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Durian (*Durio* spp.) Shell as an important ingredient in Vietnamese and Asian traditional medicines: A review

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Abstract
The aim of this review was to comprehensively examine various traditional medicines and recipes derived from the Southeast Asian countries that prominently feature durian shell as one of the key ingredients. Durian (*Durio* spp.), renowned as the "king of fruits," is a highly sought-after tropical delicacy that thrives in Southeast Asia, particularly in countries like Thailand, Malaysia, and Vietnam. With its increasing popularity, the annual production of durian has surged significantly, reaching an impressive level of 1,000,000 tons in 2021 that position it as a vital agricultural commodity in the region. However, the production of durian generates significant waste, primarily from its thick, inedible shell, which is often discarded, hence, also triggers huge industrial interests in utilizing. The review's method used was synthesizing of existing literature from 2001 to 2024 in order to highlight the medicinal properties attributed to durian shell, which has been utilized in folk medicine for the treatment of a range of ailments, including respiratory issues, digestive disorders, and skin conditions. The results showed that, traditionally, durian shell has been used in Vietnamese and other Asian medicinal practices for its diverse pharmacological properties. And durian shell has been employed in various formulations aimed at treating fever, inflammation, skin conditions, digestive disorders, and liver detoxification. Its cooling, anti-inflammatory, antioxidant, and antimicrobial properties make it a valuable ingredient in remedies targeting both internal and external ailments. Notably, in traditional Vietnamese medicine, durian shell is used to balance the body's thermal state after durian consumption and treat conditions like diarrhea, joint pain, and fungal infections. This review also further highlighted the fact that scientific research and applications on durian shell's pharmacological effects is still extremely limited and demand proper validation and exploitation. This study contributed and underscored the significance of durian shell in traditional healing practices, providing a valuable resource for researchers and practitioners interested in exploring its therapeutic potential and promoting the integration of traditional remedies into contemporary healthcare frameworks.

Keywords: *Durio* spp., durian peel, agricultural waste, traditional remedies, medicinal applications

Introduction

Durian, commonly regarded as the "king of fruits," belongs to the genus *Durio* and comprises over 30 species, with *Durio zibethinus* being the most widely cultivated and recognized. Indigenous to Southeast Asia, durian grows in tropical areas, e.g. Vietnam, Malaysia, Thailand, Indonesia, and the Philippines, where it plays an essential role in local economies and cuisines. The fruit is characterized by its large size, thorn-covered husk, and distinctive odor, which can be polarizing to unfamiliar consumers. Despite its strong aroma, durian is revered for its creamy, flavorful flesh, earning it cultural significance in Southeast Asia, where it is integrated into social, cultural, and religious traditions [1]. In addition to its culinary value, durian has a rich history in traditional medicine. Across Southeast Asia, various components of the durian tree, including its shell, fruit, leaves, and roots, have been applied for medicinal purposes. Historical records indicate that durian was used to treat fever, skin conditions, and digestive disorders [2].

Traditional medicine remains a vital aspect of healthcare, particularly in rural and indigenous communities where access to modern medicine is limited [3]. Ethnopharmacology, which studies the medicinal use of plants, provides scientific frameworks for understanding the pharmacological properties of traditional remedies [4]. Plant-based materials, often derived from indigenous knowledge, serve as the foundation for many contemporary pharmaceuticals. The World Health Organization (WHO) estimates that neary 80% of the world population consumes folk medicine as part of their healthcare treatment [5]. This highlights the importance of validating and preserving traditional knowledge as a means of ensuring continued access to effective treatments, especially in the face of global health challenges. And the exploration of non-edible parts of fruits, such as peels, shells, and seeds, for their potential medicinal benefits has become a growing area of interest within ethnopharmacology [4]. These once discarded parts are now being studied for their bioactive compounds, which could offer new avenues for drug discovery. This shift in focus from edible to non-edible fruit parts aligns with sustainable practices by reducing waste and uncovering new therapeutic resources.

The objective of this review was to explore the traditional uses of durian shell and rind, parts of the fruit that are typically discarded, in medicinal practices. Historically, these non-edible components have been utilized in various treatments across Southeast Asia, yet scientific research validating their efficacy has only recently begun to emerge. Therefore, this review aims to summarize the ethnopharmacological applications of durian rind, examining how traditional knowledge aligns with modern scientific findings. By compiling both anecdotal and

empirical evidence, this review aims to provide a comprehensive understanding of the potential medicinal benefits of durian shell, contributing to the broader discussion of sustainable and effective uses of plant-based resources.

Recent situation of durian and its shell waste in southeast asian markets

Durian has long been a staple in Southeast Asia. The fruit's strong cultural and culinary significance has kept it in demand within regional markets, particularly in Vietnam, Thailand, and Malaysia. The cultivation of durian dates back centuries, but commercial production has only intensified in the last few decades as global demand grew, especially from China, where the fruit has gained a large following [6]. Southeast Asia produces nearly 90% of the world's durian supply, with Thailand being the top exporter. In recent years, Vietnam has rapidly increased its durian production, mainly in order to cater to the rising demand of both domestic and international markets. According to recent agricultural data, Vietnam's durian export in 2023 has seen a substantial increase, positioning the country as a major player in the market [7]. This shift is largely due to favorable conditions in the southern regions of Vietnam, where tropical climates allow for optimal durian cultivation.

According to the Ministry of Agriculture and Rural Development, several factors have contributed to the rise of durian production in Vietnam. The government's push toward diversifying agricultural exports, especially high-value crops, has led to increased interest in fruit cultivation, including durian. Additionally, the fruit's expanding popularity in China has spurred many Vietnamese farmers to convert other crops into durian orchards. Agricultural advancements, better farming practices, and government-supported programs have further accelerated the production of durian in regions like the Mekong Delta, where soils are ideal for the fruit. However, this rapid increase in durian farming has also brought about some concerns regarding sustainability, environmental impact, and waste management.

Phytochemical compositions and nutritional profile of the durian shell

1. Phytochemical compositions

The durian shell or rind, a part of the fruit typically discarded after consumption, has gained scientific attention due to its rich phytochemical profile. Recent studies have revealed that durian shell consists of a large quantity of bioactive compounds, including flavonoids, phenolic acids, saponins, tannins, and alkaloids [8]. Those phytochemicals are known for their potential health benefits and play a crucial role in traditional medicinal practices across Southeast Asia [9].

Flavonoids, a class of polyphenolic compounds, are abundant in the durian shell, as reporting of 0.405 ± 0.002 mg QE.g^{-1} in Monti durian shell [10]. Flavonoids are widely recognized for their antioxidant characteristic in the neutralization of free radicals and also in the reduction of oxidative stress. This antioxidant activity is significant as it contributes to the prevention of chronic diseases, e.g. cardiovascular diseases, cancer, and neurodegenerative disorders [11]. Additionally, flavonoids extracted from have anti-inflammatory and antimicrobial properties, which make them potential candidates for treating infections and inflammatory conditions.

Phenolic acids, another major group of bioactive compounds in durian rind, further enhance its medicinal value. Phenolic acids, such as gallic acid and ferulic acid, possess strong antioxidant activities and have been linked to anti-inflammatory, anticancer, and cardioprotective effects [12]. The phenolic compounds extracted from ripen durian (3180.32 - 5285.37 mg GAE.g^{-1}) help inhibit the production of pro-inflammatory molecules, contributing to their role in reducing inflammation-related diseases [13, 14]. Phenolic acids also contribute to the protection against oxidative damage, making them valuable for overall health maintenance.

Saponins, a class of glycosides commonly found in plant tissues, are also found with a considerable present in durian shells, with reporting up to 11 different types [2]. Saponins have a wide range of pharmacological effects, including their ability to lower blood sugar levels, boost the immune system, and exhibit anti-cancer properties [15]. Their ability to interact with cell membranes and modulate immune responses makes them promising candidates for further therapeutic exploration.

Overall, the rich phytochemical composition of durian shell provides a strong foundation for its use in traditional medicine. The identified bioactive compounds not only possess various therapeutic potentials but also align with the growing trend of utilizing plant-based compounds for modern medical applications.

2. Nutritional profile

Beyond its phytochemical composition, the durian shell also contains important nutrients that contribute to its medicinal value. One of the key components of durian rind is fiber, consisting of 60.45% of cellulose, 15.45% of lignin and 13.09% of hemicellulose [16], which plays a significant role in promoting digestive health. Dietary fiber is essential for maintaining gut health, preventing constipation, and supporting the growth of beneficial gut microflora. High fiber intake has been linked with a lower risk of developing gastrointestinal disorders, heart disease, and type 2 diabetes [17]. The durian shell also contains essential minerals, such as calcium (4.8 g.kg^{-1}), potassium (50.7 g.kg^{-1}), and magnesium (8.1 g.kg^{-1}) [18]. Calcium is well-known for its role in maintaining bone health, while potassium regulates blood pressure and supports proper muscle and nerve functions [19]. Magnesium plays a vital role in over 300 enzymatic reactions in the human body, contributing to energy production, protein synthesis, and muscle relaxation [20]. These minerals, though present in small amounts, have significant implications for health, especially in preventing mineral deficiencies and promoting overall wellness. Furthermore, trace elements, including zinc and manganese, are also present in durian shells [21]. Zinc (0.15 - 0.45 mg per 100 g fresh weight) [22] is an essential nutrient for immune function, wound healing, and DNA synthesis, while manganese plays a key role in antioxidant defense and bone development. These trace elements, though required in smaller amounts, are vital for maintaining various physiological functions and preventing chronic diseases.

As a result, the nutritional profile of durian shell highlights its underexplored potential as a medicinal resource. While traditionally discarded, this part of the fruit contains a variety of compounds that can offer health benefits ranging from antioxidant protection to improved digestive health. By exploring these components, researchers can pave the way for more sustainable uses of plant resources in both traditional and modern medicine.

Durian shell as an important ingredient in vietnamese and asian traditional medicines

1. Current status of the demand for consuming of traditional medicine in Vietnam

The demand for traditional medicine in Vietnam remains substantial, influenced by a combination of cultural traditions, public trust, and governmental support. Vietnamese traditional medicine, which encompasses Thuốc Nam (indigenous Vietnamese herbology) and Thuốc Bắc (herbology influenced by Chinese medicine), plays a significant role in both preventive and therapeutic healthcare. Studies suggest that around 60-70% of Vietnam's population utilizes traditional medicinal practices for various health conditions, particularly chronic diseases, immune support, and general well-being [23]. Vietnam's traditional medicine system is recognized for its holistic approach to health, focusing not only on treating symptoms but also on balancing the body's internal energies, i.e. Yin and Yang, and promoting harmony. Herbal remedies, acupuncture, and massage therapy are common treatments used in conjunction with conventional medicine. These practices are well-aligned with the global rise in demand for natural and integrative health solutions [24].

The Vietnamese government has implemented policies to support and promote the development and integration of traditional medicine into modern healthcare systems. Vietnamese traditional medicine is integrated into public healthcare facilities, including hospitals and clinics, with trained practitioners working alongside conventional medical professionals. The Ministry of Health in Vietnam has also established the National Institute of Traditional Medicine to promote research, standardize practices, and encourage the cultivation of medicinal plants [23]. The Vietnamese government actively supports the cultivation of medicinal plants to meet rising local and international demand, with over 3,800 species of medicinal plants being utilized. Research into these plants' pharmacological effects has gained international attention, further driving Vietnam's role in the global herbal medicine market [23].

Additionally, the World Health Organization (WHO) has recognized the importance of integrating traditional medicine into healthcare systems, promoting safety, efficacy, and accessibility. The WHO's Global Centre for Traditional Medicine is working to scale up these efforts, and Vietnam is a participant in these initiatives to ensure traditional medicine plays a sustainable and safe role in modern healthcare [25].

2. Status of durian shell usage as an ingredient in traditional medicines

In Southeast Asia, especially in China and Vietnam, parts of the durian fruit, particularly the shells, have been traditionally used in folk medicine for their health benefits [9]. Durian shells, often discarded as waste, are rich in bioactive compounds such as flavonoids, polyphenols, lignin, and cellulose, making them valuable in traditional remedies [1]. The sustainable development of traditional medicine resources can be ensured by medicinal research on agricultural leftovers, which supports the growth of the circular economy and environmental protection. Traditional medicinal preparations using plant parts in these countries generally involve processes such as boiling, grinding, or fermenting the materials to extract the active compounds [2]. Durian shells are typically dried and ground into powders or boiled to create decoctions, which are then applied topically or ingested as part of herbal treatments [26]. The high bioactive content also suggests that they may have detoxifying properties, aligning with the traditional use of plant-based remedies to balance the body's internal health. These practices reflect the cultural importance of utilizing natural resources in holistic health management across Southeast Asia.

3. Various applications of durian shell in Vietnamese and Asian traditional medicine practices

3.1. Skin nourishing and moisturizing

In traditional medicine, durian husk has been utilized for various purposes, particularly in Southeast Asian countries, owing to its unique medicinal properties. In nature, durian shells have a warm characteristic, a strong and sweet flavor that enters the lung, liver, and kidney meridians. They also show signs of skin nourishing and moisturizing against dryness [2]. Additionally, the high antioxidant content helps reduce oxidative stress, and is believed to assist in rejuvenating the skin and promoting wound recovery [22]. Although these remedies are based on traditional knowledge and practices, it is important to seek guidance from a licensed practitioner or expert to ensure safe and effective usage.

3.2. Relaxation

Durian shell is believed to have calming properties that help alleviate insomnia and promote relaxation. The cooling nature of the durian shell works to balance the body's internal heat, which is often associated with restlessness, agitation, or an overactive mind—common contributors to insomnia. By clearing this excess heat, the shell is thought to restore the body's natural equilibrium, allowing the mind to settle and improving the quality of sleep. Additionally, unbalanced or excessive Yang energy can cause difficulty in relaxing, while the cooling and Yin-nourishing qualities of the durian shell help to harmonize these energies [27]. It is often prepared as a decoction or herbal tea, sometimes combined with other calming herbs, to soothe nervous tension and support restful sleep. This holistic approach targets the root causes of insomnia rather than just the symptoms.

3.3. Controlling of internal heat

One of the common applications of durian husk is in formulations aimed at reducing fever and clearing internal heat. This remedy typically includes ingredients such as durian husk, which can be used either fresh or dried, together with other medicinal herbs, e.g. *Imperata cylindrica*, *Chrysanthemum morifolium*, and *Glycyrrhiza uralensis*. These components are cleaned, dried, and boiled together to produce a beverage that helps lower body temperature, reduce fever, and detoxify the body. This use of the durian shell was proven to help subside the fever condition of infants [28]. Another remedy involves using durian husk to balance body heat after consuming durian fruit. In this case, the husk is boiled with water, and sometimes with added *Mentha arvensis* leaves to create a drink that helps regulate body temperature and prevent conditions such as mouth ulcers or acne, which are often associated with the heating properties of durian flesh [28].

3.4. Detoxification, digestive and fertility support

Another notable application of durian shell is in liver detoxification and digestive support. When boiled with *Glycyrrhiza uralensis*, *Lactuca indica*, and *Curcuma longa*, the resultant decoction helps enhance liver function, improve digestion, and cleanse the body, largely due to the antioxidant properties present in durian husk. In addition, durian husk boiled with water is also utilized in diarrhea treatment by soothing the intestines and reducing symptoms of diarrhea [29]. In India and the Nilgiris, durian is highlighted for its fertility enhancement, as well as the consumption of its burnt peel during women's post-childbirth period [29].

3.5. Antioxidant and anti-inflammatory

Durian husk is employed in formulations designed to treat inflammation and skin abscesses. When combined with other ingredients, e.g. *Piper betle*, *Lonicera japonica*, and *Camellia sinensis*, the final mixture not only aids in reducing inflammation but also provides antibacterial benefits, promoting the healing of skin wounds and addressing bacterial skin conditions like abscesses [29]. Beyond internal treatments, durian husk is also used in formulations for relieving joint pain. When combined with *Artemisia vulgaris*, *Zingiber officinale*, *C. longa*, the husk is processed into a topical ointment or poultice applied to affected areas of the joints, where its anti-inflammatory properties help alleviate pain and swelling. Additionally, in Thailand and Malaysia, durian shells have also been employed to treat skin conditions and inflammation [22].

3.6. Anti-cancer

The consumption of a decoction made by boiling durian shell in water is traditionally believed to reduce cancer risk due to the presence of bioactive compounds. Research suggests that durian shell, rich in flavonoids and saponins, has promising anti-cancer properties. These compounds are known to induce apoptosis, or programmed cell death, in cancer cells, making durian shell a potential natural remedy for combating cancer [30]. A study on liver cancer cells demonstrated significant cytotoxic effects of durian extracts, including the shell, indicating its ability to inhibit cancer cell growth. However, while these early results are encouraging, further research is necessary to fully understand the molecular mechanisms and potential therapeutic applications of durian shell in oncology.

3.7. Antimicrobial and anti-fungal properties

The antimicrobial properties of durian shell extracts are often utilized to create natural ointments for wound healing and bacterial infections. In addition, for treating fungal skin infections, durian husk is dried, ground into powder, and mixed with *C. sinensis* leaves and *Angelicae dahuricae* to form a paste applied to the affected areas. The antifungal compounds in durian husk aid in cleansing and treating fungal conditions such as nail or foot fungus. As a consequence, an antimicrobial gel from durian husk was developed at lab-scale as an advancement in the value-added applications [31].

3.8. Potential antidiabetic properties

There is an increasing interest in the antidiabetic properties of durian shell, particularly its potential to help regulate blood glucose levels. Studies have indicated that the phytochemical profile of durian shells, rich in flavonoids and phenolic compounds, may contribute to their hypoglycemic effects [32]. Research shows that certain polyphenolic compounds can enhance insulin sensitivity and modulate glucose metabolism, potentially offering therapeutic benefits for managing diabetes. Additionally, the high fiber content in durian shells may also play a significant role in controlling blood sugar levels by slowing glucose absorption in the intestines and improving overall digestive health [32]. This combined action of phytochemicals and dietary fiber suggests that durian shell extracts could be valuable in developing natural adjunct therapies for diabetes management.

However, while preliminary findings are promising, more extensive research is required to fully elucidate the specific mechanisms through which durian shell affects blood glucose regulation and to determine the appropriate dosage and formulation for therapeutic use. Understanding these interactions could pave the way for innovative approaches to diabetes management, leveraging durian shell as a sustainable resource in functional foods and nutraceuticals.

4. Precaution in the usage of durian shell as an ingredient in traditional medicines

Traditional medicine is often described in vague terms, lacking standardized dosages, formulations, and scientific validation. This uncertainty can result in inconsistent outcomes and safety concerns. Many remedies rely on anecdotal evidence and cultural beliefs, with minimal clinical research to support their efficacy [33]. Moreover, traditional remedies can be utilized by individuals of all ages, but caution is advised, particularly for infants and the elderly. In children, dosages must be adjusted based on body weight and age, as their metabolic responses can differ significantly from adults. For older adults, potential interactions with prescribed medications necessitate careful consideration. As a result, it is crucial for practitioners to assess individual circumstances and consult scientific literature to ensure the safe and effective use of traditional medicine across various age groups [34].

The overuse of durian shell in traditional medicine may raise concerns about both sustainability and potential adverse health effects. While durian shell contains bioactive compounds such as flavonoids, saponins, and polyphenols, which have been linked to anti-inflammatory, antioxidant, and antimicrobial properties, excessive harvesting of durian shells for medicinal use could contribute to environmental degradation. Overharvesting might disrupt ecosystems and affect durian tree populations in Southeast Asia [35]. Additionally, the unregulated use of durian shell, especially without proper scientific validation, could pose risks, such as skin irritation or allergic reactions [36]. Although the therapeutic properties of durian shells are promising, careful regulation and sustainable practices are necessary to prevent misuse and ecological harm. Further research is also needed to standardize the extraction methods and evaluate long-term effects in traditional and modern medicinal contexts.

Potential orientation for durian shell in modern medicine

Recent advancements in extraction methods have improved the efficiency of isolating bioactive compounds from durian shells [37]. Green ethanol-based solvent extraction is an efficient method for isolating valuable compounds from

durian shells [38]. Ethanol, a less toxic and environmentally friendly solvent, is often used to extract valuable chemicals such as flavonoids, and essential trace elements like zinc and magnesium. The polar nature of ethanol allows it to dissolve and extract a wide range of bioactive substances from the fibrous husk material. Research highlights that ethanol extraction can optimize the recovery of functional compounds from durian shells, offering advantages in producing high-quality extracts for food, pharmaceutical, and cosmetic applications. Ethanol also provides a safer and more sustainable option for processing plant waste, such as durian shells, making it a valuable technique for converting agricultural byproducts into useful materials in comparison to traditional acid-based solvents [39]. This method contributes to the valorization of durian waste, improving its economic and environmental potential.

Durian shell extract, containing bioactive compounds like flavonoids, phenolic compounds, and trace elements, e.g. zinc and magnesium, is being explored for formulation into modern supplements and pharmaceuticals. These extracts exhibit potent antioxidant, anti-inflammatory, and antimicrobial properties, making them suitable for development into nutraceuticals and adjunct therapies [40]. The high content of bioactive components and minerals supports immune modulation and promotes skin regeneration, making it valuable for supplements targeting immune health and wound healing. Additionally, the fiber and micronutrient-rich composition of durian shell extract may contribute to cardiovascular and gastrointestinal health, making it a candidate for dietary supplements aimed at reducing cholesterol and improving gut function [39]. Incorporating durian shell extracts into modern drug formulations not only adds therapeutic value but also aligns with the sustainability trend, utilizing agricultural waste for health product development.

Conclusion

Durian shell has shown significant therapeutic potential in traditional Vietnamese and Southeast Asian medicine, with applications ranging from fever reduction and inflammation treatment to liver detoxification and skin care. Its bioactive compounds, including antioxidants and anti-inflammatory agents, support these uses. However, modern scientific research on its pharmacological effects is still limited. Further studies are needed to validate its traditional applications, ensure safety, and explore new medical uses, potentially integrating durian shells into modern plant-based therapies and pharmaceuticals.

Competing interests

The authors declare no conflicts of interest.

Author contributions

Phu H. Le conceived the idea, provided support, and critically revised the manuscript. Uyen P. Le structured the contents and wrote the manuscript. Phuc N.T. Le, An D.X. Nguyen, and Anh N. Nguyen contributed to the finding of materials and proofreading. All authors read and approved the final manuscript.

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