ETHNOECOLOGICAL DOCUMENTATION AND NUTRITIONAL ANALYSIS OF *NELUMBO NUCIFERA*

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Abstract

The historic town of Charsadda, located in the Khyber Pakhtunkhwa province of Pakistan, holds significant archaeological importance, with evidence of ancient civilizations such as the Gandhara and Mauryan periods. Its diverse flora, thriving in the fertile lands and along the Kabul River banks, consists of crops like wheat, rice, sugarcane, and fruit orchards, contributing to biodiversity and supporting local livelihoods. The lotus plant, *Nelumbo nucifera*, native to the region, thrives with its unique adaptations, symbolizing purity and spiritual enlightenment in various religions. Beyond its cultural and spiritual significance, the lotus holds medicinal properties, with its leaves, seeds, and rhizomes utilized for their anti-inflammatory, antioxidant, and antibacterial effects. This plant's enduring influence is evident not only in its practical applications but also in its depiction in art, literature, and architecture across cultures. The study of the nutritional composition of the lotus rhizome reveals its moisture content (2.65%), ash (3.45%), crude fat (1.15%), crude protein (15.15%), crude fiber (3.70%), crude carbohydrates (13.23%), starch (8.7%), vitamin C (29.3 mg), calcium (40 mg), iron (0.9 mg), phosphorous (53 mg), and potassium levels (273 mg), offering insights into its potential health benefits. This study provides a condensed overview of Charsadda's historical significance, diverse flora, the cultural importance of the lotus plant, its medicinal and nutritional value, and its enduring impact on human creativity and well-being.

Keywords: Ethnoecological, Nutritional analysis, *Nelumbo nucifera*, Rhizome, Crude protein, Charsadda, Pakistan.

Introduction

Charsadda is a historic town located in the Khyber Pakhtunkhwa province of Pakistan. Situated at the coordinates 34.1670° N latitude and 71.7366° E longitude, Charsadda is nestled in the Peshawar Valley, approximately 29 kilometers northeast of Peshawar, the provincial capital. This ancient town holds significant historical and archaeological importance. It is believed to have been inhabited for over 2,000 years, with evidence of ancient civilizations such as the Gandhara and Mauryan periods. Charsadda has witnessed the rise and fall of several empires, including the Achaemenid Empire, Mauryan Empire, and Kushan Empire. These influences have left their mark on the cultural and architectural heritage of the region.

Flora in and around Charsadda is diverse and reflects the geographical and climatic characteristics of the area. The region is primarily an agricultural hub, known for its fertile lands and extensive cultivation. Crops such as wheat, rice, maize, sugarcane, and vegetables thrive in Charsadda's agricultural fields. Fruit orchards, including apple, apricot, peach, and citrus, dot the landscape, adding splashes of color and providing a source of livelihood for local farmers. The natural vegetation of Charsadda includes shrubs, grasses, and various flowering plants. The banks of the Kabul River, which flows through the town, offer a habitat for riverine plants. Trees like acacia, eucalyptus and mulberry can be found in abundance, providing shade and enhancing the beauty of the surroundings.

The flora of Charsadda not only contributes to the region's aesthetic appeal but also plays a vital role in supporting biodiversity, maintaining ecological balance, and sustaining the livelihoods of the local population. The diverse plant life of Charsadda adds to the charm and allure of this historically rich town, making it a fascinating destination for nature enthusiasts, historians, and archaeologists alike. Flora of Charsadda is been documented by Shah *et al.* (2021).

The lotus plant is known for its unique adaptation, as it can withstand both extreme temperatures and water conditions. They come in a variety of colors, including white, pink, and sometimes even blue. The flowers possess numerous petals arranged in a distinct spiral pattern, creating an enchanting visual effect (*Sayre*, 2004). These blossoms are not only aesthetically pleasing but also emit a delightful fragrance, attracting pollinators like bees and butterflies. Beyond its physical beauty, Nelumbo nucifera holds immense cultural and spiritual significance. It is revered in several religions, including Hinduism and Buddhism. In these traditions, the lotus symbolizes purity, enlightenment, and rebirth. The unfolding of the lotus petals represents the

awakening of one's spiritual consciousness, while the plant's ability to rise above muddy waters and blossom in pristine beauty signifies the transcendence of worldly attachments. Furthermore, the lotus has numerous practical applications.

In traditional medicine, various parts of Nelumbo nucifera, such as the leaves, seeds, and rhizomes, are used for their medicinal properties (Sheikh, 2014). They are believed to have anti-inflammatory (Lin JY *et al.* 2006), antioxidant (Wu MJ *et al*. 2003), antibacterial effects (Venkatesh *et al.* 2011) and various secondary metabolites (Mukherjee *et al*. 2009). The lotus seeds are also consumed as a nutritious food source, often used in culinary preparations or as a healthy snack. In addition to its cultural and medicinal significance, Nelumbo nucifera has also inspired art, literature, and architecture. Its elegant form and symbolic meaning have been depicted in sculptures, paintings, and poems across different cultures. The lotus motif can be found in ancient temples, palaces, and even modern structures, serving as a testament to its enduring influence on human creativity.

Materials and Methods

The lotus rhizomes were collected from the natural growing fields in Charsadda, Khyber Pakhtunkhwa, in the company of classmates and a research supervisor. The selection of healthy and fresh rhizomes was ensured to obtain a representative sample. The collected lotus rhizomes were cut into small pieces and left to dry in sunlight for a period of two days. This process aimed to remove excess moisture from the rhizomes, facilitating their subsequent grinding. After the drying period, the cut rhizome pieces were ground to a fine powder using a grinder. This step aimed to homogenize the sample and prepare it for further analysis. The proximate analysis of the lotus rhizome powder was performed using the official methods outlined in the AOAC (Association of Official Analytical Chemists) 19th edition, 2012. The following parameters were determined: Moisture content, Ash content, Crude Protein content, Crude Fat content, Crude Fiber content, Crude Carbohydrates, Starch, Vitamin C, Calcium, Iron, Phosphorous and Potassium.

Results and Discussion:

Moisture:

Moisture refers to the presence of water or liquid particles in the form of vapor, droplets, or humidity within a given environment or substance. The moisture content of dried lotus rhizome was determined using the A.O.A.C Official method for analysis, 19th edition, 2012. The present analysis show 2.65% of moisture content. Sruthi *et al.* 2019. Reported 72.14%, Moisture content of 75.40% and 77.58% has been reported by Li *et al*. (2017) and Khattak *et al.* (2009) and Mukherjee *et al.* (2009) reported 83.80%.

Ash:

Ash is the inorganic residue that remains after the complete combustion or incineration of organic materials. The study revealed 3.45% of Ash content. Mukherjee *et al*. (2009) reported 1.22% and Faruk *et al.* (2012) reported 1.04%.

Table.1. Nutritional composition of Nelumbo nucifera rhizome

S. No	Parameters	Results
1.	Moisture (%)	2.65
2.	Ash (%)	3.45
3.	Crude Fat (%)	1.15
4.	Crude protein (%)	15.15
5.	Crude Fibers (%)	3.70
6.	Crude Carbohydrates (%)	13.23
7.	Starch (%)	8.7
8.	Vitamin C (mg)	29.3
9.	Calcium (mg)	40
10.	Iron (mg)	0.9
11.	Phosphorous (mg)	53
12.	Potassium (mg)	273

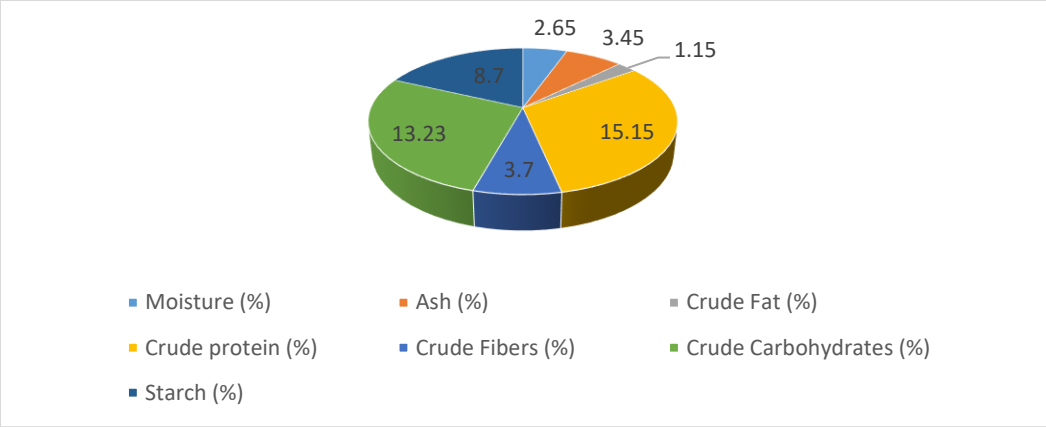

Fig. 1. Showing Percentage of Nutritional composition of *Nelumbo nucifera* rhizome

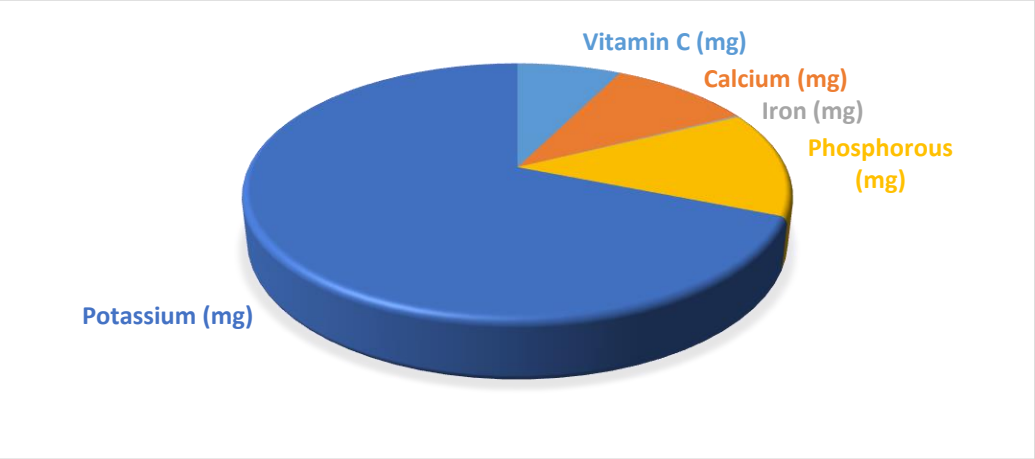

Fig. 2. Showing milligram of Nutritional composition of *Nelumbo nucifera* rhizome

Crude Fat:

Refers to the total fat content present in a substance. Analyzing crude fat content is essential in nutritional assessment, as fats serve as a concentrated source of energy and play various vital roles in the body, affecting factors such as palatability, digestibility, and absorption of certain nutrients. The study revealed 1.5% crude fat content form a dried Lotus rhizome. Sheikh. 2014. Reported 0.07 g of carbohydrates content in their study, Sruthi *et al.* (2019) studied fat content 0.10 g, Mukherjee *et al*. (2009) investigated 0.11 g of fat content.

Crude protein:

Crude protein refers to the total nitrogenous compounds present in a substance. Analyzing crude protein content is crucial in assessing the nutritional value of a sample, as proteins play a

fundamental role in various physiological processes, serving as the building blocks for tissues, enzymes, and hormones. According to the study findings, the dried Lotus rhizome exhibited a crude protein content of 15.15%. Sruthi *et al.* (2019) Reported 2.60% in fresh rhizome, Khattak *et al.* (2009) and Mukherjee *et al*. (2009) reported 1.10%.

Crude fibers:

Crude fibers refer to the indigestible plant components, including cellulose, hemicellulose, and lignin, present in a substance such as food or feed. Analyzing crude fiber content is essential in nutritional evaluation, as it provides insights into the material's dietary roughage or insoluble fiber content. It aids in assessing the potential impact on digestion, absorption of nutrients, and overall gastrointestinal health. According to the study results, the dried Lotus rhizome demonstrated a crude fiber content of 3.70%. Sruthi *et al.* (2019). Reported 4.20%, Sheikh (2014) reported crude fiber of 3.10 g. Khattak *et al.* (2009) observed 1.63 g. Paudel and Panth (2015) reported 0.85%,

Crude Carbohydrates:

Crude carbohydrates refer to the total carbohydrate content present in a substance, such as a food or feed sample, as determined through specific analytical methods. It encompasses all forms of carbohydrates, including simple sugars (monosaccharides and disaccharides) and complex carbohydrates (polysaccharides), without further differentiation of individual carbohydrate types. Analyzing crude carbohydrate content is significant in nutritional assessment, as carbohydrates serve as a primary source of energy for living organisms and play essential roles in various physiological processes. The quantification of crude carbohydrates aids in evaluating the overall carbohydrate composition and nutritional value of the Lotus Rhizome, providing valuable information for dietary and nutritional assessments. According to the study findings, the dried Lotus rhizome exhibited a crude Carbohydrates content of 13.23%. Sheikh. 2014. Reported 16.02 g, Khattak *et al.* (2009) reported 16.60 g, Sruthi *et al.* 2019. Reported 2.60, Mukherjee *et al*. (2009) reported 1.10%.

Starch:

Starch is a complex carbohydrate, composed of glucose units linked together, and it serves as a storage form of energy in plants. It is the most common carbohydrate reserve in many plant-based foods, such as grains, potatoes, and legumes. Starch can be broken down by enzymes in the digestive system to release glucose, providing a source of energy for human and animal

consumption. Due to its importance as a dietary carbohydrate, starch content is often analyzed in food and feed samples to assess their nutritional value and impact on energy intake. The study revealed 8.7% crude starch content form a dried Lotus rhizome. Man et al. 2012. Reported 40-60% starch content in the seed of lotus, Mukherjee *et al*. (2009) reported 9.25%, Sruthi *et al.* 2019. Documented 10.05%, Faruk *et al.* (2012) reported 8.7%, Syed *et al*. (2012) reported 15%, Geng *et al.* (2007) reported 21.16%.

Vitamin C:

Vitamin C, also known as ascorbic acid, is a water-soluble essential nutrient and antioxidant that plays a vital role in various biological processes. It is naturally found in many fruits and vegetables. As an antioxidant, vitamin C helps protect cells from oxidative stress by neutralizing free radicals, which can cause damage to cellular structures and DNA. Moreover, it aids in collagen synthesis, a crucial protein that supports the skin, bones, cartilage, and blood vessels. The present analysis show 29.03 mg of Vitamin C content. Sruthi *et al.* 2019, Reported 38 mg. Sheikh (2014) reported that the Vitamin C content of lotus rhizome as 27.4 mg. NIN (2002) reported 28 mg.

Calcium:

It is an essential mineral that plays a crucial role in various physiological processes within the human body. It is predominantly known for its role in maintaining strong bones and teeth, as about 99% of the body's calcium is stored in these structures. Calcium also plays a vital role in muscle contraction, nerve transmission, blood clotting, and the activation of certain enzymes. The study revealed 40 mg of calcium content. Sruthi *et al.* 2019 also reported 40 mg, Sheikh (2014) reported 27.4 mg Faruk *et al.* (2012) observed 0.26%.

Iron:

It is a crucial micronutrient required for various biological processes in living organisms. Iron is found in various dietary sources, including red meat, poultry, fish, legumes, nuts, seeds, and fortified grains. Its absorption is influenced by several factors, such as the form of iron present in the diet, individual iron status, and the presence of enhancers (e.g., vitamin C) or inhibitors (e.g., phytates) in the diet. Reveled 0.9 mg of iron content. Sruthi *et al.* (2019) reported 1.07 mg. Sheikh (2014) revealed 0.9mg. Mukherjee *et al*. (2009) reported the iron content of 0.05.

Phosphorous:

Phosphorus is an essential nutrient for both plants and animals. In plants, it plays a vital role in various processes, such as energy transfer, DNA synthesis, and root development. Plants absorb phosphorus from the soil in the form of phosphate ions. In animals, phosphorus is critical for bone and teeth formation, as well as for energy metabolism and cellular functions. It is obtained through the consumption of plants or animals that have accumulated phosphorus in their tissues. Adequate phosphorus intake is necessary for the growth, development, and overall health of both plants and animals. Reveled 53 mg of Phosphorus content. Sheikh (2014) stated 78 mg. Faruk *et al.* (2012) reported 6.77% and Sruthi *et al.* (2019) reported 58 mg.

Potassium:

Potassium is an essential mineral and electrolyte for plants and animals. In plants, it regulates important processes like enzyme activation, photosynthesis, and water uptake, leading to improved drought tolerance and disease resistance. Animals rely on potassium for fluid balance, nerve impulse transmission, and proper muscle function, including heart contractions. Plants absorb potassium from the soil as a positively charged ion, and it is crucial for their growth and development. Potassium-rich fertilizers are used in agriculture to enhance crop yields. Animals obtain potassium from various dietary sources, and adequate intake supports overall health and blood pressure regulation. Reveled 273 mg of Potassium content. Sheikh (2014) reported potassium of 363 mg.

Fig. 3. Nelumbo nucifera seeds

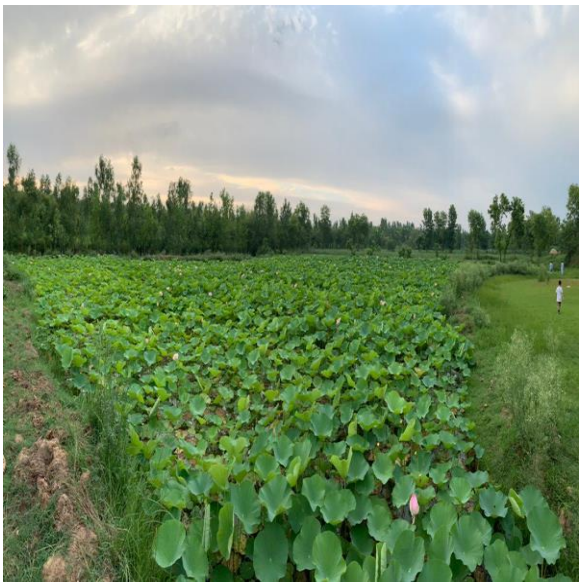

Fig. 4. Nelumbo nucifera field

Fig.5. Respected supervisor during field data collection

Fig.6. Nelumbo nucifera flower

Fig.7. Nelumbo nucifera Rhizome

Fig. 8. Cut placed for removal of moisture.

Conclusion

1) A native vegetation *Nelumbo nucifera* rhizome is collected and powdered.
2) The rhizome utilized for their anti-inflammatory, anti-oxidant and anti-bacterial effects.
3) Nutritional composition of lotus rhizome reveals crude protein (15.15%) as high.
4) Also reveal the potassium level with 273 milligram.
5) *Nelumbo nucifera* rhizome possess high nutritional and medicinal value.

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