z. oxyphyllum* reflect their active photosynthetic role, in agreement with previous research emphasizing foliage as a key carbohydrate reservoir (Handique, 2003; Longvah et al., 2017). Meanwhile, the low values in roots and tubers of *C. serratum* and *S. sonchifolius* suggest limited carbohydrate allocation to non-photosynthetic tissues in these shrub species, echoing findings by Konsam et al. (2016).

3.2. Total Carbohydrate content among the Shrubs

The data pertaining to total carbohydrate content among the shrubs is depicted in Table 2. The highest carbohydrate concentration was found in leaves of *Acacia pennata* (21.28±1.98 mg g^{-1} of dry weight) followed by leaves of *Zanthoxylum oxyphyllum* (16.70±0.17 mg g^{-1} of dry weight), stem of *A. pennata* (16.63±0.75 mg g^{-1} of dry weight). and leaves of *Clerodendrum serratum* (15.40±0.71 mg g^{-1} of dry weight). The lowest carbohydrate concentration was recorded in root of *C. serratum* (6.89±0.42 mg g^{-1} of dry weight) followed by flower of *C. serratum* (7.15±0.08 mg g^{-1} of dry weight), stem of *C. serratum* (7.24±0.20 mg g^{-1} of dry weight) and tuber *Smallanthus sonchifolius* (7.28±0.08 mg g^{-1} of dry weight).

The high carbohydrate levels in leaves and stems of *A. pennata* and *Z. oxyphyllum* reflect their active photosynthetic role, in agreement with previous research emphasizing foliage as a key carbohydrate reservoir (Handique, 2003; Longvah et al., 2017). Meanwhile, the low values in roots and tubers of *C. serratum* and *S. sonchifolius* suggest limited carbohydrate allocation to non-photosynthetic tissues in these shrub

Table 2: Total carbohydrate content among the shrubs

Sl. No.	Plant sample	Local name	Family	Plant part	Carbohydrate concentration (mg g^{-1} of dry weight)
1.	*Clerodendrum serratum*	Moirang khanambi	Verbenaceae	Flower	7.15±0.08
				Stem	7.24±0.20
				Root	6.89±0.42
				Leaves	15.40±0.71
2.	*Acacia pennata*	Khang	Fabaceae	Leaves	21.28±1.98
				Stem	16.63±0.75
3.	*Smallanthus sonchifolius*	Ground apple	Asteraceae	Tuber	7.28±0.08
4.	*Zanthoxylum oxyphyllum*	Singjol	Rutaceae	Leaves	16.70±0.17

*The data represented were means of 3 replications species, echoing findings by Konsam et al. (2016).

3.3. Total carbohydrate content among the Herbs

The data pertaining to total carbohydrates content among the herbs has been depicted in Table 3. The highest total carbohydrate content was found in leaves of *Alpina officinarum* (17.40±0.93 mg g^{-1} of dry weight) followed by rhizome of *Kaempfera parviflora* (15.43±0.50 mg g^{-1} of dry weight), rhizome of *Maranta arundinaceae* (15.26±1.19 mg g^{-1} of dry weight) and rhizome of *Curcuma caesia* (12.03±0.92 mg g^{-1} of dry weight). The lowest carbohydrate content was recorded in *rhizome of Curcuma amada* (4.58±0.65 mg g^{-1} of dry weight) followed by rhizome of *Zinziber striolatum* (6.50±0.74 mg g^{-1} of dry weight). Leaves of *Brachycorythis obcordate* (6.76±0.38 mg g^{-1} of dry weight). Rhizome of*Siphonochilus aethiopicus* (6.93±0.26 mg g^{-1} of dry weight) and Rhizome of *Alpinia galanga* (11.73±0.92 mg g^{-1} of dry weight).

The high carbohydrate content in the rhizomes of Zingiberaceae herbs is consistent with Srivastava et al. (2019), who documented abundant starch and soluble sugars in underground storage organs. The leaves of *A. officinarum*, being actively photosynthetic, also supported higher carbohydrate levels. In contrast, the lower content in *C. amada* rhizomes and *B. obcordata* leaves may be attributed to lower metabolic activity or developmental stage during collection (Leisembi et al., 2024).

Table 3: Total carbohydrate content among the herbs

Sl. No.	Plant sample	Local Name	Family	Plant part	Carbohydrate concentration (mg g^{-1} of dry weight)
1.	*Kaempfera parviflora*	Sing amuba	Zingiberaceae	Rhizome	15.43±0.50
2.	*Curcuma amada*	Yaiheinouman	Zingiberaceae	Rhizome	4.58±0.65
3.	*Brachycorythis obcordata*	Kak-uba	Orchidaceae	Leaves	6.76±0.38
4.	*Alpina officinarum*	Pulleimanbi	Zingiberaceae	Leaves	17.40±0.93
5.	*Siphonochilus aethiopicus*	Lam sing	Zingiberaceae	Rhizome	6.93±0.26
6.	*Alpinia galanga*	Kanghoo	Zingiberaceae	Rhizome	11.73±0.92
7.	*Maranta arundinaceae*	Alaloo	Marantaceae	Rhizome	15.26±1.19
8.	*Curcuma caesia*	Yaingangamuba	Zingiberaceae	Rhizome	12.03±0.92
9	*Zinziberst riolatum*	Sarei	Zingiberaceae	Rhizome	6.50±0.74

*The data represented were means of 3 replications

3.4. Total carbohydrate content among the Creepers

The data pertaining to total carbohydrate content among the creepers has been depicted in Table 4. The highest total carbohydrate content was found in the leaves of *Paedaria foeteda* (16.74±0.45 mg g^{-1} of dry weight) followed by the stem of *P. foeteda* stem (16.09±0.37 mg g^{-1} of dry weight). The lowest carbohydrate content was recorded in the seed of *Hodgsonia heteroclite* (4.10±0.72 mg g^{-1} of dry weight) followed by the gall of *P. foeteda* (4.58±0.82 mg g^{-1} of dry weight).

The elevated carbohydrate content in *P. foetida* leaves and stems suggests high photosynthetic activity and metabolic flux, supporting its role in traditional diets across Northeast India (Swargiary et al., 2017). In contrast, the low carbohydrate content in *H. heteroclita* seeds and *P. foetida* gall aligns with their reproductive and defensive roles, where energy storage is not prioritized (Konsam et al., 2016; Talang et al., 2023).

The overall variability in carbohydrate content across plant species and organs reflects physiological and ecological adaptations. Environmental factors such as altitude, soil composition, and seasonality may influence carbohydrate biosynthesis and storage (Chapin et al., 1990; Korner, 2007). Notably, higher carbohydrate levels in edible parts support their role as important energy sources in the traditional diets of rural and tribal communities.

Table 4: Total carbohydrate content among the creepers

Sl. No.	Plant sample	Local name	Family	Plant part	Carbohydrate concentration (mg g^{-1} of dry weight)
1.	*Paedaria foeteda*	Oinum	Rubiaceae	Leaves	16.74±0.45
				Gall	4.58±0.82
				Stem	16.09±0.37
2.	*Hodgsonia heteroclita*	Kathai/Lam mairen	Cucurbitaceae	Seed	4.10±0.72

*The data represented were meansof 3 replications

These findings emphasize the nutritional potential of WEPs to combat energy and micronutrient deficiencies. As highlighted by Hazarika et al. (2022) and Khan et al. (2023), incorporating WEPs into local food systems enhances food diversity, resilience, and cultural heritage preservation.

4. Conclusion

Several wild edible plants from Kangchup Chingkhong, notably *Wendlandia grandis*, *Acacia pennata*, and *Alpinia officinarum*, exhibited high carbohydrate content, surpassing some cultivated vegetables. These findings underscored the role of WEPs in enhancing nutritional security in rural and tribal areas.

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