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Sustainable utilization and applications of snake plant (*Dracaena trifasciata*): A review

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Abstract

The growing demand for sustainable and environmentally friendly materials has increased interest in plant-based natural fibres as alternatives to synthetic textile fibres. *Dracaena trifasciata* (snake plant), traditionally cultivated as an ornamental species, has emerged as a promising source of natural fibre due to its high strength, durability, biodegradability, and low cultivation requirements. The plant thrives under diverse environmental conditions and requires minimal water, fertilizers, and maintenance, making it an eco-friendly and economically viable fibre crop. This review highlights the botanical characteristics, fibre extraction techniques, physicochemical properties, and sustainability advantages of snake plant fibres. It also examines their current and potential applications in textiles, composites, handicrafts, ropes, mats, and other value-added products. Furthermore, challenges related to fibre processing, commercialization, and large-scale utilization are discussed. The review concludes that snake plant fibre possesses significant potential for sustainable textile development and rural economic growth, supporting the transition toward environmentally responsible material production.

Keywords: *dracaena trifasciata*, snake plant fibre, sustainable textiles, natural fibres, eco-friendly materials, biodegradable fibres, fibre utilization

1. Introduction

Natural fibers play a crucial role in sustainable material production, offering renewable and biodegradable alternatives to synthetic fibers. In India, natural fiber production is estimated at 14.5 million tons, while global production reaches approximately 45.5 million tons annually (Kant and Alagh, 2015) [8]. Despite the abundance of fiber-yielding plants, many remain underutilized, particularly long-leaved species with high fiber potential (Wolela, 2019) [14]. *Dracaena trifasciata*, commonly known as snake plant, belongs to the *Asparagaceae* family and is native to India, Indonesia, and Africa. Cultivated since the 16th century, it encompasses over 70 species and adapts to diverse climates, including tropical, subtropical, and arid regions. This perennial, rhizomatous plant grows vertically from a basal rosette, producing stiff, sword-shaped leaves 70–90 cm long and 5–6 cm wide (Abdullah, 2020; Dewatisari and Bungan, 2024) [1, 6]. Traditionally ornamental, *D. trifasciata* is also valued for medicinal properties due to its antibacterial phytochemicals and has been used to treat boils, cough, bronchitis, and injuries (Berame *et al.*, 2017) [5]. The leaves contain lignocellulosic fibers with over 50% cellulose, making them suitable as reinforcing materials in composites (Ahmed *et al.*, 2024) [3]. Their durability and strength support applications in ropes, fishing nets, handicrafts, nonwovens, and composites (Abdullah, 2020) [1]. This review highlights the sustainable utilization and textile potential of *D. trifasciata*, emphasizing its role in eco-friendly material systems.

2. Extraction methods of Snake plant fibre

Snake plant fibre (*Dracaena trifasciata* syn. *Sansevieria trifasciata*) can be extracted using mechanical, biological, and chemical techniques. The most commonly reported extraction methods include hand scraping, water retting, dew retting, and chemical retting (Ahmed, 2024) [3]. The extraction technique significantly affects fibre yield, cleanliness, fineness, mechanical strength, and suitability for textile and composite applications.

Recent studies have emphasized the importance of sustainable fibre extraction processes that minimize environmental impacts while maintaining fibre quality (Song, 2024) ^[12]. Consequently, eco-friendly methods such as hand scraping and water retting continue to receive considerable attention in natural fibre research.

Hand scraping is regarded as one of the simplest and fastest methods for extracting snake plant fibre. This mechanical process involves manually removing the fleshy portions of the leaf to isolate the fibrous bundles. Freshly harvested leaves are placed on a flat surface and scraped using a knife, blunt metallic tool, or ceramic scraper until the fibres become visible. The extracted fibres are then washed thoroughly with water and dried under sunlight. Researchers have reported that scraping should be completed within a few days of harvesting because leaf dehydration makes fibre separation difficult and may reduce fibre quality (Adeniyi, 2020) ^[2]. The method is environmentally friendly, requires no chemicals, and produces fibres with relatively good strength and cleanliness. However, it is labour-intensive and less suitable for large-scale industrial production.

Water retting is another widely adopted extraction technique. In this method, harvested leaves are bundled and submerged in water for approximately 2–4 weeks. During retting, naturally occurring microorganisms degrade pectins, hemicellulose, and other cementing materials that bind the fibres to the surrounding tissues. After sufficient decomposition, the softened non-fibrous tissues are removed manually, and the fibres are washed thoroughly to eliminate residual pulp and impurities. The fibres are subsequently dried under sunlight to reduce moisture content. Water retting generally produces fibres with improved fineness, flexibility, and spinnability compared with direct mechanical extraction, although the process is time-consuming and requires large amounts of water (Kumari, 2023) ^[9]. Studies on *Sansevieria trifasciata* fibres have shown that water retting followed by mild alkali treatment can further improve fibre fineness and tensile properties, making the fibres suitable for textile and composite applications (Wolela, 2019) ^[14].

Alternative extraction methods such as dew retting and chemical retting have also been investigated. Dew retting relies on natural microbial activity under field conditions and requires lower water consumption than water retting. Chemical retting employs alkaline or acidic solutions to accelerate fibre separation and obtain higher fibre yields within a shorter period. Nevertheless, chemical methods may generate environmental pollution and require additional wastewater treatment (Farag, 2025) ^[7]. Recent reviews on natural fibre extraction have highlighted emerging technologies such as enzymatic retting, ultrasonic treatment, microwave-assisted extraction, steam explosion, and deep eutectic solvent treatments as promising alternatives that combine extraction efficiency with environmental sustainability (Angulu, 2024) ^[4]. These innovative approaches are being explored to overcome the limitations of conventional retting methods and improve the industrial utilization of plant fibres (Palanisamy, 2024) ^[11].

3. Properties of Snake plant

The mechanical and physical properties of snake plant fibres (*Dracaena trifasciata* syn. *Sansevieria trifasciata*) are influenced by several factors, including plant species, cultivation conditions, maturity age, geographic location, fibre position within the leaf, climate conditions, harvesting method, decortication process, and post-harvest handling and transportation (Ahmed, 2024) ^[3]. These

variables collectively determine fibre quality, consistency, and suitability for various industrial applications.

The chemical composition of snake plant fibre plays a crucial role in defining its performance. The fibre is mainly composed of cellulose, hemicellulose, lignin, pectin, and waxes. Among these, cellulose is the most important component as it contributes to tensile strength, crystallinity, and structural stability. Higher cellulose content generally results in improved mechanical performance, while lignin contributes to rigidity, stiffness, and resistance to microbial degradation. However, excessive lignin may reduce flexibility, making chemical or biological treatments necessary for textile applications (Farag, 2025) ^[7]. Therefore, an optimal balance between cellulose and lignin is essential for achieving desirable fibre properties.

In terms of physical properties, snake plant fibres are generally light in weight, have moderate density, and exhibit good moisture absorption capacity. These fibres also possess relatively high length-to-diameter ratios, which enhance their suitability for reinforcement in composite materials. The surface morphology of snake plant fibres is rough and irregular, which improves interfacial bonding when used in polymer matrix composites. Additionally, the fibre exhibits moderate thermal stability, making it suitable for applications in building materials and automotive components where heat resistance is required (Palanisamy, 2024) ^[11].

Mechanically, snake plant fibres demonstrate moderate to high tensile strength and stiffness compared to other natural fibres. However, their mechanical performance can vary significantly depending on extraction method and chemical treatment. Alkali treatment and retting processes have been shown to improve fibre strength, surface roughness, and adhesion properties by removing non-cellulosic materials (Kumari, 2023) ^[9]. Because of these properties, snake plant fibre is increasingly being explored as a sustainable reinforcement material in biocomposites, packaging materials, and lightweight structural components.

Another important functional property of snake plant is its environmental adaptability and air purification ability. Studies have shown that the plant can absorb and reduce indoor pollutants such as carbon dioxide, formaldehyde, and other volatile organic compounds, thereby improving indoor air quality (Widyasanti, 2020) ^[13]. This characteristic, combined with its fibrous structure, makes it a valuable multipurpose plant for both environmental and industrial applications.

Overall, snake plant fibre is considered a promising natural fibre due to its combination of mechanical strength, biodegradability, renewability, and environmental benefits. With appropriate processing and treatment, its properties can be further enhanced, making it a strong alternative to synthetic fibres in sustainable material development.

4. Applications of Snake plant in various sectors

The snake plant (*Dracaena trifasciata* syn. *Sansevieria trifasciata*) is widely recognized for its versatility and multifunctional applications across different sectors, including textiles, environmental management, decoration, and advanced material engineering. Owing to its strong fibrous structure, adaptability, and low maintenance requirements, it has gained increasing attention as a valuable natural resource. The plant's long, erect, and stiff leaves make it particularly suitable for ornamental and decorative purposes. It is frequently used in interior landscaping and artistic floral arrangements due to its aesthetic appearance and ability to thrive in low-light conditions

with minimal care.

One of the major applications of snake plant fibres is in the textile and traditional fibre-based industries. The extracted fibres are typically white, strong, and elastic in nature, making them suitable for producing ropes, fishing lines, bowstrings, cords, clothing materials, mats, and other woven products. These fibres exhibit relatively high tensile strength and durability, which makes them competitive with other natural fibres used in traditional craft industries. According to Adeniyi *et al.* (2020)^[2], snake plant fibres possess high specific strength and flexibility, making them suitable for cordage and lightweight textile applications. Their biodegradability also adds an environmental advantage over synthetic fibres, which contribute to pollution and waste accumulation.

In environmental applications, the snake plant is well known for its air-purifying properties. It has the ability to absorb carbon dioxide and other harmful pollutants such as formaldehyde, benzene, and xylene from indoor environments. Mishfa *et al.* (2023)^[10] reported that the presence of snake plants can reduce CO₂ concentration by approximately 16%, while also contributing to a reduction in electricity consumption by about 24% due to improved indoor air quality and thermal balance. This makes the plant highly valuable in residential buildings, offices, and urban environments where air pollution is a growing concern.

Another important and rapidly developing application of snake plant fibre is in polymer composite reinforcement, particularly in the automotive, construction, and packaging industries. Snake plant fibres are attractive as reinforcement materials due to their low density, high specific strength, biodegradability, renewability, and cost-effectiveness (Ahmed, 2024)^[3]. In addition, the relatively high cellulose content-often exceeding 50%-contributes significantly to their mechanical performance and suitability for composite applications. These properties make snake plant fibres a sustainable alternative to synthetic fibres such as glass or carbon fibres in lightweight engineering materials.

To improve composite performance, chemical treatments such as alkali treatment are commonly applied to snake plant fibres. Alkali treatment removes hemicellulose, lignin, waxes, and other impurities from the fibre surface, resulting in increased surface roughness and improved fibre-matrix adhesion. This modification enhances stress transfer between fibre and polymer matrix, thereby increasing the mechanical strength of the resulting composite materials (Mishfa *et al.*, 2023)^[10]. After treatment, the fibres are thoroughly washed with distilled water to remove residual chemicals and unwanted particles, ensuring better bonding efficiency in composite fabrication.

Overall, snake plant fibres offer a wide range of applications due to their unique combination of mechanical strength, environmental benefits, and biodegradability. Their use in textiles, environmental purification, and advanced composite materials highlights their importance as a sustainable resource for future industrial development. With continued research and improvement in extraction and treatment techniques, the potential applications of snake plant fibres are expected to expand further in modern engineering and environmental technologies.

5. Conclusion

Snake plant (*Dracaena trifasciata* syn. *Sansevieria trifasciata*) has emerged as a promising natural resource due to its multifunctional properties and wide range of applications. The fibre extracted from its leaves exhibits favourable mechanical, physical, and chemical characteristics, making it suitable for various industrial uses. Different extraction methods such as hand scraping, water retting, dew retting, and chemical retting

significantly influence fibre quality, with eco-friendly methods like hand scraping and water retting being preferred due to their sustainability and minimal environmental impact. The properties of snake plant fibre are largely governed by its cellulose-rich composition, which contributes to its strength, stiffness, and durability. At the same time, the presence of lignin enhances rigidity and resistance to degradation, making the fibre suitable for both structural and non-structural applications. The fibre's lightweight nature, biodegradability, and good thermal stability further increase its potential in engineering applications, particularly in composite materials. In addition to its mechanical advantages, the snake plant also offers notable environmental benefits. Its ability to absorb carbon dioxide and indoor air pollutants makes it an effective natural air purifier, contributing to improved indoor air quality and energy efficiency. These characteristics enhance its value in sustainable urban development and eco-friendly living environments. Furthermore, snake plant fibres have significant applications in textile production, decorative items, cordage, and especially as reinforcement materials in polymer composites used in automotive and construction industries. Surface modification treatments such as alkali treatment improve fibre-matrix adhesion, resulting in enhanced mechanical performance of composites. Overall, snake plant fibre represents a sustainable, biodegradable, and cost-effective alternative to synthetic fibres. With continued research into improved extraction techniques and material processing, its industrial applications are expected to expand further, contributing to the development of environmentally friendly and sustainable materials for the future.

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