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REVIEW ARTICLE

Overview of the Traditional Dyeing Technique of Mud-Gambiered Silk in Guangzhou, China

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ABSTRACT

This paper explores the Mud-Gambiered silk dyeing technique that is unique to the Guangdong Province of China. Document analysis methods are used to explore the historical origins, cultural significance and dyeing processes of local artisans. This traditional dyeing of the Mud-Gambiered silk relies on local river mud and Dioscorea cirrhosa root extracts. The process has demonstrated a reliance on local natural resources and an understanding of traditional craftsmanship. The application of the raw materials creates indigenous local textile products. The study traces the historical background of the dyeing technique concerning the cultural context of the people in Guangdong. It also analyses the role of socio-economic and significant contributions to the community. The steps in selecting natural materials, extracting and dyeing are highlighted to emphasize the ecological procedures. Hence, the outcome exhibits the potential of the dyeing technique for future applications especially in balancing cultural traditions and responding to modern market demands.

Contribution/Originality: The paper's primary contribution is Mud-Gambiered silk originated from Guangdong Province has significant scientific and research value in the fields of material science, textile technology and cultural heritage preservation. The outcome becomes a theoretical basis for optimising the dyeing process.

1. Introduction

The history of silk production and spinning in China dates to 2700 B.C. when records reveal various activities within the country. The most prominent evidence can be seen through folk images of women "picking mulberry and feeding silkworms" and "mulberry and silkworm weaving" in traditional Chinese painting works (Hong, 2023). The techniques and technology applied could be tracked down to the Han Dynasty where Guangzhou became the distinctive area for silk-making activities.

Guangzhou in Guangdong Province is one of the regions where weaving, dyeing and producing silk takes place in China. It is located at the Delta of Pearl River on the southeast coast of mainland China, bordered by the South China Sea to the east, the Guangxi Zhuang Autonomous Region to the west, Hunan and Jiangxi Provinces to the north and Hainan Province to the south (Liu, 2023). The area has been announced as China's countrywide intangible cultural heritage due to the flourishing production of *Mud-Gambiered* silk. Despite the unique geographical environment particularly the Pearl River Delta, Guangdong also contributes to the uniqueness of local characters in textiles (Liao et al., 2024).

Subsequently, the origins and development of Mud-Gambiered silk around the province inhibit the environmental, cultural, economic and ideology of the local settlers along the Pearl River. The interaction with various aspects of life reflects the great influence of social change on textiles (Peng, 2020). The ideal climate condition mainly with abundant rainfall and sufficient sunlight concurrently stimulates dyeing activities among the locals' craftsmen. As a result, in 2008, the "Mud-Gambiered Silk Dyeing and Finishing Technique" was inscribed as the Second List of Intangible Cultural Heritage in China (Xu, 2021). The inheritance has been interpreted in the form of a *two-colour* traditional textile that is associated with an ecological dyeing process using natural resources.

The application of biodegradable silk fibre from a locally reared cocoon dyed with natural plant extracts and river mud is the fundamental feature in creating this textile. Hence, these uniformities date back to the Ming Dynasty in the 5th century when all elements were synthesized distinctively (Chen, 2022). Evidence from the summer garments of the Tang and Ming dignitaries exhibited the same source and techniques to obtain the shades (Liu, 2023).

1.1. Research Objectives

i. To identify the traditional dyeing process of Gambiered Silk.
ii. To research the factors affecting the dyeing of Gambiered Silk.

2. Literature Review

The Mud-Gambiered silk or *Xiang-yun-shā* has gone through a process where extracts from the resources (mud and plant root of *Dioscoreacirrhosa Lour*) are combined to create a two-tone shining and lightweight dyed fabric (Lin et al., 2024). The 2-sides-opposed coloured fabric, namely the mud-coated and the reddish brown is the outcome of the interaction of both sources (Pan, 2017). Research by Ma (2022) confirmed the result indicating the interaction between Ferrous ion/Fe (II) and dyes allows them to display extraordinary features. The application of these natural materials with inherent properties significantly contributes to its appearance.

Profoundly, the dyeing process is tedious and requires the proficient craftsman to immerse the eco-friendly silk fabric into dye extracts before coating it with mud. This process allows the hues to diffuse and bind the fibres, thus creating a tonality effect (Li et al., 2023). Peng (2020) outlined the procedure as a unique ancient craft based on the laws of nature at every step of the process. Time, location and harmony of the people play important roles in determining the result. Although textiles have manifested as the most important traditional craft in China, it is also acknowledged the scarcity of output and an expensive price affected the production (Zhao & Zhu, 2024). Yuan, Wan, and Li (2023) indicated that the continuous dye application (plant roots) and longer processing

time have dramatically shaped queries on the Mud-Gambiered silk in recent years. It is not only substantiating a sign of the times but also a cultural symbolic imprint that witnesses the change of national enculturation.

The transformation towards the needs of modern aesthetics has deliberately bounded the traditional inheritance. Lin et al. (2024) underlined the importance of elucidating the materials and methods to maintain traditional culture. Thus, in retrospect, the application of authentic eco-materials, customary methods and other influencing factors is crucial to be addressed for the reference of future generations.

3. Method

This review paper is structured into three main phases: planning, implementation and reporting. In the planning stage, the author clarified the direction of the research objectives and questions. The core of this phase is to ensure that the literature review has a clear direction and focus for the research so that the next step of literature searching and screening can be accurately centered on the specific research question. Clarifying the research questions and objectives helps to remove references that are not relevant to the dyeing process and ensures that the final research results are of high quality and relevance.

In this paper, three databases were selected as the primary search sources, namely Google Scholar database, SciencDrect database and CNKI database. Compared with other databases, these three databases are well-known academic databases, and the literature included has been rigorously audited and reviewed, with high credibility and authority; moreover, these databases can provide powerful search functions and advanced search tools, which can help this paper to locate the required literature quickly and accurately. Articles, journals, academic papers, and descriptions of qualitative and quantitative studies focusing on Mud-Gambiered Silk staining technique research.

4. Results

4.1. Dioscorea cirrhosa

Legend has said that fishing nets soaked in Dioscorea cirrhosa extracts by local fishermen in the Pearl River Delta became more durable in terms of colour performance. The reason for darkening the nets during this period is documented in the Guangdong Xinyi (New Language of Guangdong). The stain was believed to be less likely to come off when fishing in the river (Peng, 2020). Xu and Xu (2020) described that those treated nets became durable, non-perishable and less water-absorbent compared to uncured ones. The effect is a consequence of the reddish ochre colour from the dyes that changed to black once thrown into the river, thus contacting the bottom mud. It is speculated that the locals may have used the same techniques to treat other fibre (cotton) and later gradually formed the highly distinctive process for the textile.

Dioscorea cirrhosa is an important raw material for Mud-Gambiered silk dyeing and finishing (Peng, 2020). This type of *perennial lianas* can be found growing in the southern mountainous areas of China including Guangdong Province (Ma, 2022). However, due to the drastic industrial exploitation that has been going on, the source is now mainly obtained from Hunan, Zhaoqing and Guangxi. Chen (2022) described the Dioscorea cirrhosa tubers are highly tannic and able to produce a black ferrous hue

when reacting to iron ions from the river's mud. The natural compound of ellagic acid (bioactive polyphenolic compound) from the plant influences the condition. Consequently, the colour will turn from brown to bright black on one side of the fabric's surface once the mud's liquor splashes onto it. A study by Pan (2017) mentioned that Dioscorea cirrhosa tuber can be categorised into two common types: *reddish brown* and *yellow*. The matured reddish-brown tuber is the one commonly utilized for getting the extracts. The cross-section image in Figure 1 illustrates the hues.

Figure 1: The Cross-section from Two Types of Tubers

Source: Sohu (2019a)

4.2. River Mud

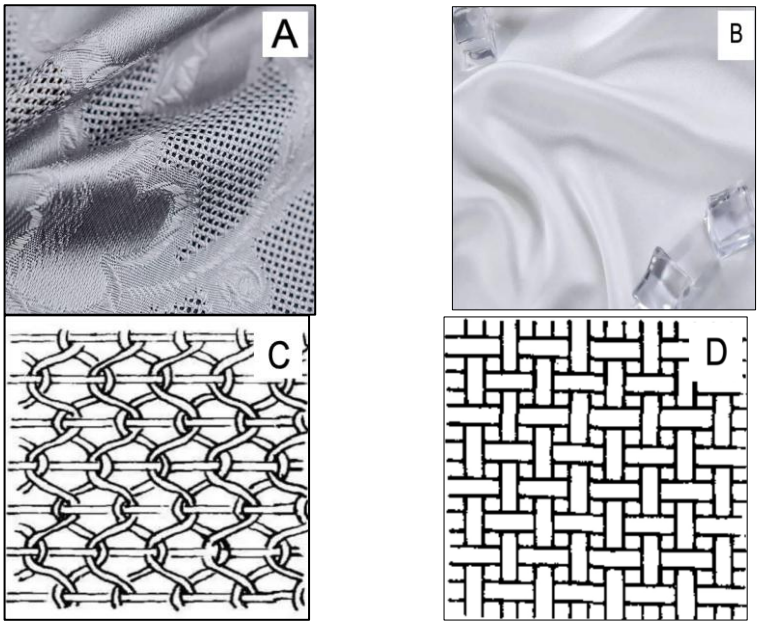
In a conventional method, the semi-finished Mud-Gambiered silk coated with river mud displays a distinctive feature of the Pearl River Delta region's traditional heritage (Li et al., 2023). According to Ma (2022), the mud's coating is one of the principal steps to determine the range of black hue on one side of the fabrics. Various literature reports on the effectiveness of mud during the dyeing and finishing process. Wu (2019) highlighted the composition of Fe 2+ in the mud as the key factor contributing to the black colouration of textiles. Other than that, microorganisms are also believed to play a role in maintaining the properties of river mud. Pan (2017) significantly highlighted the improved quality of the dyeing effect when introduced into sterilized river mud. On the other hand, Ma (2016) hypothesized the humus in river mud is one of the effective components in making silk black.

In short, the evidence demonstrates the river mud's composition is complex with four most important categories: minerals, organic matter, interstitial water and microorganisms. It is believed that the river mud used in Mud-Gambiered silk is clay rich in organic matter (Xu & Xu, 2020). The good quality dyed fabric is free from impurities, odorless, sticky and grayish black in colour. The chemical composition, pH value and particle size of river mud are considered to affect the visible coating of the fabric (Ma, 2016).

4.3. Silk Fabric

The fabrics used in the making of traditional Mud-Gambiered textile are divided into *Gambiered gauze silk* and *Gambiered silk* (Chen, 2022). These plain base textiles are made of uniform twisted yarn organization with a full of small patterns, fine small holes /eyes and plain ones. Thus, after went through the glue tanning, the fabric with a full of small patterns and holes /eyes is named Gambiered gauze. Subsequently, the plain organization silk is known as Gambiered silk (Figure 2). With modern technology available in the market; incense cloud gauze jacquard, crepe and other types of silk fabrics with blended materials are experimented for this traditional textile.The application resulted in different dyeing effects.

Figure 2: Type of Silk Fabrics for Gambiered Dyeing



Source: Sohu (2019b, 2023)

4.4. Tools

The traditional processing of Mud-Gambiered silk requires a wide range of equipment. Wooden-based apparatus such as wooden pots and barrels, bamboo poles, bamboo pegs and short wooden stakes are the long-established preferences (Peng, 2020). Other than that, there are soaking tanks, copper pots, bushel brooms for sweeping the dye bubbles from the billet silks and large cloth mops for absorbing the morning dew and applying the river mud. It is important to note that iron metal drums cannot be used in the process due to the inherent properties of tannin from the Dioscorea cirrhosa tuber. The dye extract will react with the iron, thus making it colourless. Consequently, wooden barrels, wooden tubs or bamboo barrels are used to store filtered scoria water (Pan, 2017).

Nowadays, manufacturers have replaced the bulky size of wooden containers with plastic barrels for filtering the dye solution. These containers are lighter, easy to clean and maintained by the dyers. Pools made of stone are replaced with stainless steel for dyeing the fabrics. Apart from that, a motorized boat for pumping river mud, sewing machines and two-wheeled tin trolleys are the modern equipment used in the process. A

concrete site for applying the mud and a washing dock are the important spaces built to complete the procedures. The dyeing workshop needs to be built near the drying ground so that it is convenient for the craftsman to do the laying out, drying and as well as finishing. Figures 3, Figures 4 and Figures 5 illustrate the condition of the workshop and the tools.

Figure 3: Production Equipment, Dyeing Plant and Over-water Pool

Source: Peng (2020)

Figure 4: Dioscorea cirrhosa Pulveriser and Dyeing Pool

Source: Peng (2020)

Figure 5: Copper Pot for Fabric Boiling and Other Auxiliary Tools

Source: Peng (2020)

4.5. Dyeing Process

The dyeing and finishing process of Mud-Gambiered silk is complicated and elaborate. As the saying goes, "Three washes, nine steams, eighteen suns, one or two pieces of gold,

one or two pieces of yarn" (Liu, 2015). According to Wu (2019), the whole dyeing and finishing process must be manually repeated dozens of times. The base material of this traditional textile is handmade silk woven by artisans. The entire traditional process of producing the cloth is purely manual except for the pressing of Dioscorea cirrhosa. However, the tuber is not manually grounded nowadays due to the availability of high-technology machines. Hence, climate conditions and the state of the soil nonetheless contribute to the dyeing activities.

The process can be divided into two parts; the first part consists of three operations: *Dioscorea cirrhosa soaking*, *Gambiered dyeing* and *silk boiling* (Ma, 2022). After the brownish-red tuber was collected, cleaned and pounded to obtain concentrated dye extract, it was added to different ratios of water. Then, the solution was applied on the surface of silk fabric and exposed to the sun to form a thin “film" (Ma, 2016). This process was repeated more than 20 - 30 times. As the number of dyeing increased, the amount of water was also raised significantly to avoid mesh blockage on the silk fibre during soaking and drying.

The second part of the process is to coat the dyed fabric with river mud, known as "over-wooing". The dyed semi-finished Mud-Gambiered silk is first laid face up on clean ground to apply with mud. The sludge is evenly applied to the front side with a brown silk mop. Once one side of the semi-finished fabric is coated, the iron ions (river mud) react with the tannic acid from the dye causing the black colour to appear on the side. Later, the fabric is transported to the nearby river to wash off the excess mud from the surface and then laid flat on a grassy area for drying in the hot sun. By this time, the mud-coated side has developed a dark colour. As a result, the method established the characteristic of a two-sided heterochromatic appearance with one side reddish-brown and the other side black (Pan, 2017). The hue gradation from the number of processes is shown in Figure 6.

Figure 6: The transformation of Mud-Gambiered Silk After 27 Processes

Source: Chen (2022)

At the reporting stage, the authors conducted a detailed critique and analysis of the identified literature and provided a detailed summary overview of the literature based on its research content, methodology, and conclusions. Through this process, the authors distilled the key factors in the field and provided a systematic theoretical framework and data support for subsequent research. The key task at this stage is to integrate the collected references, deepen the in-depth understanding of existing research, and provide valuable references for future research content.

5. Discussion

In the present study, the dyeing process of Mud-Gambiered silk was sorted out. The first stage of the dyeing process is dye extraction, mainly using brownish-red Dioscorea cirrhosa.These tubers are washed and crushed to extract the dye solution. The extracted dye liquor is usually diluted with appropriate amount of water at different stages so that it can be evenly dyed on the silk fabric. After the silk fabric has been dipped and dyed, it must be exposed to sunlight on grass for natural drying. In the presence of sunlight, the dye absorbs into the fabric fibers and forms a film. This process needs to be repeated about 20 to 30 times in order to achieve the desired colour depth and colour fastness. Each dip-dyeing and exposure to sunlight gradually darkens the colour of the fabric, allowing the dye to penetrate more firmly and gradually form the desired layer of colour. The second stage of dyeing is the application of river mud. After several dyeing sessions, the silk fabric will be laid flat on the floor in the shade and the river mud, which is rich in iron ions, will be evenly applied to the front of the fabric with a mop. The iron ions in the mud react with the tannins in the dye to form black colour. This process creates a two-sided colour effect of the silk, with one side being brownish red and the other appearing black. Finally, after the mud application, the fabric needs to be washed again with river water and dried in the sunlight to finally form Mud-Gambiered silk.

This study summarizes the factors affecting the final dyeing effect of Mud-Gambiered silk, of which the most critical factors are the dyeing material, the iron ions of the river mud, the climatic conditions, and the skill of the workers. First, the quality of Dioscorea cirrhosa determines the saturation and depth of the dyeing effect. The reddish-brown tuber is rich in natural tannins, which can react with the iron ions in river mud during the dyeing process and make the fabric appear black. Therefore, the extraction quality and concentration of the dye directly affect the depth of the dyeing effect. Secondly, the composition of river mud, especially the content of iron ions in it, is one of the important factors for the black colour of fabrics. When the iron ion in river mud reacts with the tannic acid in the dyed material, it produces a black effect, thus making the fabric appear a unique two-sided colour. If the concentration of iron ions in river mud is too low, the black effect may not be sharp enough to give the desired black colour. The composition of river mud contains not only iron ions, but also some degree of organic matter and minerals which also play a role in the dyeing process. Finally climatic conditions, especially the intensity of sunlight, also play an important role in the dyeing process. This is because sunlight helps the dye to penetrate the fibers.

Finally, the skill and experience of the artisan is also key to the effectiveness of the dyeing. By controlling the number of dyeing sessions, the concentration of the dye, and the time of day, the artisan is able to ensure that each piece has a saturated colour and a thick black colour that reflects the uniqueness of the traditional techniques of Mud-Gambiered silk.

6. Conclusion

The Mud-Gambiered silk originated from Guangdong Province has significant scientific and research value in the fields of material science, textile technology and cultural heritage preservation. The in-depth study of the chemical reaction mechanism in the dyeing process has made it possible to further understand its influence on the fabric properties. The outcome becomes a theoretical basis for optimising the dyeing process.

Research on the reaction mechanism of Dioscorea cirrhosa tubers with the internal structure of silk fibres during dyeing and impregnation assists in the development of new antibacterial textile attributes. It also exhibits an ultraviolet protection function, especially in the treatment of skin diseases and other aspects of the potential value of medical research (Yang, 2018). The findings from this study have not only enriched the application scope of silk yarn but also provided an important reference for the finishing process of other plant-dyed fabrics.

China's perspective of economic development views the textile as having an optimistic prospect for the overall fabric market value (Ma, 2022). Its sales trend is in line with contemporary consumers' favourites that emphasize green ecology. Liu (2023) believes these sustainable materials will further deepen the development and sales planning through robust integration with relevant industry chains. The transformation (theoretical and practical) provides a good opportunity for the future development of fabrics as well as the inheritance of intangible cultural heritage from the Guangdong Province of China

The traditional production process of Mud-Gambiered silk relies on manual operation which requires multiple procedures such as repeated dipping, drying and mud coating. This hand-intensive production method not only limits mass production but also results in low production efficiency and high labour costs (Peng, 2020). Although modern equipment and technology can partially solve this problem, there is still a challenge to improve production efficiency while maintaining the traditional craft characteristics.

The production of Mud-Gambiered textiles is restricted by geography. River mud exists in specific regional rivers in the Pearl River Delta Basin of Guangdong Province which makes its production somewhat territorial. It is a challenge for future research to find alternative materials in other regions or to effectively preserve and transport these materials from the area. In addition, there is uncertainty in the supply of quality river mud due to environmental pollution and changing climatic conditions which in turn makes production more difficult.

Present-day research has mostly focused on the improvement process and marketing with relatively minimal research on textile cultural value and historical background. Although scholars explored the historical origin and cultural connotation of the Mud-Gambiered silk, the outcome is fragmented and lacks systematic and in-depth studies.

Regardless, future research could continue to explore the significant contribution this textile would bring to Chinese art and cultural heritage. Textile produced through this process is bio and environmentally friendly with a fresh breathable texture. Modern research shows that the dyeing process provides excellent performance and contains scientific research value. Many experts and scholars are committed to optimising the processing of Mud-Gambiered by improving production efficiency and expanding market applications. Extended research is necessary to combine the applicability with other natural fibres, optimize the fiber structure or fabric function and design ultraviolet resistant effects to meet the current pursuit of clothing functionality.

Scholars have studied the reaction mechanism of the dye extracts and yarn in the dyeing process where the internal structure of river mud enhanced the fabric hues. Future exploration from the pharmacological perspective is indeed valuable to understanding the potential outcome. A series of fabrics with anti-bacterial content in hope will bring

therapeutic and health care effects on skin diseases, hence providing certain value for medical research.

Finally, textile and apparel scholars are combining the applicability of the yarns, fiber structure, fabric functionality and ultraviolet resistance from the dyed fabrics to meet the current pursuit of clothing practicality. Through integrated data and significant output from innovative discoveries, this textile can be improved in value and production efficiency to attract the attention of future generations.

Ethics Approval and Consent to Participate

This study did not involve human or animal subjects, and thus, no ethical approval was required. The study protocol adhered to the guidelines established by the journal.

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Conflict of Interest

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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