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Assessment of Physico-Chemical Characteristics and Phytochemical Screening of Some Wild Edible Fruits from Kohima, Nagaland

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Abstract: Wild edible fruits make a significant contribution to the overall well-being of humans, owing to their substantial nutritional, medicinal, and economic value. The focus of this particular study was to assess the physico-chemical properties and screen the phytochemical constituents of five distinct fruits including *Choerospondias axillaris*, *Docynia indica*, *Passiflora edulis*, *Phyllanthus emblica* and *Spondias pinnata* used by the ethnic community of Kohima district in Nagaland. The physico-chemical properties of the selected WEFs, including fruits length and breadth, shape, pH content, MC and DMC were analyzed. It was observed that there were variations among the fruits in all the parameters investigated. The moisture content was relatively high, where the highest and the lowest MC with 85.33% and 75.67% being observed in *Phyllanthus emblica* and *Passiflora edulis* respectively. Contrary to this, DMC was highest in *Passiflora edulis* and lowest in *Phyllanthus emblica*. The pH content of selected WEFs was in the range of 3.45 to 3.85, with the highest pH found in *Passiflora edulis* and the lowest pH recorded for *Spondias pinnata*. The phytochemical screening of methanolic extracts of studied fruits unveiled the presence of significant bioactive compounds, such as alkaloids, glycosides, phenols, flavonoids, tannins, carbohydrate, starch, protein, saponins, phytosterols, anthraquinones and coumarins. This investigation highlights the necessity of conserving these fruits in order to avert the depletion of this valuable resource. The identification of wild species possessing medicinal properties underscores the significance of conducting further research to fully explore their potential.

1. Introduction

One of the primary concerns in developing nations is the problem of malnutrition, which is caused by a variety of factors (Thakur *et al*. 2022). An immense enthusiasm exists in the pursuit of discovering nourishing resources that can support a sustainable food system while possessing substantial nutrient content. One potential solution to address the challenge of food security is through the utilization of underutilized wild plants (Thakur *et al*. 2022) including wild edible fruits (WEFs). WEFs are indigenous species that undergo growth and propagation autonomously, in the absence of any human involvement, within their innate environments (Atemni *et al*. 2022). They are among the important non-timber forest products that are extensively gathered and utilized by tribals (Sreekumar *et al*. 2020). The WEFs can be found in abundance during specific seasons and are regularly consumed by indigenous populations as a primary food source as well as for their potential medicinal properties. Wild edible fruits have a significant impact on the dietary habits of indigenous populations,

contributing to their overall nutritional well-being. Moreover, the nutritional composition of these wild fruits surpasses that of their cultivated counterparts (Sreekumar *et al*., 2020), further highlighting their importance in providing essential nutrients to tribal communities. From a nutritional standpoint, wild edible fruits are a rich source of vitamins, minerals, fiber, and antioxidants (Elmsellem *et al*., 2019; Diass *et al*., 2023). Valuable phytochemicals in certain medicinal plants, which hold substantial importance in treatment of diseases and exhibit potential in pharmaceutical development, are also detectable within some WEFs (Mwamatope *et al*. 2023). Various types of wild fruits have demonstrated a multitude of biological functions, encompassing antioxidant, antimicrobial, anti-inflammatory, anticancer, and anti-acetylcholinesterase activities (Li *et al*. 2016).

WEFs play an important role in the tribal communities of Nagaland. They provide essential nutrients that are necessary for maintaining good health and preventing diseases. In addition to their nutritional value, wild edible fruits also have economic importance for local communities in Nagaland. These fruits are often harvested from the forest and sold at local markets, providing an important source of income for rural households. The collection and sale of wild edible fruits can also promote sustainable forest management practices, as it encourages the conservation of forest resources. Despite possessing unique and captivating qualities that make them appealing and safe for human consumption, delivering economic as well as medicinal value, WEFs often undervalued due to limited information about them. The current investigation was conducted with the purpose of ascertaining the physico-chemical characteristics and evaluating the phytochemical composition of a selection of WEFs cultivated in Kohima, India. The collection and analysis of such data is anticipated to contribute not only to an enhanced comprehension of the intrinsic attributes of these fruits, but also to serve as a catalyst for the recognition and utilization of these fruits as potential sources of functional food. Consequently, it is expected that this study will pave the way for an augmented consumption of these fruits, thereby promoting the overall well-being and nutritional status of the populace.

2. Methodology

2.1 Collection and preparation of samples

The WEFs consume by the residents of the Kohima district, Nagaland, India were collected over the course of the specified time frame spanning from December 2022 to February 2023. The scientific names and families of these fruits have been meticulously compiled and presented in Table 1. Collected fruit sample was cleaned, packaged in a ziploc bag and immediately transported to the St. Joseph University, Nagaland laboratory for further processing. The fruit samples were initially washed with tap water and subsequently rinsed with distilled water. The excess surface water was eliminated by spreading and gently dabbing it dry (Figure 1).

Table 1. Names of selected wild edible fruits

Scientific name	English name	Family
Docynia indica	Wild apple	Rosaceae
Phyllanthus emblica	Indian gooseberry	Phyllanthaceae
Choerospondiasaxillaris	Nepali hog plum	Anacardiaceae
Spondias pinnata	Hog plum	Anacardiaceae
Passiflora edulis	Passion fruit	Passifloraceae

2.2 Physico-chemical characterisation

The physical characteristics of the fruit (weight, shape, width and length) were measured from randomly selected samples of matured unripe and ripe fruits. For each fruit, edible portions were cut into small pieces using a sterile knife. The cut samples were then divided into three separate parts: One portion of each sample was blended to extract juice or pulp, which was then used to measure the pH. Another portion was utilized to determine the moisture content (MC) and dry matter content (DMC) while, the remaining part was dried for further analysis.

pH of fruits was measured using 1:5 (w:v) in distilled water and recorded in pH meter. The MC was determined gravimetrically where triplicates of 5g of finely shredded fresh sample were dried at 105°C until constant weight. The sample was weighed repeatedly until a steady weight was noted. MC was calculated using the formula:

$$\text{MC (\%)} = = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \text{ X } 100$$

DMC was calculated as % dry matter = 100 - % moisture.

2.3 Phytochemical screening

To facilitate drying for phytochemical analysis, fruit samples were left to air-dry for a period of 24 hours and subsequently placed in a hot air oven set at 40°C. Once thoroughly dried, the material was processed in a kitchen blender to convert it into a powdered form (Figure 2). The powder samples were soaked in ethanol and water separately and kept under shaking condition for 72 hours at room temperature. The samples were filtered and collected filtrate was dried under evaporation. The extracted residue was re-dissolved in the appropriate extractant for several phytochemical analyses to produce a final volume of 10 mg/mL and the content was then kept cool (at 4°C) until it was needed. In accordance with standards protocols, extracts were tested for the presence of phytoconstituents (Abubakar and Haque 2020; Egwaikhide and Gimba 2007; Islary *et al*. 2016, Kokate 2005; Ramya *et al*. 2022).

2.4 Data analysis

Microsoft Excel 2010 was utilized to arrange the data collected for physico-chemical properties. For each parameter, data were expressed as the mean values of three replicates ± standard error mean.

3. Results and Discussion

Physico-chemical characterization and phytochemical screenings of WEFs are crucial for determining their roles in human health and nutrition as well as in developing strategies for their preservations. To investigate this further, a study was conducted focusing on evaluating the physico-chemical properties and phytochemical screening of five fruits used by the ethnic community of Kohima district in India.

3.1 Variation in physico-chemical attributes

The physico-chemical attributes of fruits encompass a multitude of physical and chemical parameters that govern the fruit's quality and its level of acceptance among consumers (Hazarika *et al*. 2023). Physico-chemical analysis of selected WEFs showed variations in all parameters studied. (Table 2). The length and breadth of selected WEFs ranged from 1.35 cm - 4.42 cm and 0.68-4.53 respectively. The sizes of these fruits were in the following order:

Phyllanthus emblica<Choerospondias axillaris<Spondias pinnata<Docynia indica<Passiflora edulis.

These differences in physical characteristics observed between WEFs can be attributed to a number of factors, including genetics, environmental conditions and growing conditions.

Figure 1. Wild edible fruits collected from Kohima. A. *Docynia indica*, B. *Phyllanthus emblica*, D. *Choerospondias axillaris*, E. *Spondias pinnata*, F. *Passiflora edulis*.

Figure 2. Finely powdered fruit samples.

For example, some species of WEFs may have naturally smaller or larger fruit sizes due to genetic differences, while variations in environmental conditions such as temperature, rainfall, humidity, light and soil fertility can also affect fruit size. These variations in the physical attributes of WEFs can result in significant consequences for their applications and potential economic worth. For instance, fruits with larger sizes may have more edible portions and be more suitable for processing and enhancing their value. Conversely, smaller fruits may be easier to transport and store, and may have unique flavor profiles or health benefits that are attractive to consumers.

Table 2. Physico-chemical properties of selected wild edible fruits from Kohima

Parameters	*Phyllanthus emblica*	*Docynia indica*	*Passiflora edulis*	*Spondias pinnata*	*Choerospondias axillaris*
Length (cm)	1.35 ± 0.10	3.9 ± 0.05	4.42 ± 0.13	4 ± 0.15	2.64 ± 0.07
Breadth (cm)	0.68 ± 0.08	4.53 ± 0.06	3.36 ± 0.09	3.17 ± 0.13	1.63 ± 0.06
MC (%)	85.33 ± 0.33	79.67 ± 0.33	75.67 ± 0.33	77.00 ± 0.51	78.67 ± 0.33
DMC (%)	14.67 ± 0.33	20.33 ± 0.33	24.33 ± 0.33	23.00 ± 0.51	21.33 ± 0.33
pH	3.59 ± 0.00	3.61 ± 0.01	3.83 ± 0.01	3.45 ± 0.01	3.78 ± 0.01

± indicates standard error mean

3.2 Phytochemical screenings of wild edible fruits

Evaluation of MC revealed relatively high amount in the studied WEFs (Table 2). MC and DMC are two of the important physico-chemical attributes in WEFs which determines the amount of water present in the fruit sample. The study revealed all the five fruits possessed MC above 75% and DMC less than 25% (Table 2). The highest MC in fruits is a crucial factor to take into account in order to assess the appropriateness prior to ingestion as it impacts the physical and chemical characteristics of the fruit, which are closely linked to the freshness and stability of the food during storage over an extended period of time, as well as its subsequent processing (Hazarika *et al*. 2023). MC was observed for *Phyllanthus emblica* with 85.33 % while the lowest MC was observed for *Passiflora edulis* with75.67%. On the contrary, DMC was observed to be highest in *Passiflora edulis* with 24.33% and lowest in *Phyllanthus emblica* with 14.67%. Among the WEFs, *Phyllanthus emblica* exhibited the highest MC and lowest DMC with 85.33 % and 14.67 % respectively. The present result is in

accordance with other study where the MC in fruits of various Indian gooseberry cultivars varied from 84.89 to 87.50% (Tewari *et al*. 2019). The MC in *Spondias pinnata* (77%) also agrees with another study where it was observed to be 77.23 % (Khomdram *et al*. 2014). On the contrary, Barthakur and Arnold reported MC of 79.8% in *Phyllanthus emblica* (Barthakur and Arnold, 1991). The lowest MC was observed for *Passiflora edulis* with 75.67% which is lower than the previously reported value of 83.76% (Lima-Neto *et al*. 2017). The decrease in moisture content of the fruits might be due to continuous moisture loss by evaporation and respiration in fruits (Khomdram *et al*. 2014). The differences could also be due to various factors including time of harvesting, maturity, variety, temperature, climatic and soil conditions. The pH of WEFs studied was in the range from 3.45 to 3.83 indicating the acidic nature of these fruits. (Table 2). The pH values of fruits are an indicative of its organic acid content hence it is also an important parameter in determining fruit quality. The highest pH was found in *Passiflora edulis* (3.83) followed by *Choerospondias axillaris* (3.78), *Docynia indica* (3.61), *Phyllanthus emblica* (3.59) and the lowest pH was recorded for *Spondias pinnata* (3.45). The acid content present in fruits can serve as an index for determining the maturity stage of fruits and can potentially be a key analytical measurement for evaluating flavor quality (Khomdram *et al*. 2014). This measurement can also be utilized to determine the full ripening age of the fruit and assist in determining the optimal harvesting time (Khomdram *et al*. 2014). The pH content of *Phyllanthus emblica* in this study was much higher than the reported 2.94 (Barthakur and Arnold, 1991). On the contrary, the pH of 3.45 in *Spondias pinnata* observed in the present study was slightly lower than those reported in other study (Khomdram *et al*. 2014) from Manipur where they recorded the value of 3.93. Differences in pH value in fruits with other regions could be due to soil pH and other soil conditions.

Phytochemical screenings of WEFs are crucial as it reveal the constituents of the plant extracts as well as the one that predominates over the others and helps in searching for bioactive agents which can be used in the synthesis of useful drugs (Pant *et al*. 2017). Screening and determination of phytochemicals from different plant parts can be carried out in polar solvents as well as water. The phytochemical screening of dried fruits extracts of *Choerospondias axillaris*, *Docynia indica*, *Passiflora edulis*, *Phyllanthus emblica* and *Spondias pinnata* from the Kohima district in Nagaland revealed the presence of major bioactive compounds including alkaloids, glycosides, polyphenols, flavonoids, tannins, carbohydrate, protein, saponins and phytosterols (Table 2).

The study found that all five WEFs tested contained alkaloids, which are naturally occurring organic compounds that can have various biological activities. Alkaloids show chemical compounds which contain basic nitrogen atoms and has importance medicinal properties including cytotoxicity, analgesic, antispasmodic and antibacterial (Anand and Deborah, 2017). The alkaloids result varied between tests used in these fruits (Table 2). Alkaloids detected through Wagner's, Mayer's and Hager's test showed positive result for Wagner's test in *Choerospondias axillaris*, *Docynia indica*, *Passiflora edulis* and *Spondias pinnata* whereas for Mayer's and Hager's test, it was positive in *Choerospondias axillaris*, *Passiflora edulis* and *Spondias pinnata* and *Phyllanthus emblica* respectively. This result suggests that different fruits may contain different types and amounts of alkaloids, which could potentially affect their medicinal properties. This also indicates that the specific alkaloids present in each fruit may vary, and that different tests may be needed to detect them. Further research is necessary to identify and quantify the specific alkaloids in each fruit and understand their potential health benefits.

The present study revealed the presence of saponins in all of the WEFs that were studied. This is not surprising, as saponins are known to be widely distributed in plant tissues and are commonly found in a variety of plant foods. Saponins are a type of naturally occurring plant compounds that have a wide

range of biological activities, including anti-inflammatory, antimicrobial, and immune-modulating effects. Saponins display certain attributes such as the ability to generate foams in aqueous solutions, hemolytic activity, their capability to bind to cholesterol, and their inherent bitterness (Anand *et al*. 2017). Saponins also possess the unique property of precipitating and coagulating red blood cells (Okwu, 2004).

Protein was not detected in most of the fruits as per Buirest and Xanthoproteic. Among the WEFs tested for proteins, it was present in only *Choerospondias axillaris* and *Phyllanthus emblica* indicating their nutritional power as potential protein supplements and hence can be considered as an efficient source of protein.

Table 2. Phytochemical screenings of wild edible fruits from Kohima

Phytoconstituents	**Test**	***Docynia indica***	***Choerospondias axillaris***	***Spondias pinnata***	***Passiflora edulis***	***Phyllanthus emblica***
	Wagner's	+	+	+	+	-
Alkaloids	Mayer's	-	+	+	+	-
	Hager's	-	-	-	-	+
Saponin	Saponin	+	+	+	+	+
	Legals	-	+	+	+	+
Glycosides	Hydroxyanth-raquinone	-	+	-	-	+
Flavonoids	Alkaline reagent	+	+	+	+	+
	Ferric	+	+	+	-	+
Phenols	chloride					
	Lead acetate	+	+	+	-	+
	Gelatin	+	+	+	-	+
	Ferric	+	+	+	-	+
Tannins	chloride					
	Lead acetate	+	+	+	-	+
	Gelatin	+	+	+	-	+
	Buirest	-	-	-	-	-
Protein	Xanthoprotei c	-	+	-	-	+
Carbohydrates	Fehling's	+	+	+	+	-
Starch	Iodine	-	-	-	-	-
Phytosterols	Salkowski	-	-	+	-	+
Anthraquinones	Modified Borntragers	+	+	+	-	+
Coumarins	Coumarins	-	-	+	-	+

+ indicates positive result; - indicates negative result.

The study conducted on presence of glycosides in WEFs showed that four out of the five fruits tested, namely *Choerospondias axillaris*, *Passiflora edulis*, *Phyllanthus emblica* and *Spondias pinnata*, contained glycosides (Table 2). Glycosides are a class of compounds that are widely distributed in plants and are known to have various biological activities. Glycosides such as cardiac glycosides act on the contractile force of the cardiac muscle as well as help in reducing the blood pressure and can be used as medicines in treatment of heart failure and certain irregular heartbeats (Islary *et al*. 2016). The Legal and Hydroxyanthraquinone tests were used to detect the presence of glycosides in the fruits. The results of these tests indicate that the selected wild edible fruits are a rich source of glycosides and may have significant nutritional and medicinal value for local communities.

Phenolic and flavonoid compounds are the most important classes of phytochemicals owing to their vast health benefiting properties (Roopashree *et al*. 2008). All of the selected WEFs extracts showed the presence of phenol except *Passiflora edulis* (Table 2). Phenols, when present, exhibit pharmacological characteristics that include the ability to prevent apoptosis, inhibit the development of cancer, reduce inflammation, slow down aging, prevent atherosclerosis, inhibit angiogenesis, stimulate cell proliferation, and offer protection to the cardiovascular system (Han *et al*. 2007). Phytoconstituents flavonoid was detected in all fruit extracts indicating their immense importance in human health especially in combating microbial infections. Flavonoids are hydroxylated phenolic substances, known to be synthesized by plants as a defensive response to pathogenic microorganisms as well as possess notable antioxidant properties and exhibit potent anticancer effects (Anand *et al*. 2017). Naturally, it has been documented that flavonoids possess a diverse array of advantageous impacts on the human body and possess significant therapeutic potential against a broad spectrum of ailments (Nyero *et al*. 2023).

The study conducted on the WEFs showed that the presence of tannins, a group of natural plant compounds with potential health benefits, varied among the fruits. Out of the five fruits that were tested, four fruits, including *Choerospondias axillaris*, *Docynia indica*, *Phyllanthus emblica* and *Spondias pinnata*, were found to contain tannins. On the other hand, *Passiflora edulis* did not show presence of tannins. This indicates that the nutritional and medicinal properties of these fruits may vary due to the presence or absence of tannins. Although tannins have conventionally been considered as anti-nutritional elements in food, their properties encompassing anti-inflammatory, wound healing, and antibacterial attributes, along with their remarkable efficacy in the prevention of cancer, indicate that wild edible plant species harboring tannins have the potential to serve as a valuable source of bioactive compounds in the realm of cancer treatment (Nyero *et al*. 2023). However, further research is necessary to determine the specific types and levels of tannins present in each fruit and their potential health effects.

Carbohydrates are universally acknowledged as a fundamental and indispensable source of energy that facilitates growth and enable proper physiological functioning. The results of Fehling's test demonstrated the existence of carbohydrates in all of the samples, with the exception of *Phyllanthus emblica*. Conversely, starch was not observed in any of the samples.

Phytosterols and coumarin was present in only *Phyllanthus emblica* and *Spondias pinnata*. On the basis of their antimicrobial and anti-inflammatory effects, coumarins may be deemed advantageous for treating hyperproliferative skin conditions (Theis and Lerdau, 2003). Another phytoconstituent anthraquinones were present in all the fruits, except for *Passiflora edulis*. Anthraquinones is an important secondary metabolite that exhibits antibacterial, antitrypanosomal, and anti-neoplastic activities (Anand and Deborah, 2017). The presence of anthraquinones in the fruits suggests that they may possess some of these potential health benefits. However, further research is necessary to understand the types and levels of anthraquinones present in each fruit and their specific effects on health.

None of the fruits exhibited the existence of all the phytochemicals investigated suggesting considerable variation in the chemical composition of different WEFs. The present result could be ascribed to various factors such as the genuine absence of these compounds, the divergent solvents employed, the techniques applied for extraction and analysis, and the fluctuations in seasonality and collection location (Mwamatope *et al*. 2023).

The findings of the present investigation revealed that the five WEFs encompass phytoconstituents that are both nutritionally and medicinally advantageous, thereby underscoring the importance of

preserving the traditional knowledge of their uses. This can help ensure that the benefits of these natural resources are not lost, and can continue to contribute to the health and well-being of local communities. In light of these findings, it is recommended that further research be conducted on these wild species by conducting clinical trials to assess their safety and efficacy, as well as exploring their potential for use in traditional medicine and as a source of natural health-promoting compounds.

Conclusion

WEFs are a part of the natural vegetation and are consumed by humans as a dietary food source owing to the presence of essential nutrients, including vitamins, minerals, fiber, and antioxidants. They are also known to have medicinal properties and can have important economic and environmental implications. The present study was carried out to assess the physico-chemical and phytochemical characteristics of five types of WEFs including *Phyllanthus emblica*, *Choerospondias axillaris*, *Spondias pinnata*, *Docynia indica* and *Passiflora edulis*. There were significant differences in the physical characteristics of WEFs studied, with varying lengths and breadths ranging from 1.35 cm to 4.42 cm and breadths ranging from 0.68 cm to 4.53 cm respectively. These differences can be attributed to multiple factors such as genetic differences, environmental conditions, and growing conditions. The highest MC with 85.33% was recorded in *Phyllanthus emblica*, while the lowest MC with 75.67% was observed in *Passiflora edulis*. On the other hand, DMC was highest in *Passiflora edulis* with 24.33% and lowest in *Phyllanthus emblica* with 14.67%. The pH values of the WEFs studied in the present research were in the range from 3.45 to 3.83 indicating the acidic nature of all the fruits.

All WEFs tested contain saponins and alkaloid, however, the results in alkaloid varied with test performed. Proteins were found in only *Choerospondias axillaris* and *Phyllanthus emblica*, indicating their nutritional power as potential protein supplements. Majority of the WEF extracts analyzed in the study contained phenol, tannin and anthraquinones with the exception of *Passiflora edulis*, suggesting the nutritional and medicinal properties of these fruits may differ depending on the presence or absence of these compounds. Glycoside was detected in four out of the five fruits studied conversely coumarin was detected only in *Phyllanthus emblica* and *Spondias pinnata*.

This research provides valuable informations that could be utilized to promote consumption of these fruits and to develop strategies inorder to preserve their diversity and cultural significance. It also highlights the importance of preserving natural resources and traditional knowledge for the benefit of local communities and global health. The study recommends conducting clinical trials to assess their safety and efficacy, as well as exploring their potential for use in traditional medicine and as a source of natural health-promoting compounds.

Disclosure statement

Conflict of Interest: The authors declare that there are no conflicts of interest.

Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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