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Exploring the Nutritional and Medicinal Potential of Wild Edible Plants: A Focus on *Fagopyrum* and *Diplazium* Species in Himachal Pradesh

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ABSTRACT

Wild edible plants hold immense potential as sources of nutrition and medicine, yet they remain underutilized and overlooked. This study focuses on exploring the nutritional and medicinal properties of three such plants—*Fagopyrum esculentum*, *Fagopyrum tataricum*, and *Diplazium esculentum*—from Himachal Pradesh, India. Both species of *Fagopyrum*, commonly known as buckwheat, are gluten-free pseudocereals rich in essential nutrients, antioxidants, and bioactive compounds like flavonoids and tannins. These compounds have shown significant potential in managing blood sugar levels, reducing inflammation, and improving cardiovascular health. Similarly, *Diplazium esculentum*, a lesser-known fern, is a powerhouse of bioactive compounds with antioxidant, anti-inflammatory, and anticancer properties, making it a valuable asset in traditional medicine and modern dietary practices. The phytochemical analysis revealed distinct variations in the bioactive components of the seeds and leaves of these plants, underscoring their unique nutritional profiles and potential health benefits. The survey results indicated a significant trend in the consumption of these wild edible plants, with about 80% of the population incorporating them into their diets weekly. Qualitative analyses also highlighted the diverse presence of bioactive compounds in various plant parts, with the strongest presence observed in the seeds of *Fagopyrum* species and the fronds of *Diplazium esculentum*. This research highlights the importance of incorporating these wild edible plants into modern diets and health practices, offering a natural, effective way to boost nutrition and combat chronic diseases. By tapping into the untapped potential of these plants, we can pave the way for the development of functional foods and beverages, contributing to food security, sustainable agriculture, and overall human well-being.

Key words: *Fagopyrum*, *Diplazium*, bioactive, phytochemicals, FTIR, wild edible plants

INTRODUCTION

Wild edible plants have long been recognized for their nutritional and medicinal properties, serving as a critical source of sustenance for a long time in various communities (Prakash et al. 2020). These plants are not utilized properly and are often overlooked despite their potential for food, medicine, and other applications. In recent years, there has been a rekindling interest in harnessing the potential of these underutilized resources, particularly in the development of functional foods and beverages (Ray et al. 2021, Shaheen et al. 2017). This research delves into the exploration of such wild edible plants, *Fagopyrum esculentum*, *Fagopyrum tataricum* and *Diplazium esculentum*. These plants, though belonging to different families, share the common trait of being edible and have significant potential for research and application. These pseudocereals are rich in essential nutrients, gluten-free, and possess antioxidant properties. *Diplazium esculentum*, a lesser-known edible fern, offers unique nutritional attributes and cultural significance in certain regions. Investigating the cultivation practices, nutritional composition, and potential applications of these underutilized plants can contribute valuable knowledge to the fields of agriculture, nutrition, and ethnobotany.

Fagopyrum tataricum also known as 'green buckwheat', 'tartary buckwheat' and 'wild buckwheat', is a wild species of common buckwheat i.e. *Fagopyrum esculentum.* It is locally known as *Phaphra* in many regions of Himachal Pradesh and is one of the most consumed wild edible plants (Figure 1) (Pirzadah et al. 2021). Tartary buckwheat is a flowering pseudocereal in the Polygonaceae family that can reach heights of 3–7 feet in the wild (Zou et al. 2021, Tang et al. 2022). The broad triangular leaves can reach a maximum length of 6 to 8 centimetres during the growing season March through July. The plant produces triangular-shaped, dark-coloured seeds that have white to pink blooms. The plant species can grow between 400 and 4400 m in altitude, demonstrating its extraordinary flexibility (Song et al. 2020).

Fig. 1: Plant samples of *Fagopyrum esculentum* and *Fagopyrum tataricum* from study area

STUDY AREA

Lug Valley is a valley in the Kullu district of the Himalayan region in the state of Himachal Pradesh, India. Kullu region of Himachal Pradesh is one of the plant diversity-rich areas in India, blessed with a variety of flora (Sahani et al. 2020). With an average elevation of 4,193 feet, it spans 5,503 km^2 and is located between longitudes 76º 9' and 77º 9' East and latitudes 31º 25' and 32º 35' North (Khanna et al. 2021) (Figure 2).

Fig. 2: Geographical location of the study area in district Kullu (Himachal Pradesh)

These plants, despite their wild origins, are attracting attention for their impressive health benefits. Packed with various bioactive compounds viz., flavonoids, triterpenoids, D-chiro-inositol, they also exhibit anti-inflammatory and antidiabetic properties in addition to significant antioxidative potential (Zou et al. 2021). Moreover, buckwheat's naturally gluten-free nature provides a valuable alternative for individuals with gluten allergies or celiac disease. Recent studies have suggested that incorporating Tartary buckwheat-based foods into the diet can offer additional health advantages, such as lowering blood sugar and fat levels (Bhinder et al. 2022). Cell damage, cell death and illness is mainly caused due to oxidative damage from the free radicals (Zou et al. 2021). Antioxidants are known to fight from these free radicals and thus incorporation of antioxidants in different food products has become a significant area of research (Akbari et al. 2022, Pedrouso et al. 2022).

Moreover, they are good source of fiber, vitamins A and C, and essential minerals like magnesium and potassium. Because of the abovementioned qualities, the plants taken under study can play an essential role in quality production of superfoods (Wronkowska et al. 2008). *Fagopyrum* have revealed its potential to positively impact human health through various formulations. Particularly noteworthy is its role in managing health conditions, specifically in regulating blood sugar levels (Ge et al. 2023). This positions *Fagopyrum* as a valuable asset for individuals dealing with diabetes or those actively seeking effective methods to control and stabilize blood glucose. The evolving body of knowledge underscores *Fagopyrum's* significance not only as a functional ingredient but also as a targeted solution for improving overall health outcomes. This opens up exciting prospects for further investigation and application in the realm of human health and well-being (Sharma et al. 2023). Its high fiber content slows digestion and sugar release, promoting glycaemic control. Moreover, its bioactive compounds are associated with cardiovascular health, including reduced cholesterol levels and improved blood pressure regulation.

Diplazium esculentum, commonly known as the vegetable fern, is a remarkable plant favoured not only for its culinary uses but also for its profound medicinal, phytochemical, and ethnobotanical significance (Pohthmi et al. 2023). This lush green fern, traditionally consumed in various parts of Asia, is emerging as a powerhouse of health benefits, because of its rich array of bioactive compounds (Figure 3).

From a medicinal perspective, *Diplazium esculentum* has been an essential part of traditional medicine systems for centuries. It is celebrated for its anti-inflammatory, antioxidant, antimicrobial, and anticancer properties, making it a natural remedy for many ailments (Majumdar et al. 2017). The fern's potent phytochemicals, including flavonoids, saponins, tannins, alkaloids, phenolic acids, terpenoids, and glycosides, contribute to its therapeutic potential. These compounds work synergistically to counter oxidative stress, reduce inflammation, and bolster the body's immune response, thereby enhancing overall health and well-being.

Fig. 3: Young coiled fronds of *Diplazium esculentum* from the study area

Ethnobotanically, the plant's fronds are often used in herbal preparations to treat digestive issues, respiratory problems, and skin conditions. Its role in folk medicine underscores its versatility and importance in maintaining health and treating diseases.

From a health perspective, incorporating *Diplazium esculentum* into one's diet offers a natural and effective way to boost nutrition and promote health. Its high nutrient density, coupled with its low-calorie content, makes it an ideal food for weight management and overall health maintenance. The fern's rich phytochemical profile aids in detoxification, supports cardiovascular health, and may even play a role in cancer prevention. *Diplazium esculentum* stands out as a multifaceted plant with significant medicinal, phytochemical, and ethnobotanical importance (Akbari et al. 2022). Adding *Diplazium esculentum* to modern health practices and diets can greatly improve health and help prevent diseases, making it a valuable natural wellness option.

By examining the phytochemical composition of these plants, this study opens the door to the creation of value-added food products that are enhanced by their special nutritional and bioactive qualities. Focus of this research lies in harnessing the synergistic potential of these ingredients, maximizing their individual benefits while creating a holistic experience that nourishes both body and soul. Through meticulous phytochemical analysis and careful formulation, the aim is to unveil the hidden gems of the Himalayas, transforming them into a delicious and health-promoting elixir.

MATERIALS AND METHODS

Survey and Sample Collection

Key Informant Survey

A detailed survey of localities from 10 different villages of the study area was conducted. The key informant survey aimed to evaluate the consumption rate, sources, and forms of consumption of significant wild edible species. Participants in the survey were selected for their familiarity and expertise with the area and the plant species identified during the focus group discussion. The informants included individuals renowned for their knowledge of wild edible plants as food, such as traditional healers, local foresters, wood cutters, hunters, market vendors (selling products derived from edible plants), and others. These individuals were also expected to have substantial knowledge about their community's situation, local natural resources, cultural practices, and the changes occurring in the area.

Plant Material

The wild species, i.e., *Fagopyrum tataricum* also known as tartary buckwheat was collected from the wild forests at a high altitude (~2300 m) of Lugvalley region of district Kullu, Himachal Pradesh in the months of March & April. *Fagopyrum esculentum* was collected from the cultivated fields which were grown at a lower altitude (~1700 m). The collected seeds and leaves were dried properly to avoid any form of fungal attack.

Extraction Procedure for Qualitative Analysis of Leaves and Seeds of *Fagopyrum* sp.

The leaves and seeds of *F. esculentum* and *F. tataricum* were grounded with mortar pestle. 5 g of plant powder of each sample was weighed and dissolved in 100 mL of 50% ethanol (solvent). The sample was kept in a shaker for 2 h and filtered through Whatman filter paper no. 1. The obtained extract was used further for the phytochemical analysis tests (Bhaduri et al. 2016).

Phytochemical Analysis of Secondary Metabolites

Phytochemical analysis of seeds and leaves of *F. tataricum* and *F. esculentum* were carried out as per the methods mentioned below.

Test for Flavonoids

Two to three drops of sulfuric acid were added to the extract, a bright yellow colour was formed, which indicated the presence of flavonoids.

Test for Saponins (Also Known as Foam Test)

The extract was shaken with 2 mL of water vigorously for 30 s. The presence of saponins is indicated if the foam generated lasts for ten minutes.

Test for Tannins and Phenolics (Ferric Chloride Test)

A few drops of dil. ferric chloride solution (5%) were added to the extract. The development of a blue-black hue denoted the presence of phenolics and tannins.

Test for Terpenoids (Salkowski Test)

A few drops of chloroform were added to the extract, and then H_2SO_4 was added to the mixture. The development of a reddish-brown hue signifies the existence of terpenoids.

Test for Coumarins

To the extract, a few drops of diluted 1N NaOH were added. Yellow coloration indicates the presence of coumarins.

Test for Lignins

To the extract, a few drops of 2% phloroglucinol solution was added. The formation of pink colour indicated the presence of lignins.

Test for Glycosides

To the extract, 2 mL of glacial acetic acid was added. It was mixed with a few drops of 2% $FeCl_3$ solution. The brown ring formation signifies the presence of glycosides.

Test for Carbohydrates (Reducing Sugars)

Fehling A and Fehling B were added to the extract in 0.5 mL increments. When the extract was heated, the presence of reducing sugars was indicated by the production of an orange-red precipitate.

Test for Steroids

Add 0.5 mL of anhydrous acetic acid to the extract and let it cool for 15 min in an ice bath. In the cold solution, 0.5 mL of chloroform and 1 mL of concentrated H_2SO_4 were added. Presence of steroids was confirmed by the formation of a reddish-brown ring interjunction of two liquids.

Test for Phenolics

To the extract (1 mL), equal volume of 1% $FeCl_3$ was added. The appearance of blue or green colour indicates the presence of phenols.

Test for Quinones

A few drops of conc. HCl was added to 2 mL of plant extract. The appearance of green colour of extract indicates the presence of quinones.

Test for Cardiac Glycosides

1 mL of glacial acetic acid was added to the extract followed by three to four drops of 5% $FeCl_3$. 1 mL of concentrated H_2SO_4 was added to the mixture carefully. The emergence of a brown ring at the contact indicates the presence of cardiac glycosides.

Test for Tannins

When 1 mL of 5% $FeCl_3$ is added to 2 mL of the extract, a yellow-brown precipitate is formed, which suggests the presence of tannin.

Test for Protein

In a test tube, 1 mL of 40% NaOH and 2 mL of the extract were mixed, $CuSO_4$ was gradually added to the mixture in one or two drops. Protein is present when the solution's hue changes to violet.

Test for Carbohydrates

After combining 2 mL of the aqueous extract with 2 mL of Molish's reagent (5%-α naphthol in absolute ethanol), the mixture was thoroughly agitated. It was carefully poured with 2 mL of concentrated H_2SO_4 along the test tube wall. The creation of a crimson ring at the intersection of two liquids suggested the presence of carbohydrates.

Qualitative Analysis of *Diplazium esculentum* *(Fronds)*

Preparation of Extract for Phytoconstituent Analysis of *Diplazium esculentum* Fronds

95% of three polar solvents chloroform, methanol and ethanol were used to prepare the extract for the phytochemical analysis of *D. esculentum* fronds. 4 g of finely ground fronds were taken in 100 mL of conical flask. 50 mL of 95% of chloroform/methanol/ethanol were added. The conical flask was placed in shaker for overnight incubation at room conditions. The extract was filtered using double layered Whatman filter paper. The volume was made up to 200 mL by adding 95% of chloroform/methanol/ethanol. The extract was stored at 4 °C after proper labelling for further phytochemical tests (Majumdar et al. 2017). Tests for saponins were similar to the phytochemical analysis of *Fagopyrum sp.*

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FTIR Analysis of the Plant Extract

The FTIR analysis of plant extracts from the leaves and seed powder of *Fagopyrum esculentum* and *Fagopyrum tataricum* and *Diplazium esculentum* was conducted following a standardized protocol. Initially, the leaves and seeds were dried and finely ground into a uniform powder. Ten grams of leaf samples and ten grams of seed powder were weighed and placed into separate beakers, to which 100 mL of ethanol was added for maceration. The beakers were covered and left at room temperature for 24 h, with occasional shaking. After the maceration period, the extracts were filtered using Whatman No. 1 filter paper to remove solid particles, and the filtrate was collected in clean, labelled glass containers.

RESULTS

The survey results revealed a significant trend in the consumption of wild edible plants during their respective seasons (Figure 4). It was found that a notable proportion of the population i.e. approximately 60%, incorporate these plants into their diets at least once a week, with an additional 20% consuming them twice a week. This indicates a consistent and widespread utilization of these nutritious resources within the community. Almost 60%, of individuals gather these wild plants directly from their natural habitats, where they grow abundantly and are freely available (Figure 4). This underscores the traditional practice of foraging for wild edibles, which not only supplements the diets of local residents but also comes at no financial cost to them.

Interestingly, for those residing in urban areas or infrequently visiting rural locales, approximately 40% of the population, the availability of these wild edibles differs. In such cases, individuals often rely on local vendors to procure these plants, suggesting a thriving market for wild edibles and presenting an additional source of income for villagers engaged in their collection and sale. Moreover, the versatility of these wild edibles was evident, with respondents reporting consumption in various forms such as vegetables (saag), pickles, chutneys, and more. Remarkably, over 90% of the surveyed population embraced the diversity of these plants by consuming them in multiple edible formats, showcasing their culinary adaptability and cultural significance within the community.

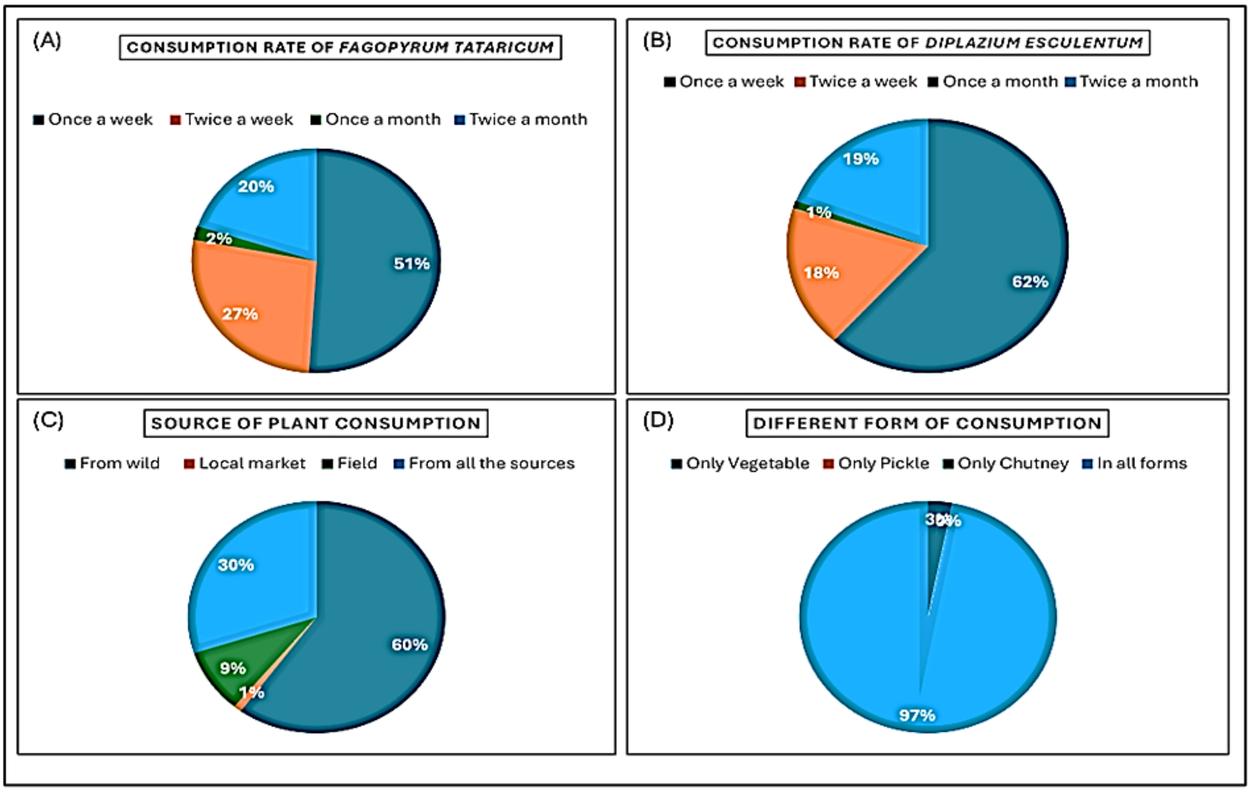

Fig. 4: (**A**) Consumption rate of *Fagopyrum tataricum and* (**B**) *Diplazium esculentum* by locals (**C**) No. of People consuming *Fagopyrum* from different sources (**D**) Different forms of wild plants consumed by people

Qualitative Analysis of *F. tataricum* and *F. esculentum* (Leaves and Seeds)

Qualitative analysis revealed the strong presence of flavonoids in seeds of both *F. tataricum* and *F. esculentum* while it was absent in the leaves of *F. esculentum* (Figure 5) (Hassan et al. 2017). Tannins and phenolics showed a strong presence in both the seed samples and *F. esculentum* leaves and were moderately present in the leaves of *F. tataricum*. Both terpenoids and coumarins were strongly present in leaves and seeds of *F. esculentum* in comparison to other samples. Glycosides showed a strong presence in *F. tataricum* leaves and *F. esculentum* seeds, while it was found to be absent in the seeds of *F. tataricum*. Reducing sugar was present in all the samples except the leaves of *F. esculentum*. Lignins were found to be absent in all the plant samples (Figure 6).

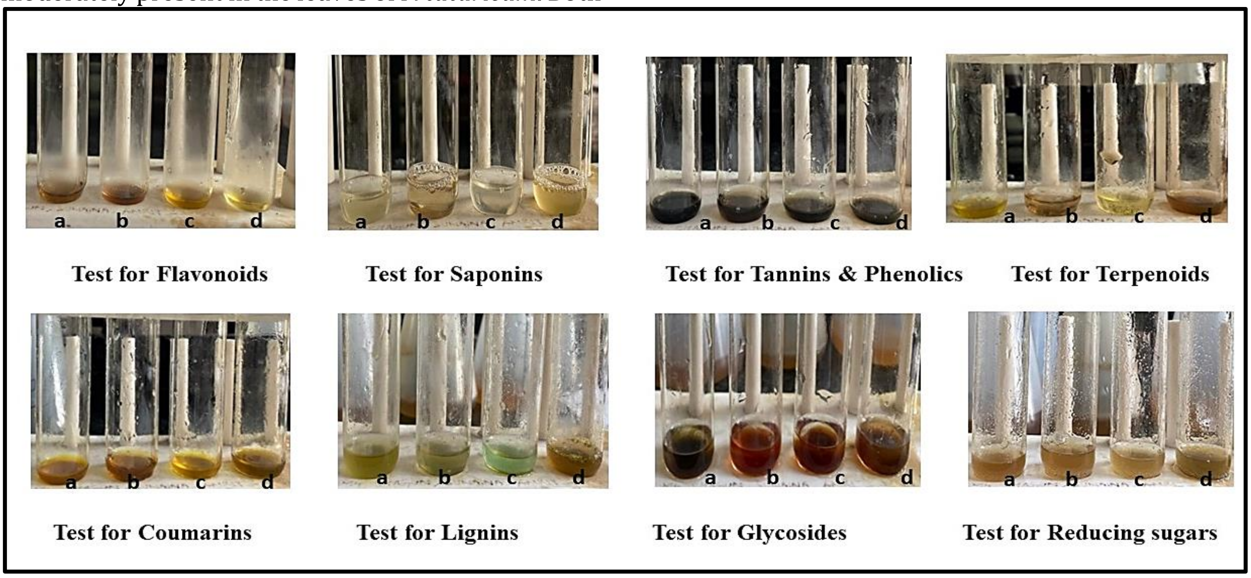

Fig. 5: Qualitative analyses of phytoconstituents in ethanolic extracts of leaves and seeds samples of *Fagopyrum tataricum* and *Fagopyrum esculentum.* (a= *Fagopyrum tataricum* seeds extract, b= *Fagopyrum tataricum* leaves extract, c= *Fagopyrum esculentum* seeds extract, d= *Fagopyrum esculentum* leaves extract)

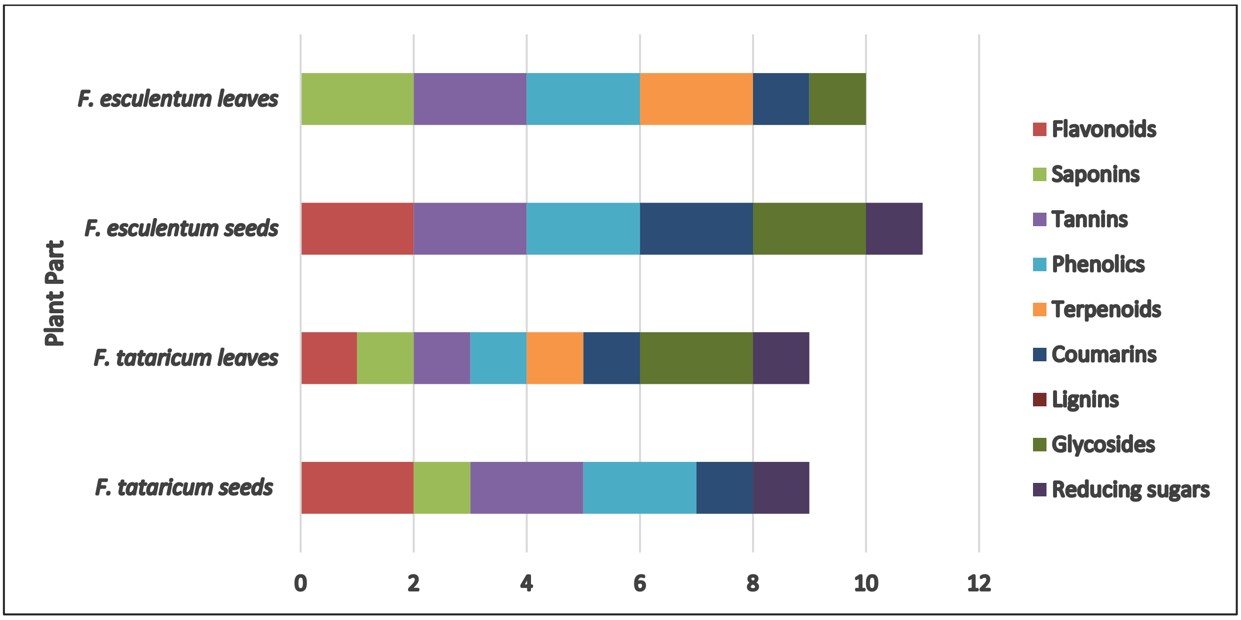

Fig. 6: Qualitative analysis of phytoconstituents in ethanolic extracts of leaf and seed samples of *Fagopyrum tataricum* and *Fagopyrum esculentum*

The qualitative analysis of phytoconstituents in the ethanolic extracts of *Fagopyrum tataricum* and *Fagopyrum esculentum* reveals distinct variations in the presence and strength of bioactive components across seeds and leaves. In *F. tataricum* seeds, a strong presence of flavonoids, tannins, and phenolics was observed, along with the presence of saponins, coumarins, and reducing sugars, while terpenoids, lignins, and glycosides were absent. *F. tataricum* leaves exhibited a strong presence of glycosides and a moderate presence of terpenoids, saponins, coumarins, tannins, phenolics, and reducing sugars, but flavonoids, lignins, and reducing sugars were either present weakly or absent. For *F. esculentum* seeds, flavonoids, tannins, and phenolics were strongly present, along with moderate levels of glycosides, coumarins, and reducing sugars, while saponins, terpenoids, and lignins were absent. In *F. esculentum* leaves, a strong presence of saponins, tannins, phenolics, and terpenoids was noted, with coumarins and glycosides also present, but flavonoids, lignins, and reducing sugars were absent.

Qualitative Analysis of *Diplazium esculentum* (Fronds)

Three distinct solvents were used for the phytochemical analysis of *D. esculentum* fronds: ethanol (95%), methanol (95%), and chloroform (95%). The results revealed that saponins were only present in the chloroform extract (Figure 7). Phenols and alkaloids were absent in all the extracts. Fronds of *D. esculentum* showed good presence of quinones, cardiac glycosides, tannins, protein, and total carbohydrates in all the three extracts. The extract with 95% chloroform revealed the best results in comparison to 95% methanol and 95% ethanol (Figure 7).

Qualitative Analysis of Phytoconstituents in Chloroform, Methanol and Ethanol Extracts of Fronds of *Diplazium esculentum*

The qualitative analysis of phytoconstituents in the chloroform, methanol, and ethanol extracts of *Diplazium esculentum* fronds reveals a diverse range of bioactive compounds (Figure 8). The chloroform extract demonstrated the presence of saponins, steroids, quinones, cardiac glycosides, tannins, proteins, and total carbohydrates, with an absence of phenolics and alkaloids. Similarly, both the methanolic and ethanolic extracts showed the presence of steroids, quinones, cardiac glycosides, tannins, proteins, and total carbohydrates. However, saponins were absent in these extracts, and like the chloroform extract, neither methanol nor ethanol extracts contained phenolics or alkaloids.

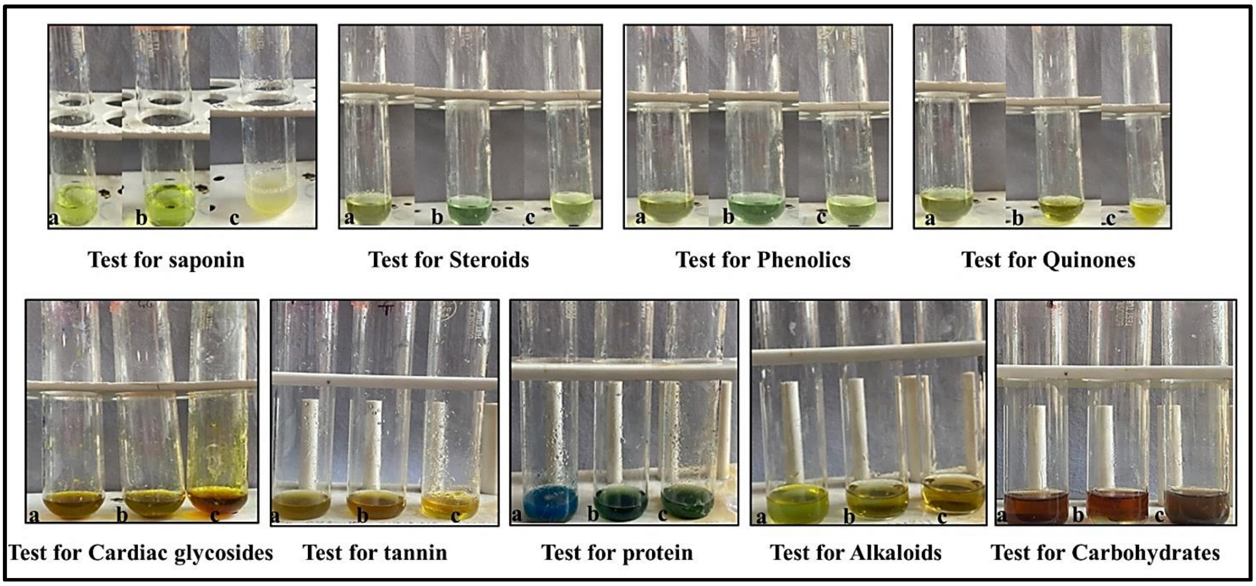

Fig. 7: Qualitative analysis of phytoconstituents in Chloroform, Methanol and Ethanol extracts of fronds of *Diplazium esculentum.* (a= Chloroform extract, b= Methanol extract, c= Ethanol extract)

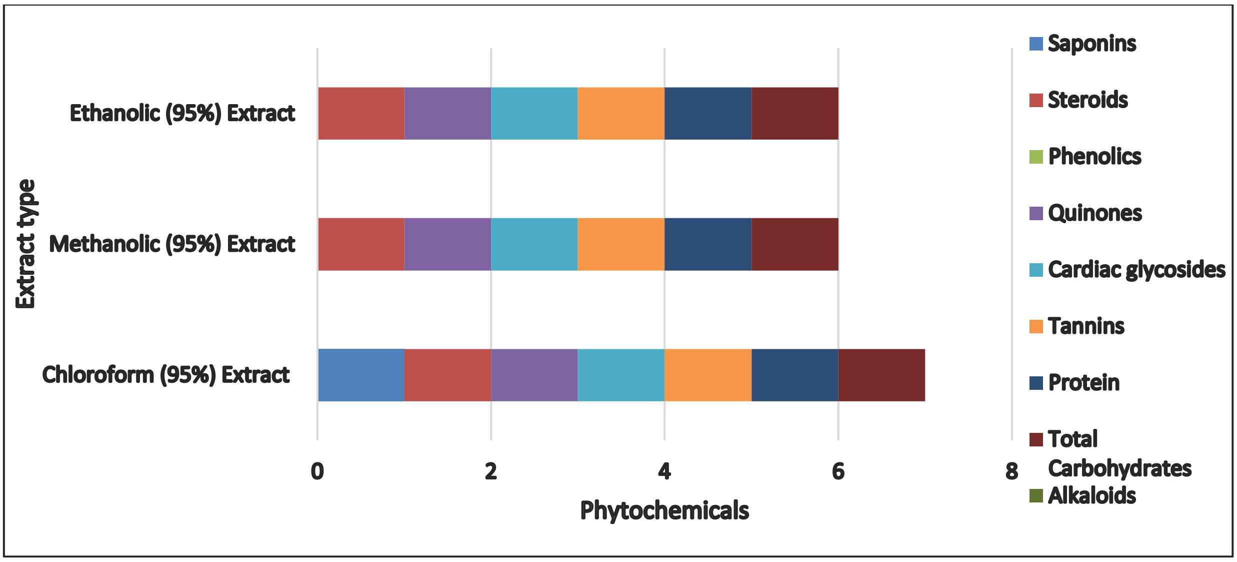

Fig. 8: Qualitative analysis of phytoconstituents in Chloroform, Methanol and Ethanol extracts of fronds of *Diplazium esculentum*

FTIR Results

Spectral data were recorded in the range of 4000 to 400 cm^{-1}, capturing the characteristic peaks corresponding to various functional groups. The resulting spectra were analysed to identify the presence of different organic compounds, including hydroxyl, methyl, methylene, and carbonyl groups, indicative of the biochemical composition of the plant extracts.

The FTIR analysis of *Fagopyrum esculentum* leaves reveals a rich chemical composition, with significant peaks observed at 3317.29 cm^{-1}, indicating O-H stretching vibrations in phenols, alcohols, and carboxylic acids. Peaks at 2944.08 cm^{-1} and 2831.81 cm^{-1} correspond to C-H stretching in methyl and methylene groups, suggesting the presence of lipids, waxes, and carbohydrates. Additionally, peaks at 653.47 cm^{-1} and 414.77 cm^{-1} suggest C-H bending vibrations in aromatic compounds or polysaccharides (Figure 9). Other notable peaks include 1448.77 cm^{-1} and 1409.79 cm^{-1} for C-H bending, 1114.08 cm^{-1} for C-O stretching in carbohydrates or esters, and high transmittance peaks at 2360.88 cm^{-1} and 2520.72 cm^{-1}, indicating C≡C stretching in alkynes or aromatic compounds. The FTIR analysis of *Fagopyrum tataricum* leaves also reveals a similar composition, with notable peaks corresponding to hydroxyl groups, methyl and methylene groups, C-H bending vibrations, and carbonyl bonds, indicating a presence of alcohols, phenols, carboxylic acids, lipids, carbohydrates, proteins, and aromatic compounds.

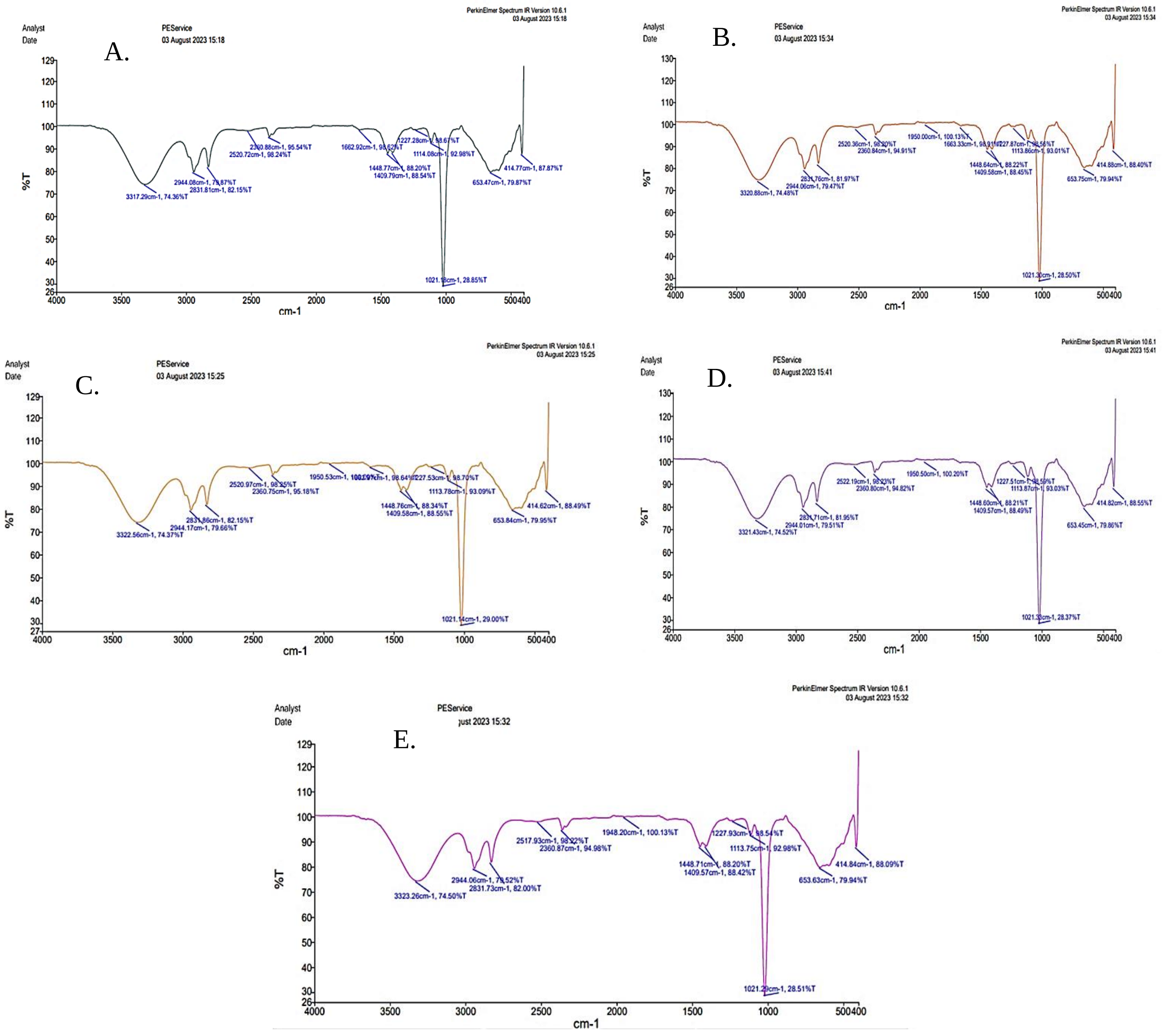

Fig. 9: FTIR spectra of (**A**) *Fagopyrum esculentum* leaves (**B**) *Fagopyrum esculentum* seeds. (**C**) *Fagopyrum tataricum* leaves (**D**) *Fagopyrum tataricum* seeds (**E**) *Diplazium esculentum* fronds

The FTIR spectrum analysis of *Fagopyrum esculentum* seeds shows peaks at 3320.88 cm^{-1} indicative of O-H bonds, suggesting moisture or free hydroxyl groups, while peaks at 2944.06 cm^{-1} and 2831.76 cm^{-1} are associated with C-H bonds in aliphatic hydrocarbons, pointing to lipids or oils. The spectrum also reveals peaks at 2360.84 cm^{-1} related to atmospheric CO_2 and 2520.36 cm^{-1} indicating nitrogen compounds, possibly amines or amides. The 1663.33 cm^{-1} peak corresponds to C=O bonds in carbonyl groups, indicating proteins or carbohydrates (Figure 9). Similarly, the FTIR analysis of *Fagopyrum tataricum* seeds indicates the presence of carbohydrates, aliphatic hydrocarbons, and potentially phenolic compounds, with peaks corresponding to hydroxyl groups, C-H stretching, and bending vibrations, as well as carbonyls.

Discussion

The present study highlights the significant nutritional and phytochemical properties of wild buckwheat (*Fagopyrum tataricum*), a notable wild edible plant in India. The findings align with the increasing recognition of wild edible plants as valuable sources of essential nutrients and bioactive compounds that can contribute to human health. *Fagopyrum tataricum* seeds demonstrate a rich presence of flavonoids, tannins, and phenolics, indicating their potential as a source of antioxidants and anti-inflammatory agents. The moderate presence of saponins and coumarins further suggests potential therapeutic uses, although the absence of terpenoids and lignins limits certain applications. The leaves of *F. tataricum* show a broader spectrum of phytochemicals, particularly with a strong presence of glycosides and terpenoids, which could be of interest in medicinal formulations, though the weaker presence of flavonoids may affect their antioxidant capacity. In contrast, *Fagopyrum esculentum* seeds are notably rich in flavonoids, tannins, and phenolics, aligning with their potential use in antioxidant-rich supplements. The presence of glycosides and coumarins adds to their therapeutic potential, although the absence of saponins and terpenoids might limit their versatility (Soleimanifar et al. 2019). The leaves of *F. esculentum* present a different profile, with a strong presence of saponins, tannins, phenolics, and terpenoids, suggesting their suitability for use in anti-inflammatory and antimicrobial treatments. The absence of flavonoids in the leaves, however, may reduce their overall antioxidant efficacy. Overall, these findings highlight the species-specific and organ-specific distribution of phytoconstituents, offering valuable insights for the development of targeted phytopharmaceuticals. The presence of multiple bioactive compounds across the different extracts of *Diplazium esculentum* fronds highlights the plant's potential medicinal value. The chloroform extract, in particular, displayed a wider variety of phytochemicals, including saponins, which were absent in both methanolic and ethanolic extracts. The consistent detection of steroids, quinones, cardiac glycosides, tannins, proteins, and carbohydrates across all three solvents suggests that these compounds are relatively abundant and possibly contribute to the plant's therapeutic properties.

In addition to its nutritional benefits, the phytochemical analysis revealed the presence of various bioactive compounds, including flavonoids, phenolics, and antioxidants (Kılıç et al. 2017). These compounds have been linked to numerous health benefits, such as anti-inflammatory, anti-diabetic, and anti-cancer properties. The high antioxidant activity of *F. tataricum* suggests its potential role in mitigating oxidative stress (Liu et al. 2019) and preventing chronic diseases. Moreover, the functional food properties of wild buckwheat indicate its possible incorporation into health-promoting diets. The FTIR results for both *Fagopyrum esculentum* and *Fagopyrum tataricum* highlight the complex chemical makeup of the leaves and seeds, characterized by a wide array of functional groups. The presence of O-H stretching vibrations in both leaf and seed samples suggests a significant amount of phenols, alcohols, and possibly moisture content.

The FTIR spectrum reveals that both the leaves and seeds of *Fagopyrum* species are rich in bioactive compounds, such as phenolic compounds, which are indicated by the aromatic C-H bending vibrations and the presence of hydroxyl groups. The detection of carbonyl groups and amides in the seeds is particularly noteworthy, as these functional groups are often associated with proteins and secondary metabolites, which could have potential health benefits (Kılıç et al. 2017). This chemical diversity underscores the potential applications of *Fagopyrum* species in food, medicine, and industry.

Given the rising interest in plant-based and functional foods, *F. tataricum* could be a valuable addition to health food markets, contributing to both culinary diversity and public health. However, further research is necessary to fully understand the bioavailability of these nutrients and phytochemicals and their effects on human health. Additionally, awareness and knowledge dissemination regarding the benefits of wild edible plants like *F. tataricum* are essential for promoting their consumption and integrating them into local diets.

Conclusion

This study underscores the remarkable potential of wild buckwheat (*Fagopyrum tataricum*) as a highly nutritious and bioactive-rich food source, particularly within the context of India's diverse edible plant heritage (Rauf et al. 2020). The comprehensive analysis of its nutritional composition reveals that *F. tataricum* is a valuable addition to the diet, offering a rich source of proteins, essential vitamins, and minerals that can significantly contribute to alleviating nutritional deficiencies in vulnerable populations. The identification of diverse phytochemicals, coupled with their associated health benefits, positions wild buckwheat as an important functional food with potential roles in disease prevention and overall wellness. Its high antioxidant activity highlights its relevance in combating oxidative stress, a contributing factor to many chronic health issues prevalent in modern society.

The findings of this research advocate for the greater recognition and utilization of *F. tataricum* not only as a nutritious food source but also as a sustainable agricultural option that can enhance food security and support local economies (Rodríguez et al. 2020). Promoting the consumption and cultivation of wild edible plants like wild buckwheat can help foster biodiversity conservation and sustainable development.

In summary, the study illuminates the multifaceted benefits of wild buckwheat (Fujita et al. 2019), encouraging its incorporation into health-promoting diets and highlighting the need for further research and awareness initiatives. By harnessing the potential of *F. tataricum*, we can move towards a more sustainable and health-focused pharmaceutical system, enriching the diets of communities while respecting and utilizing the ecological wealth of wild edible plants.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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