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REVIEW OF MEDICINAL VALUES IN BAMBUSA VULGARIS

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ABSTRACT

The building construction industry is one of the largest consumers of energy derived from fossil fuels in various forms. As the world's population grows, so does the demand for housing, infrastructure, and development. Building materials have a high embodied energy due to chemical processes and other variables, notwithstanding advancements in technology. This study emphasizes the importance of using natural materials like bamboo, which are energy-efficient, have lower embodied energy, and are environmentally friendly. The study used a Universal Testing Machine (UTM) to assess the tensile and compressive strength of treated and untreated bamboo, comparing them to concrete and steel. Bamboo has the potential to be a sustainable building material for both small and large buildings, reducing the carbon footprint. It can be cultivated in numerous areas with no effort and is quickly refilled.

Plants are a valuable source of herbal remedies for treating specific diseases and disorders. Indigenous medicinal plants are increasingly being used in complementary and alternative medicine (CAM) due to their considerable contribution to pharmaceuticals. Bambusoideae is a big Poaceae grass family with 119 genera and 1482 species. Approximately 70% of Asia's bamboo woods are covered. This study will provide an overview of the ethnobotanical relevance and traditional knowledge of therapeutic plants in the Bambusoideae. This review provides valuable information on medicinal plants, their applications, and parts used by indigenous people and societies in Asian locations. Bamboo has made major contributions to the ethnobotanical area, particularly as medicines for various ailments, as reviewed here. Ethnobotanical data has successfully contributed to the CAM. This review on ethnobotany and traditional knowledge of bamboo has numerous benefits and can serve as a foundation for future study in the pharmaceutical area, both locally and worldwide. Herbal medications are commonly utilized in medical systems to treat and manage various disorders. Gold bamboo shoots (Bambusa vulgaris) have significant nutritional value, making them a viable food source. Gold bamboo plants have been traditionally utilized to heal human ailments. The phytochemical composition of this plant includes carbohydrates, glycosides, saponins, alkaloids, flavonoids, phenolics, tannins, phytosterols, triterpenoids, oils, and lipids. Gold bamboo has traditionally been used to treat malaria and diabetes. This plant has several pharmacological properties, including analgesic, antipyretic, antidiabetic, anti-inflammatory, antimicrobial, antioxidant, antiviral, antikidney stone, hepatoprotective, diuretic, abortifacient, anti-anxiety, and renal disease actions.

KEYWORDS: *Asia, Bambusoideae, Complementary and Alternative Medicine, Ethnobotany, and Traditional Knowledge.*

REVIEW OF LITERATURE

1. **Antony Kumar Boity**
   The building construction industry is a big consumer of energy derived from fossil fuels in various forms. As the global population grows, so does the demand for housing, infrastructure, and other forms of construction. With modern technology and innovation, a wide choice of building materials are accessible, but they have a high embodied energy due to several chemical processes and other considerations. The current research emphasizes the importance of using materials like bamboo, which are abundant in nature and can be easily used without requiring a lot of energy, have low embodied energy, and are environmentally sustainable.
2. **T. Vijaya Gowri**
   The Indian population is rapidly growing, and it is critical to meet their fundamental necessities such as food and shelter. It necessitates the use of additional construction materials and contributes to resource depletion. To ensure resource sustainability, it is vital to develop novel alternatives to conventional materials. Bamboo is a green, renewable, quick growing, and environmentally beneficial material that can be used as an alternative to steel reinforcement. This study discusses the various varieties of bamboos available, testing procedures, their use as reinforcement, testing methods for mechanical qualities, and a comparison between steel reinforcement and various forms of bamboo reinforcement.

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3. **Wei Zhang**
   Bamboo fiber is a novel type of natural fiber derived from bamboo using machine technology, and it is at the forefront of bamboo timber processing, innovative composite and textile research. The combing method is mostly used for processing bamboo fiber. Bamboo fiber had to be plastic and strong in order to be processed by machine. The purpose of this study is to investigate changes in mechanical properties - lengthways tensile qualities of bamboo following alkali treatment, with an emphasis on the relationship between lengthways tensile properties of alkali treated bamboo and moisture content. This research first identified the mechanism of bamboo plastic deformation.
4. **L. Y. Lee**
   Bamboo is one of the most rapidly growing natural building materials, and it is widely available in most developing countries, including South America, Africa, and Asia. Bamboo is a "green gold" plant in the tropical rainforest. It is a fast-growing monocotyledon plant from the Gramineae family (Bambusoideae) that requires little time to reproduce. Bamboo's physical strength has allowed builders throughout history to employ bamboo as a natural and sustainable construction material for houses and constructions. Because of its capacity to bend, bamboo is the most chosen material in vernacular construction, especially recently in Southeast Asian countries, which has birthed a new trend in architectural design.

INTRODUCTION

The building industry is the world's greatest energy consumer, accounting for over one-third of global energy consumption. Since the turn of the 20th century, the amount of energy consumed has increased alarmingly, and this trend is expected to continue in the years to come due to the growing population and all the energy-intensive industries—power plants, factories, transportation, and buildings that are expanding. According to a number of earlier studies, in order for developed and developing countries to evaluate and rank energy-saving initiatives in the world's biggest energy-consuming countries, a thorough analysis of energy use in the building sector is necessary. It has been discovered that choosing sustainable building materials and using them in construction has a number of advantages, including lowering the embodied energy of the materials, lowering the toxic emissions they produce, and affecting the building's environmental impact [3]. This highlights how important it is to use sustainable materials that have lower embodied energy and lifecycle carbon emissions. Doing so will minimize energy consumption and emissions and pave the path for a sustainable environment [4].

As a result of increased usage of new and innovative materials in building due to advancements in technology, the environment is being negatively impacted, mountains are being destroyed in the process of extracting minerals, and the limited supply of natural resources is being depleted. To maintain both the sustainability of building construction and the availability of natural resources such as land, water, and air for our future generations, we need to search for substitute materials. Globally, bamboo products are becoming more and more well-liked as an affordable, environmentally friendly, and sustainable alternative to traditional building materials [5]. It grows three times faster than most plants and is regarded as one of the fastest-growing grasses due to its rapidly expanding root system. "The Green Gold" is as sturdy as most of the wood on the market and is more affordable than timber [6]. This cutting-edge architectural building material will support sustainable development in the construction sector in addition to green development. Over 1200 species of bamboo belonging to more than 70 genera can be found throughout the world's more than 14 million hectares of natural forests, which have not received enough research attention [7]. Interestingly, about seven million hectares of bamboo forest, or South and Southeast Asia, are home to 80% of these species [8]. This includes China, India, and Myanmar. Bamboos are found growing practically everywhere in India, and they show good physical strength performance due to their high stiffness, high growth rate, high intensity, and superior thermal stability [9]. Additionally, this renewable resource is "one of the fastest growing plants."

Bambusa vulgaris, often known as common bamboo or golden bamboo, is a type of open bamboo cluster, according to Wikipedia [1]. Although it is native to southern China's Yunnan Province and Indochina, golden bamboo has been widely grown and has naturalized in several locations. Bamboo gold is one of the most prevalent and recognizable species of bamboo. The clumps that Bambusa vulgaris develops are loose and thornless. Its leaves are a dark green color, while its stems are lemon yellow with green stripes. The stems have thick walls, are initially robust, are not straight, are difficult to split, and are not flexible. Densely tufted stems are 4–10 cm thick and can reach heights of up to 10–20 m (30–70 ft). The trunk is either flexible or straight, drooping at the ends and curved in various directions. The walls of trunks are quite thick. Nodes somewhat increased. It is 20–45 cm (7.9–17.7 in) in length. From the center trunk node to the top, certain branches grow. The leaf blade is lanceolate and thin.

Large gramineous plants, bamboo can reach heights of 40 m and diameters of up to 20 cm on woody stalks (Scurlock et al., 2000). It is found all over the world, with 1707 species in 128 genera (Nayak and Mishra, 2016; Sawarkar et al., 2020; Vorontsova et al., 2016). Bambusa oldhamii Munro, which grows around 4 feet per day, is one of the fastest growing bamboo species on the planet, with a growth

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rate of up to 1 m per day (Wu et al., 2011). 36 million hectares (MH) of bamboo forest span the world; 16 MH are in India, 6.5 MH are in China, and 4 MH are in Brazil (Forest Survey of India (FSI), 2019; INBAR, 2019).



Picture: Bamboo Plant

MATERIAL AND METHOD

The mature bamboo specimen used in this study is between three and four years old. A green solution called Borax was applied to certain bamboo specimens to prevent fungal and insect assaults. The course of treatment lasted for three days. Sections of bamboo, both treated and untreated, were utilized and put through testing using a Universal Testing Machine (UTM). The compressive strength, tensile strength, and shear strength tests were performed.

PROPERTIES OF BAMBOO AS BUILDING MATERIAL

Fascinating findings were observed when comparing the mechanical characteristics of bamboo with several regularly used materials, like steel and concrete (Fig. 1). It is discovered that bamboo has compressive strength comparable to the grade of concrete that is frequently used in residential buildings. These days, M25 or M30 grade concrete is used for most building projects; this indicates that the concrete can support up to 30N loads per millimeter of area. Table 4 displays the capabilities of treated bamboo.

APPPLICATION OF BAMBOO IN THE BUILDING

Bamboo undergoes modifications and treatments to enable them to grow into the desired shape and structural form. All it takes to create a squared cross-section is to push the bamboo's tail inside. Bamboo can be bent into the desired shape by compacting it into the desired shape. This would be less expensive than using timber for a similar building. Bamboo can be given any required length, curvature, or shape in order to be used as a structural material, depending on the structural

BACKGROUND OF BAMBOOS IN ASIAN REGIONS

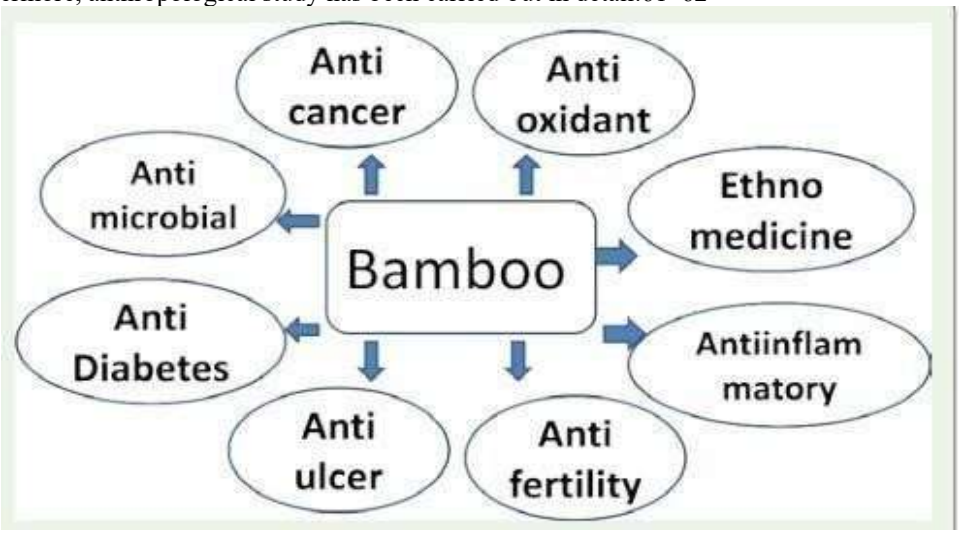
Bamboo is renowned for their hardiness, rapid growth, and brief harvest seasons. Additionally, they are affordable, offer a steady supply, and sustain people's livelihoods throughout history. Because of these characteristics, bamboo is a dependable resource for supplying the demands of a growing market, population, and growth.23–24 As a result, it has been deeply entwined with Asian culture, embodying the continent's bamboo civilization.25 Although these grasses are widespread throughout Africa, Latin America, and Asia, they

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originated in Southeast Asia. Climates mostly dictate the geographic distribution of bamboo.26 It can quickly adapt to a wide range of climatic and soil conditions, which allows it to be extensively dispersed in the tropical and subtropical zones between 46° N and 47° S latitude. It can reach elevations of up to 4000 m in the Himalayas and portions of China.27– 28 While 8.8 to 36°C is the ideal temperature range for bamboo to grow in, several species can withstand temperatures as low as -20°C.30 Because bamboo grows best in regions with heavy rainfall—roughly 1270 mm to 6350 mm or more— rainfall has a major influence on the distribution and growth of these species, as evidenced by studies 31– 32.

ETHNOBOTANT AND TRADITIONAL KNOWLEDGE OF BAMBOOS IN ASIA

"The study of plants used by humans" is the definition of ethnobotany, which was first used in 1896 by American botanist John Harshberger.55 Ethnobotany is a subfield of botany that studies goods made from natural sources, including food, building materials, fiber plants, coloring agents, fertilizers, taboos, avoidance, and poisonous and useful plants as well as magical or religious beliefs.56–58 Stated differently, ethnobotany is the study of the uses of native plants by humans in particular areas and civilizations.59 Nowadays, it is often accepted that ethnobotany and the organic, customary relationship between plants and people in a dynamic ecosystem are intimately related. .. Ethnic people largely depend on plants for nearly all of their daily wants and requirements, and they strongly believe that native folklore medicine is a part of the system. Indigenous societies' religious activities and beliefs are closely linked to the practical techniques that make up traditional medicine. Knowledge of medicinal plants plays a major role in traditional medicine. Six billion people, or around 80% of the world's population, rely mostly on traditional medicines, according to the World Health Organization.60 Furthermore, anthropological study has been carried out in detail.61–62



Picture: Bamboo Medicinal Properties

• **ANTICANCER ACTIVITY**

Since the test endpoint of mammalian cell transformation systems is the neoplastic conversion of target cells, they are especially helpful among the several short-term evaluation systems for the detection of environmental carcinogens/mutagens. For hundreds of years, people in Eastern Asia have utilized Sasa sentanensis leaves as a possible source of natural medicine. The alkaline extract made from the leaves is referred to as "Sasa health."

Using the BALB/c 3T3 A31-1-1 cell transformation system, the carcinogenic and tumor- promoting potential of Chikusaku-eki, a bamboo charcoal by-product used as a folk treatment, was assessed for carcinogenic/co-carcinogenic activity in BALB/c 3T3 cells. The findings demonstrated that Chikusakueki did not increase tumor growth [21]. Immune function inhibition is one of the unintentional causes of tumor growth. It has been demonstrated that polysaccharides derived from microbial cell walls or mushrooms are effective immunostimulant agents. Traditional Japanese medicine uses kumaizasa bamboo leaf extracts as an anti-inflammatory. The anticancer activity and immunopotentiating efficacy of bamboo (Sasa senanensis) leaf extracts prepared under "vigorous conditions" were assessed in a study on immunostimulus- mediated anti-tumor activity. The extracts activated natural killer cells and macrophages, indicating that they might be the main immunostimulant element that is crucial for preventing cancer. [22]

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• **ANTIOXIDANT ACTIVITY**

In many South-East Asian nations, bamboo shoots are the most widely consumed traditional food item, typically in the form of fresh, fermented, or canned goods. [26] conducted a study on overcoming cyanogenic toxicity and navigating high altitude for safe edible bamboo shoots with abundant nutritional qualities. In Asia, it was noted that eating bamboo species with high levels of total cyanogenic content (TCC) led to a high incidence of food illness. According to the study, edible bamboo species with large, strong bamboo shoot textures that have undergone morphological and genetic evolution and grow at low elevations have high levels of TCC, low antioxidant qualities, and low levels of advantageous macronutrients and micronutrients. Crucially, it is revealed that Dendrocalamus species have a high level of TCC regardless of the increasing altitude, but Bambusa species have a moderate amount of TCC. The results unequivocally showed that the high-altitude Chimonobambusa callosa species is a safe, nutrient-dense eating bamboo [26]. According to a prior study, antioxidant phytochemicals including phenolic compounds found in bamboo leaf extracts are responsible for their therapeutic benefits [27]. Studies on the antioxidant activity of "Moso" (Phyllostachys edulis), a plant grown in China, revealed notable inhibitory effects on ferrous metal-chelating abilities, superoxide radical, hydroxyl radical, and DPPH radical [28].

• **ANTIMICROBIAL ACTIVITY**

Bamboos are utilized as bioactive agents in many different products, such as the Chinese food's utilization of tender shoots, vinegar, juice, beer, salt, and bamboo charcoal (bintochan). Since ancient times, Chinese herbal medicine and Indian Ayurvedic medicine have utilized a variety of traditional medications linked to bamboos for the treatment of fever and detoxification. One common vegetative, monopodial bamboo species found in China's subtropics is Moso bamboo, which belongs to the Bambusoideae (Poaceae) family. Bamboos have long been employed as therapeutic agents in ethnomedicine to reduce inflammation and boost natural immunity, and many funguses related to bamboo have both medicinal and culinary uses.

Investigated the Antimicrobial Activity and Diversity of Cultivable Endophytic Fungi Derived from Moso Bamboo Seeds. During submerged fermentation, the crude extracts of isolates B09, B34, B35, B38, and 816 also showed varying degrees of bioactivities against pathogenic fungi that are bambusicolous. The antibacterial activity of endophytic fungus linked to Moso bamboo seeds was initially documented in this work, and the findings indicated that they might be used as a possible source of bioactive chemicals and activators of plant defense. They also concluded that, in contrast to the other strains reported, strains of Shiraia sp. that were isolated and cultivated from moso bamboo seeds could produce hypocrellin A at a high yield [33].

• **ANTI-DIABETIC ACTIVITY**

Reduced pancreatic output of insulin and resistance to its effects in several tissues, including muscle, liver, and adipose, result in type 2 diabetes, which impairs glucose absorption.

Obesity prevalence has increased in tandem with one of the main risk factors for type 2 diabetes. Managing type 2 diabetes often entails dietary and activity modifications, and the majority of patients eventually need pharmacotherapy, such as an oral anti-diabetic medication. 50 diabetic rats were used to test an extract from Moso bamboo leaves,which showed a hypoglycemic effect.
When Sasa borealis leaf extract was used in place of meat in a patty, plasma glucose levels dramatically decreased, suggesting that the extract had anti-diabetic properties [37].

Pseudosasa japonica leaves were tested for their ability to prevent obesity and diabetes in C57BL/6J mice fed a high-fat diet. Despite the fact that the mice given bamboo extract had a marginally larger food intake than the control group, their weight increase was still limited [37]. When streptozotocininduced, diabetic rats were used to test the petroleum extract of Bambusa vulgaris leaves for antidiabetic effects, it was discovered that oral administration of the extract When compared to the common medication glibenclamide, the oral administration of the petroleum extract of Bambusa vulgaris leaf for 15 days was found to be effective in significantly lowering the blood glucose level in a dosedependent manner, demonstrating the extract's anti-diabetic activity in streptozotocin-induced diabetic rats [38].

• **ANTI-ULCER ACTIVITY**

Rats' incidence of water immersion and restraint stress, ethanol-induced, and indomethacin-induced stomach ulcers was considerably decreased when a hot-water extract (Folin) of bamboo grass (Sasa albomarginata) was administered orally [40]. Through histological analysis of the rats' gastric mucosa treated with Folin, these researchers assessed the antiulcer effect of bamboo

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grass in rats. They found that microscopic blood clots covered the superficial epithelium, maintaining the cellular integrity of the gastric mucosa, particularly against stress ulcers.

Folin was observed to inhibit the release of histamine from rat mast cells, stabilize erythrocytes, and speed up their agglutination in acidic environments. It also reduced the incidence of hyperemia and a decrease in acid mucopolysaccharides in the ethanol-induced ulcer. According to their findings, the prevention of stomach lesions may be due to the microscopic hemostatic action of folate strengthened by a membrane-stabilizing effect.

- **ANTI-INFLAMMATORY ACTIVITY**

Indian traditional medicine has utilized Bambusa arundinacea preparations to treat a range of inflammatory diseases. The extract's anti-inflammatory properties are believed to be highly beneficial in the management of inflammatory diseases [42] sought to comprehend Bambusa arundinacea's antiinflammatory and anti-ulcer properties.

The majority of anti-inflammatory medications on the market are known to cause ulcers. When compared to conventional medications, the methanol extract of Bambusa arundinacea leaves has been shown to have a considerable anti-inflammatory effect against both immunologically and carcinogeninduced paw oedema, as well as antiulcer activity in albino rats. The most effective anti-inflammatory activity trial with the least harmful (no ulcerogenic) activity was discovered to be the combination of methanol extract and phenylbutazone (a non-steroidal anti-inflammatory agent, or NSAIA). Therefore, the best anti-inflammatory medication was found to be produced by combining a herbal product (methanol extract of Bambusa arundinacea) with modern medicine (NSAIAs). This combination can be helpful for the long-term treatment of chronic inflammatory conditions like rheumatoid arthritis with peptic ulcers, which are frequently observed.

- **ANTI-FERTILITY ACTIVITY**

Male rats' fecundity was decreased by an ethanolic extract of Bambusa arundinacea. Seven days of BASE treatment reduced fertility. Only eight days after BASE removal did mating behavior fully restore. There were fewer spermatozoa in the caput and cauda epididymis. Additionally, spermatozoa extracted from the cauda epididymis of experimental mice showed a concurrent decrease in motility [20]. Bamboo leaves are frequently used as animal feed, and some of the compounds found in them have been linked to miscarriages in pregnant animals [47]. This suggests that teratogenic active compounds, such as alkaloids, flavonoids, and triterpenoids, can kill a fetus in the uterus and then cause spontaneous abortion or resorption. However, it was shown that eating bamboo leaves, which contain antifertility chemicals, decreased the motility of sperm in male mice. The sperm mobility of cow spermatozoa was able to be decreased by the addition of bamboo leaf infusion, and the pace at which sperm motility declined increased with concentration.

- **ANTI-HYPERTENSIVE ACTIVITY**

A variety of proteins, carbohydrates, amino acids, minerals, fat, sugar, fiber, and inorganic salts are all present in bamboo stalks. Freshly picked bamboo shoots contain cyanogenic glycosides in high concentrations, which can lead to major issues. About 57–67% of the total amino acid content is made up of tyrosine. The aqueous extract of bamboo shoots contains fractions of angiotensin converting enzyme inhibitory peptide, often known as bamboo shoot peptide [BSP]. Because the phenolic ingredient in BSP has a vasodilatory effect that lowers hypertension, the proportion that was found indicated that Asp-Tyr was the essential compound and that it lowers systolic blood pressure medicinal uses of Bambusa vuigaris include-

- Managing intestinal parasites, discomfort, and stomach issues
- Managing skin issues
- Managing menstruation discomfort
- Addressing fever and diabetes

There is possible medical use for every part of the bamboo plant, including the rhizome, culm shavings, leaves, roots, shoots, and seeds.

CONCLUSION

An alternative material for inexpensive constructions is bamboo. When compared to other bamboo varieties such as Nola, Jewa, and Yngoon, Barak bamboo is showing greater strength.

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Bamboo fibers do not demonstrate the strength for which they were intended. Nonetheless, the hybrid concrete made by combining bamboo and steel shows comparable strengths to steel-reinforced concrete.

Because the experimental ultimate moment is greater than the intended moment, the bamboo reinforced slab can be designed using the working stress approach. It is advised to use bamboo instead of stee reinforcement.

Digital image analysis can be used to determine the fiber distribution in bamboo, allowing for a somewhat accurate calculation of the modulus of elasticity. Twin-mesh bamcrete offers excellent resistance to bullet fire. However, RCC panels are not demonstrating strong enough defense against gunfire.

Bamboo is a little-studied plant with a lot of therapeutic potential. In addition to its usage in food and crafts, bamboo requires further research. For bamboo to be widely used in a variety of therapeutic applications, its ethnopharmacological uses must be supported by solid scientific research.

In addition to providing millions of people with shelter, bamboo has long been used as a substitute for food and energy. Its natural abundance of amino acids, minerals, vitamins, and fibers makes it a promising raw material for nutritional products and medicines. Every part of bamboo contains beneficial Phytoconstituents that are good for human health, and it also contributes significantly to environmental maintenance due to its high capacity to sequester carbon and its 35% higher oxygen release than an equivalent stand of trees.

Globally, people are currently dealing with several health issues, such as obesity, cancer, and cardiovascular illnesses; bamboo may be a useful treatment for most of these conditions. Bamboo and their products were primarily utilized in traditional forms or as traditional medicine in the past, but in the last ten years, their high-quality nutritional components which are outlined below have led to their conversion and consumption as an advanced medicinal product.

- Anti-inflammatory qualities: Bamboo includes substances that have anti-inflammatory qualities, which could help cure ailments including asthma and arthritis.
- Antioxidant qualities: Packed with antioxidants, bamboo shoots can lower the risk of chronic illnesses like cancer and heart disease and shield cells from harm brought on by free radicals.
- Wound treatment: Because of its antibacterial qualities and capacity to accelerate the healing process, bamboo sap has long been used to treat burns, wounds, and other skin injuries.
- Respiratory health: In traditional medicine, bamboo leaves are used to treat ailments like bronchitis and coughs because they are thought to offer respiratory advantages. Digestive health: Rich in dietary fiber, bamboo shoots can help to regulate bowel motions and enhance digestive health.

Strong scientific research is required to support bamboo's ethnopharmacological application in a variety of therapeutic contexts. Carbohydrates, glycosides, saponins, alkaloids, flavonoids, phenolics and tannins, phytosterols, triterpenoids, oils, and fats were all detected in the methanol extract of the leaves of the plant, according to qualitative chemical tests, while phytosterols and triterpenoids were detected in the other extracts.

Analgesic, antipyretic, antidiabetic, anti-inflammatory, antibacterial, antioxidant, antiviral, anti-kidney stone, diuretic, hepatoprotective, abortifacient, anti-anxiety, and renal impairment medications are among Bambusa vulgaris's pharmacological properties.

The plants of the Bambusoideae family have made significant contributions to the realms of pharmacology and ethnobotany. The bamboo plants utilized by local communities and indigenous people in Asian countries, particularly to treat various illnesses and disorders, were compiled in this review article. It's interesting to note that these known plant species and their therapeutic benefits may serve as a solid foundation for further CAM research. Accurately identifying plant resources and materials for appropriate harvesting, as well as the compounds extracted, is essential to preventing their damage.

To help preserve and use native medicinal plants in the future, it is very important to make sure the right raw materials are being gathered and supplied for pharmaceutical use. In other words, people respect and are cognizant of indigenous tradition and wisdom. Therefore, it has been demonstrated that ethnobotanical research, particularly in Asian countries, may be one of the helpful methods for cataloging and documenting possible therapeutic plants, such as Bambusoideae.

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Bamboo is a resource that is widely available and should be investigated because its potential is not being fully realized. Utilizing bamboo in construction will lower carbon emissions and advance environmental preservation. More research is required to describe the development of bamboo materials, support the market industry's focus on bamboo materials, and efficiently reveal the possible benefits of bamboo-based building materials.

The authors affirm that none of the work described in this publication may have been influenced by any known conflicting financial interests or personal ties.

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