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The Art of Coloring:
The Application and Evolution of Plant Dyes in Yunjin

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บทคัดย่อ

ผ้าหยุนจินเป็นสมบัติล้ำค่าของการทอผ้าไหมจีนแบบดั้งเดิม มีต้นกำเนิดที่หนานจิง มีชื่อเสียงในด้านทักษะการทอผ้าอันวิจิตรบรรจงและลวดลายสีสันอันสวยงาม ผ้าหยุนจินเป็นหนึ่งในสามผ้าทอที่มีชื่อเสียงของจีนในสมัยโบราณ งานวิจัยนี้มีวัตถุประสงค์เพื่อวิเคราะห์ความสำคัญเชิงสัญลักษณ์ คุณค่าทางนิเวศวิทยาและวัฒนธรรมของการย้อมสีพืชในงานศิลปะผ้าหยุนจิน จัดเรียงวิถีการพัฒนาของระบบสีของผ้าหยุนจินในสมัยราชวงศ์หยวน หมิงและชิง การสำรวจเชิงลึกเกี่ยวกับผลกระทบของสีย้อมจากพืชต่อระบบนิเวศ ความสมบูรณ์และเอกลักษณ์ของระบบสีผ้าหยุนจิน พร้อมทำการประเมินการปกป้องสิ่งแวดล้อมและคุณค่าของการพัฒนาที่ยั่งยืนในสังคมยุคใหม่ ใช้วิธีการวิจัยเอกสารอ้างอิง วิธีการสำรวจภาคสนาม วิธีการวิเคราะห์แบบสหวิทยาการและวิธีการวิเคราะห์กรณีศึกษา เพื่อจัดเรียงข้อมูลด้านประวัติศาสตร์และงานหัตถกรรมของผ้าหยุนจินจากเอกสารอ้างอิง รับข้อมูลปฐมภูมิผ่านการสำรวจภาคสนาม วิเคราะห์ความหมายแฝงทางวัฒนธรรมของระบบสีจากมุมมองแบบสหวิทยาการ พร้อมทั้งเลือกผ้าทอที่มีความโดดเด่นเพื่อทำการวิจัยเชิงลึกเกี่ยวกับองค์ประกอบของสีและความหมายเชิงสัญลักษณ์ การวิจัยแสดงให้เห็นว่า การย้อมสีจากพืชซึ่งเป็นแหล่งสำคัญของระบบสีของผ้าหยุนจิน ไม่เพียงแต่ทำให้ผ้าหยุนจินมีโทนสีที่หลากหลายและรูปแบบศิลปะที่มีเอกลักษณ์เฉพาะตัวเท่านั้น แต่ยังเป็นพื้นฐานที่สำคัญสำหรับการฟื้นฟูและนวัตกรรมสมัยใหม่อีกด้วย ในด้านการฟื้นฟูครอบคลุมถึงการฟื้นฟูระบบสีดั้งเดิม การฟื้นฟูเทคนิคการย้อมสีแบบโบราณ และการสร้างสรรค์การจับคู่สีทางประวัติศาสตร์ขึ้นมาใหม่ เพื่อรักษาความแท้จริงทางวัฒนธรรมและตอบสนองต่อความต้องการด้านการอนุรักษ์สิ่งแวดล้อม ในด้านนวัตกรรมการย้อมสีจากพืชถูกนำมาใช้อย่างแพร่หลายในอุตสาหกรรมสิ่งทอแฟชั่น มรดกทางวัฒนธรรมที่จับต้องไม่ได้ วัสดุที่เป็นมิตรกับสิ่งแวดล้อม และนวัตกรรมทางเทคโนโลยี ซึ่งช่วยส่งเสริมการพัฒนาสมัยใหม่ของผ้าหยุนจิน การวิจัยยังได้ขยายขอบเขตการประยุกต์ใช้วัฒนธรรมผ้าหยุนจินในสังคมยุคใหม่ เปิดเส้นทางใหม่สำหรับการคุ้มครองและความ

ทันสมัยของการสืบทอดมรดกทางวัฒนธรรมที่จับต้องไม่ได้ เน้นย้ำถึงคุณค่าทางนิเวศวิทยาของการย้อมสีจากพืชและศักยภาพในด้านอุตสาหกรรมวัฒนธรรม
คำสำคัญ: หยุนจิน สีย้อมจากพืช ศิลปะการใช้สี

Abstract

Yunjin is a treasure in traditional Chinese silk weaving crafts. It originated in Nanjing and is famous for its exquisite weaving skills and gorgeous color patterns. It is one of the three famous brocades in ancient times. This study aims to analyze the symbolic meaning and ecological and cultural value of plant dyeing in Yunjin art, sort out the development trajectory of Yunjin color system in the Yuan, Ming and Qing dynasties, deeply explore the impact of plant dyes on the ecology, richness and uniqueness of Yunjin color system, and evaluate its environmental protection and sustainable development value in modern society. The study used literature research method, field investigation method, interdisciplinary analysis method and case study method, sorted out Yunjin history and craftsmanship from literature, obtained first-hand information through field investigation, analyzed the cultural connotation of color system from an interdisciplinary perspective, and selected representative Yunjin fabrics to study its color composition and symbolic meaning in depth. Research shows that plant dyeing, as an important source of Yunjin's color system, not only gives it a unique artistic style, but also provides a basis for restoration and innovation. In terms of restoration, it covers the restoration of traditional color systems, ancient dyeing techniques, and historical color matching to ensure cultural authenticity and meet environmental protection needs. In terms of innovation, plant dyeing is widely used in fashion textiles, intangible cultural heritage, environmentally friendly materials,

and technological innovation, promoting the modern development of Yunjin. The research further expanded the application scenarios of Yunjin culture in modern society, opened up a new path for the protection and modernization of intangible cultural heritage, and emphasized the ecological value of plant dyeing and its potential in the cultural industry.
Keywords: Yunjin, Plant Dyes, Art of coloring

Introduction

Yunjin, as a world intangible cultural heritage, is a treasure of traditional Chinese brocade art. Its unique color system, pattern design and weaving skills are considered to have profound historical and cultural value. The origin of Yunjin can be traced back to the Yuan Dynasty. It was named for its exquisite weaving skills and gorgeous patterns like clouds. It reached its peak in the Ming and Qing Dynasties and became a royal fabric exclusively for the court. Its development process is not only a microcosm of Chinese silk culture, but also a concentrated embodiment of Chinese traditional craftsmanship and aesthetics. The color of Yunjin comes from natural plant dyes, which not only provide colorful and durable tones for brocade, but also have ecological and environmental characteristics. Before the popularization of synthetic dyes, the colors used in Yunjin all came from plant dyes, making its color performance both elegant and in line with the requirements of royal fabrics. By examining the history of the use of traditional plant dyes and their correlation with the colors of Yunjin, this article sorts out the evolution of Yunjin colors in different periods and its symbolic meaning in etiquette and social hierarchy, highlighting its unique status and cultural value in the traditional Chinese color system.

Objective

1. To analyze the development trajectory of Yunjin color system in the Yuan, Ming and Qing dynasties, the formation and hierarchical symbolism of its royal colors, and to reveal the important status and aesthetic value of Yunjin color in traditional Chinese culture.

2. To analyze the symbolic meaning and ecological cultural value of plant dyeing in Yunjin art, and emphasize its importance in cultural inheritance and modern innovation.

3.To explores the ecology, richness and uniqueness brought by plant dyes to Yunjin color system, and evaluates its environmental protection and sustainable development value in modern society by studying the types, process flow and influence of plant dyes on Yunjin color.

Conceptual framework

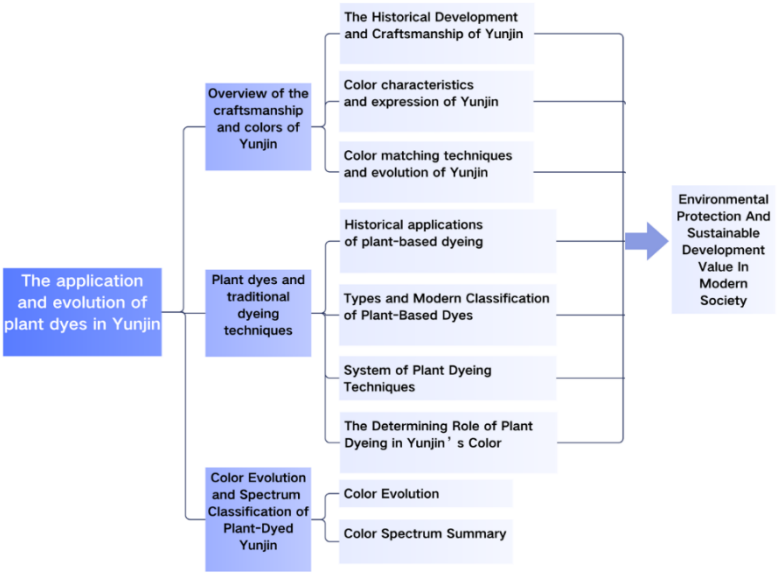

Figure 1. Conceptual Framework

Methods

1. Documentary Research Method: This study systematically reviewed historical documents, craft books, research papers and the latest scientific research results related to Yunjin craftsmanship, colors and plant dyes, followed the inclusion criteria (such as time range, subject relevance, academic authority and interdisciplinary perspective) and exclusion criteria (such as content duplication, insufficient data and non-academic), and comprehensively sorted out the development history, process flow and color characteristics of Yunjin. Through the analysis of the literature, the evolution trajectory of Yunjin from the Western Zhou Dynasty to the Qing Dynasty was outlined, especially its status in the royal fabrics during the Yuan, Ming and Qing dynasties, providing theoretical support and practical reference for the in-depth understanding of Yunjin color system and the modern inheritance of traditional crafts.

2. Field Survey Method: This study Conduct on-site research in the Nanjing area to observe the traditional Yunjin weaving process and its color presentation techniques. By visiting the Jiangning Weaving Museum, the Yunjin Research Institute, and engaging with artisans and volunteers, this method provides insight into the intricate details of Yunjin's design, material preparation, and weaving processes. Field investigation offers firsthand information on Yunjin craftsmanship, enhancing the research's understanding of the practical aspects of its techniques and dyeing applications.

Table1: Field Survey Methods

Inspection location	Subject of investigation	Research Methods	Inspection Process	Data Collation and Analysis
Nanjing Brocade Research Institute	Yunjin intangible cultural heritage inheritor (ZhouShuangxi). Researchers	Interviews, observations. video recordings	Photograph the weaving process of Yunjin,. Yunjin fabrics, plant dye exhibits; Communicate with inheritors and researchers; Record the conversation content, the history of Yunjin, the craft characteristics, and the classification of plant dyes	The materials were classified and sorted, focusing on the correlation between Yunjin color and plant dyeing. Data were obtained by cross-comparison with other research methods to supplement and verify the accuracy and systematicness of the research, and summarize the unique value of Yunjin plant dyeing from the perspectives of ecology, culture and innovation.
Jiangning Weaving Museum	Staff and volunteers	Interviews. observations. video recordings	Photographing the exhibition hall of Dream of Red Mansions, dragon robes and official uniforms of the Qing Dynasty; Communicating with staff and volunteers; Recording the history of Jiangning Weaving House; the relationship between Cao Xuegin's family and Jiangning Weaving House, and other materials	

Note. Field Survey Methods

Figure 2. Plant Dyes Displayed at the Nanjing Yun Brocade Research Institute (Trees, hyacinthus fragrans, madder, betel nut, gardenia, turmeric, phellodendron, sophora japonica)

3. Interdisciplinary Analysis Method: This method analyzes the Yunjin color system and its underlying sociocultural symbolism from a multidisciplinary perspective. Through this interdisciplinary approach, the study explores the connections between Yunjin's color palette and traditional Chinese Five Elements philosophy, as well as the social hierarchy, revealing the unique color system and cultural significance embedded within Yunjin.

4. Content Analysis Method: This study selected representative brocade fabrics as cases. The case selection was based on historical importance (such as brocade used by the royal family in the Qing Dynasty), cultural significance (such as the costumes of the characters in the Jia family in "A Dream of Red Mansions"), geographical location (classic works in Nanjing), and typical craftsmanship (fabrics that display the characteristics of color and plant dyes). The study deeply analyzed the color composition and the use of plant dyes, and explored the symbolic meaning and class embodiment of specific colors. Through specific case studies, the cultural symbols and visual effects of different colors are revealed, and the status and role of brocade in royal and folk decorations are clarified, providing empirical support for the overall study and enhancing the persuasiveness and academic value of the study.

Figure 3. Yunjin Rearrangement Costumes from the TV Series Dream of the Red Chamber Displayed at the Jiangning Weaving Museum

Synthetic Research Results

1. Overview of the craftsmanship and colors of Yunjin

1.1 Historical development and craftsmanship of Yunjin

Historical development

The art of "brocade" can be traced back to the Western Zhou Dynasty in the 11th century BCE. It is a precious colorful jacquard silk fabric. "Yunjin" is generally believed to have originated in the Yuan Dynasty and flourished in the Ming and Qing Dynasties. In fact, it was conceived and formed in Nanjing as early as the Liang Dynasty (502-557 AD) in the Southern Dynasties. Nanjing has therefore become the origin and development center of Yunjin, and Yunjin is also called "Nanjing Yunjin". (Huang, 2004) In the Yuan, Ming and Qing Dynasties, Yunjin was used as a tribute to the royal family and its production was monopolized by the court. The establishment of the "Internal Dyeing and Weaving Bureau" in the Ming Dynasty and the "Jiangning Weaving House" in the Qing Dynasty promoted the prosperity of Yunjin. By the Qianlong and Jiaqing years, the number of looms reached more than 30,000, and Yunjin occupied a leading position in the brocade industry at that time.

In the late Qing Dynasty and the Republic of China, with the decline of the feudal dynasty and social unrest, the Yunjin industry shrank sharply. In 1937, the number of looms dropped to more than 100. After the victory of the Anti-Japanese War, the "Nanjing Yunjin Industry Union" was established in 1948, and production began to gradually resume. In 1954, the Nanjing Municipal Government established the "Yunjin Research Working Group", marking the revival of Yunjin. In 1957, the "Nanjing Yunjin

Research Institute" was established to undertake the task of protecting and inheriting Yunjin craftsmanship. Since the 1980s, Yunjin has gradually entered a new stage of development, focusing on the innovation of materials, craftsmanship and patterns, and promoting the rebirth of Yunjin in the context of modern culture.

Overview of the craft system of Yunjin

(1) Varieties and uses of Yunjin

Yunjin has a variety of varieties, mainly divided into three categories: Kuduan, Kujin and Zhuanghua satin. (Wen, 2011) Kuduan is used to make clothes and is called "robes"; Kujin, also known as "Kujin" or "woven gold", and Zhuanghua is famous for its complex patterns and rich colors. During the Yuan, Ming and Qing dynasties, Yunjin was mainly supplied to the court and dignitaries for dragon robes and court clothing. It was also sold to Tibet, Mongolia and other places for ethnic clothing and temple decoration. From the late Qing Dynasty to the early days of liberation, Yunjin was sold abroad for clothing, ties, curtains, etc. After the modern revival, Yunjin added new varieties such as Yuhuajin and Jinyinzhuang, and its application range expanded to modern clothing, home textiles, craft gifts and art collections.(Figure 4)

Figure 4. Yunjin varieties: Kuduan, Kujin, Zhuanghua satin

(2) Yunjin craft system process

The production process system of Yunjin is huge and complex. Before the emergence of modern machinery, the division of labor in traditional hand-weaving was extremely detailed. Its production process can be summarized in three keywords: "design", "material preparation" and "weaving". The first step "design" includes pattern and organization design, pattern making; the second step "material preparation" covers the preparation of raw materials such as gold thread and peacock feathers and loom assembly, and plant dyeing is also included; the third step "weaving" involves weaving operations and finished product inspection and sorting, which is the key process for the final formation of Yunjin. Different varieties of Yunjin have slightly different processes. For example, Ku satin needs to shake white warp and dye silk, Ku brocade adds rubbing gold thread and sizing silk, and

Zhuanghua satin adds hammering silk. Design, material preparation and weaving are closely linked and indispensable.

1.2 Comparative analysis of Yunjin and other brocade types

First, Yunjin originated in Nanjing and flourished in the Ming and Qing Dynasties. As a royal fabric, it developed a unique color system and craftsmanship. Compared with the soft and elegant Shujin (Sichuan, 2000 years of history) and the elegant and restrained Songjin (Suzhou, originated in the Song Dynasty), Yunjin uses the "through warp and broken weft" technology to combine gold and silver threads with bright colored silk to form a magnificent visual effect. The color emphasizes high contrast tones such as gold, red and blue, which directly serves the symbolic needs of the royal family. This display of imperial power and wealth makes it a clear distinction from the folk styles of Zhuangjin (Guangxi Zhuang, strong ethnic colors) and Yuejin (Lingnan, fresh and bright).

Second, the color system of Yunjin is closely related to its historical function. Unlike the geometric natural patterns of Shujin or the practicality of painting and calligraphy mounting of Songjin, Yunjin's auspicious patterns such as dragons and phoenixes, cloud patterns and luxurious colors interwoven with gold and silver not only reflect the high level of craftsmanship, but also become a visual symbol of power and culture. The rough animal and plant patterns of Zhuang brocade and the delicate floral patterns of Yue brocade respectively reflect the differences in the aesthetics of ethnic minorities and regions. By comparison, it can be seen that the color selection of Yunjin is limited by the court etiquette, and the hierarchy concept needs to be strengthened through strong visual impact, which is completely different from the orientation of folk brocade to freely express the interest of life.

Finally, the comparative analysis reveals the historical particularity of Yunjin: its craftsmanship and color system are the product of feudal imperial aesthetics, carrying the dual imprint of the ancient Chinese hierarchy and the peak of craftsmanship. Compared with the regionality, practicality or nationality of other brocade types, Yunjin emphasizes symbolic meaning. Its magnificent style has not only become the pinnacle of Chinese brocade art, but also provides a unique material cultural perspective for studying ancient politics, culture and social structure.

1.3 Color characteristics and expression of Yunjin

Color characteristics of traditional Yunjin

Yunjin is rich and elegant in color, with harmonious and warm tones, which are both full of vitality and not too dazzling. Its unique visual effect comes from the calm texture of natural plant dyeing and the exquisite color matching, which makes the bright colors well set off against the deep background. In addition, the luster of materials such as gold thread, silver thread and peacock feather enhances the gorgeousness of the color tone, and at the same time plays a harmonizing role between different color blocks, making Yunjin show a unique artistic charm among traditional silk fabrics. (Zhao, 2009)

The expression of Yunjin color

The color expression of Yunjin is mainly divided into three types: "area contrast", "brightness contrast" and "weaving expression". (Zhang, 2004) (Figure 5)"Area contrast" divides the color through the size layout of different color blocks to increase the sense of layering; "brightness contrast" uses the brightness difference between the main

pattern and the background color to highlight the pattern; "weaving expression" uses "color halo", "twisted edge" and "white and black" and other techniques to carefully handle the color. For example, "color halo" is woven with two to three colors to create a sense of layering with dark inside and light outside; "twisted edge" outlines the pattern with gold or silver threads; "white and white" uses white or silver to buffer the transition between color blocks, making the color changes more natural and coordinated.

Figure 5. Green space entwined lotus makeup satin

1.4 Matching techniques and evolution of brocade colors

Traditional brocade fabrics can present more than a dozen to more than fifty colors, and the rational use of color matching techniques makes these rich colors harmonious and unified. The color

matching technique of brocade is centered on the "color halo" technique. The brocade artists of all generations have gradually formed a set of fixed matching rules and summarized color matching formulas. Some of these formulas have been lost due to inheritance from generation to generation, and the existing ones are particularly precious. These color matching formulas mostly use two to three colors, with soft gradients in brightness or hue, which conforms to the principle of "contrast and unity". In addition, different brocade varieties also have their own unique preferences in color matching. For example, the color matching methods of zhuanghua is different in color for each flower, and the adjacent colors are clearly distinguished in depth, coldness and warmth, following the color matching principle of "zhuanghua must be colorful".

The introduction of chemical dyes has brought changes in the color matching of brocade. In 1856, British scientists discovered synthetic dyes, and then synthetic indigo was introduced in Germany in 1897, gradually replacing traditional plant indigo dyes. China began to use chemical dyes around 1949, and Yunjin first tried chemical dyeing in 1956, but due to technical and equipment limitations, chemical dyes were not widely used at the time. The use of chemical dyes has brought more color matching options to Yunjin to meet the needs of modern development. Despite this, the color matching of Yunjin is still based on the color spectrum and color matching formula of traditional plant dyes, maintaining the unique color style of Yunjin.

1.5 The relationship between Yunjin color symbolism and culture

Color and hierarchy: a symbol of the supremacy of imperial power

Since the Tang Dynasty, yellow has gradually become the exclusive color of the emperor, and it was strictly monopolized in the Ming and Qing Dynasties. For example, "bright yellow" was only used for the emperor's dragon robe, symbolizing the mandate of heaven and the monarchy, and was forbidden to be used by ordinary people. Red represents nobility, and is often seen in the queen's phoenix robe and the official robes of high-ranking officials, while blue and black are used for sacrificial dresses or low-ranking officials' clothing, showing the hierarchical order of feudal society. For example, the Qing Dynasty's "Da Qing Hui Dian" stipulates that the prince's clothing should be "golden", which is strictly distinguished from the emperor's "bright yellow" to strengthen the power hierarchy.

Folk color taboos and symbolic substitutions

During the Ming and Qing Dynasties, the law strictly restricted the use of royal colors by the people, forcing the civilians to use low-saturation colors such as blue, green, and brown. At the same time, the pattern made up for the color restrictions, such as "Five Blessings Holding Longevity" with an indigo background, replacing noble colors with meanings, forming a unique folk aesthetics. Nanjing folk brocade wedding dresses are forbidden to use red, and peach red and rose red are used instead to avoid the suspicion of "overstepping one's authority" while retaining the symbol of festivity.

Monopoly of dyes and crafts: consolidating power and class barriers The royal family strictly controls rare dye resources, such as red dyes from Tibetan safflower and crimson dyes from Sumu, to ensure the uniqueness of the colors of the royal brocade. At the same time, the Weaving Bureau implemented a technical blockade on materials such as gold thread and peacock feather thread, making it impossible for the public to imitate the "gold and green" effect of the royal brocade. For example, the "weaving gold brocade" of the Ming Dynasty court used imported gold foil thread, which was complicated and costly, and became a symbol of imperial wealth and technological monopoly.

2. Plant dyes and traditional dyeing techniques

2.1. Historical application of plant dyeing

Plant dyes are the most numerous and widely distributed type of natural dyes. Natural dyes also include mineral and animal dyes. Their application history is almost as long as human civilization. In ancient China, plant dyeing was called "plant dyeing", and it was used as early as the Xia Dynasty. In the Western Zhou Dynasty, officials such as "Dyeing Grass" and "Dyeing Man" were set up to be responsible for the collection and dyeing of plant dyes. The Qin Dynasty had a "Dyeing Department", which later evolved into a "Dyeing Department"; the Tang Dynasty had a "Dyeing House", and the Song Dynasty was responsible for dyeing affairs by the "Wensiyuan"; in the Qing Dynasty, the "Indigo Institute" and "Jiangnan Weaving Bureau" were set up. (Gong, 2003) It can be seen that plant dyeing occupies an important position in ancient crafts, and it has a high degree of commercialization by the Ming and Qing Dynasties.

2.2 Types of plant dyes and modern classification

Overview of plant dye types

In a broad sense, any plant that contains extractable pigments and is used for dyeing can be called a plant dye. There are many kinds of dyeable plants in the world, and the exact number is difficult to count. Many plants rich in pigments have not yet been developed and utilized. The same plant dye may contain pigments of multiple different hues, and different varieties of the same plant may also produce very different colors, so the classification is not absolute. For example, gardenia contains gardenia yellow and gardenia blue pigments, but because gardenia blue is difficult to extract, it is usually not used as a blue dye. For example, different onion skins dyed under the same process conditions will produce color levels that fluctuate between yellow, red, and brown, but the overall color is reddish, so this article classifies them as red plant dyes.(Figure 6)

Figure 6. 16 Plants Used for Dyeing

Modern classification of plant dyes

The classification of plant dyes is usually based on color category, process type and molecular structure. Classification by color category is based on the color of the pigment contained in the dye material. According to the process type, there are direct dyeing, mordant dyeing, and reduction dyeing. For example, gardenia and pomegranate peel can be directly dyed to present bright colors; red, yellow, and brown dyes such as hematoxylin, madder, and scutellaria are mordant dyes; indigo dyes of blue grass belong to reduction dyeing. Dyes that are

sensitive to pH, such as safflower, belong to the pH adjustment dyeing type. Classification by the chemical composition of dye material pigments, that is, chemical composition classification, was proposed with the development of modern chemistry based on a clear understanding of pigment composition, which is convenient for studying dyeing mechanisms. Dyes of different pigment types require different extraction processes, and the coloring effects on various fabrics are also different. For example, henna hardly colors cellulose fibers such as cotton and linen, but has a strong coloring power on protein fibers such as silk and soy protein. In addition, plant dyes can also be classified according to their functional uses, such as edible, medicinal, and antibacterial. Many medicinal dyes have antibacterial and antibacterial effects.

Table2: The main types of chemical components in plant dyes

The main types of chemical components in plant dyes	
Type of pigment	representative
Alkaloids	Phellodendron amurense Coptis chinensis
Quinones	Rubia, Rheum sibiricum, Purple Grass
Tannins	Persimmons, tea leaves
Flavonoids	Red flowers, Scutellaria baicalensis Huai Hua, Su Mu, Jin Cao
Indole class	Liao blue, Ma blue Isatis indigotica and indigo carmine
Carotenoids	Gardenia and saffron
chlorophyll	Aicao Mountain Blue

Note. The main types of chemical components in plant dyes

2.3. Plant dyeing process system

Plant dyeing process types

Plant dyeing processes are mainly divided into single-color dyeing and over-color dyeing. The single-color dyeing process is relatively simple, including direct dyeing and pH adjustment dyeing, while reduction dyeing is mainly used for indigo dyeing. The mordant dyeing process is relatively complex, divided into single mordant dyeing and multiple mordant dyeing: single mordant dyeing can be done before dyeing (pre-mordant dyeing), after dyeing (post-mordant dyeing) or at the same time as dyeing (same-bath mordant dyeing), and the mordant dyeing sequence will affect the final dyeing effect. Multiple mordant dyeing refers to the use of two or more mordants (such as double mordant dyeing) to treat fabrics before, during or during dyeing. In addition, the mixed mordant dyeing rule is rarely used, that is, the mixture of two different mordants can also be used for multiple mordant dyeing.

Table3: Table of Plant Dyeing Process Types

Table of Plant Dyeing Process Types		
Monochrome dyeing process	Direct staining	
	Reduction staining	
	PH value adjustment dyeing	
	Single Matchmaking	Pre mordant dyeing,Post mordant dyeing, Same bath dyeing
	Multiple matchings	Double Matchmaking,Triple Matchmaking
	Mixed mordant dyeing	
Color dyeing process (multi-color dyeing)	First, use indigo coloring technique	
	Post indigo color matching process	
	Mixing dyeing of two or more types of plants and trees	

Note. Table of Plant Dyeing Process Types

2.4 Plant dyeing steps and mordants

The plant dyeing process includes cloth preparation before dyeing, pigment extraction, dyeing and post-dyeing treatment. Modern dyeing cloth preparation is relatively simple, while in ancient times, the division of labor was more detailed, with special ash training workshops, bleaching workshops and treading workshops. In ancient times, plant ash and sour chestnut water were used to adjust the pH value, while in modern times, sodium hydroxide and glacial acetic acid are mostly used.

Mordants play a significant role in improving the color fastness of fabrics and adjusting the hue. In ancient times, green vitriol, alum, yellow vitriol, stone gall and black mud were commonly used, while in modern times, ferrous sulfate and copper sulfate are introduced as substitutes. Iron ions such as green vitriol darken the color tone, copper ions such as stone gall deepen the color and add green light, alum increases the color brightness, and black mud is used for mordant dyeing of Xiangyun yarn.

As an important part of the Yunjin process system, plant dyeing plays a key role in the color of Yunjin, directly affecting the color effect after weaving, and is the basis for Yunjin to show its color charm. The two are closely linked.

The decisive role of plant dyeing on the color of Yunjin is mainly reflected in the process level, while the factors that affect the color of Yunjin include cultural, political and philosophical backgrounds. For example, in the feudal period, colors were endowed with the five elements and class symbols. In ancient times, the five colors of "blue, red, yellow, white and black" were advocated. Each color represented a different social

class, among which yellow was the most noble, followed by red, and blue and blue were mostly used by civilians. These color concepts are inseparable from the development of plant dyeing technology. Because the three primary colors are easy to extract from plants, they have become the basis of ancient fabric colors. With the maturity of dyeing technology, plant dyeing has produced intermediate colors such as green and purple on the basis of the three primary colors, laying the foundation for the color evolution of traditional fabrics such as Yunjin.

Yunjin dyeing uses a rich variety of plant dyes, and the ancient transportation main line from Nanjing to Beijing provides sufficient supply of dye materials, making the commercialization of dye materials relatively stable. However, factors such as the variety, season, soil, and light of the dye materials will lead to differences in dyeing effects, and the color depth of the same batch of Yunjin fabrics may be different. In addition, changes in temperature and pH during dyeing also affect color consistency. It can be seen that each link of the plant dyeing process directly determines the final presentation effect of Yunjin color.

3. Color evolution and color spectrum summary of plant-dyed Yunjin

3.1 Color evolution of plant-dyed Yunjin

The color evolution process of Yunjin shows the gradual improvement of the color system of imperial brocade. Before the Yuan Dynasty, especially in the Tang and Song Dynasties, Yunjin had not yet formed a unique color style, mainly influenced by the concept of "five colors" and Confucianism and Taoism. During this period, tones such as yellow and red were gradually recognized by the royal family and given

symbolic status, reflecting the early concept of hierarchy. In the Yuan Dynasty, the widespread use of gold promoted the initial establishment of the royal color system of Yunjin. By introducing the gold weaving technology of the Western Regions, Yunjin presents a luxurious golden tone in color, the royal exclusive color is more clear, and the use of royal colors is strictly regulated by official agencies such as the Weaving and Dyeing Bureau. (Yu & Zhou, 2007)

The color system of Yunjin was further standardized and enriched in the Ming Dynasty. Nanjing Shenbo Hall and Neiwaiju and other weaving and dyeing institutions were responsible for the color production of royal and official clothing. The colors of Yunjin became more complex, and the varieties of fabrics such as Zhuanghua became more gorgeous due to the increase in the number of color sets. The regulations on the use of colors for royal and official clothing were gradually systematized in the Ming Dynasty. Different levels had different color combinations, and the color hierarchy system gradually deepened. In the Qing Dynasty, the color matching of Yunjin reached a high level of maturity, with warm and soft tones, especially in the application of halo colors, which emphasized harmony and unity, making the colors of Yunjin more delicate and rich. The brocade system of the Qing Dynasty was completed by the three weaving factories in Jiangnan. The color spectrum of royal brocade gradually became rich and diverse, and the royal color system was further consolidated through rituals and strict hierarchical regulations.

From the Yuan Dynasty to the Qing Dynasty, the color system of Yunjin was gradually improved, and the royal color hierarchy

became more strict. As the feudal dynasties attached importance to royal colors, Yunjin gradually developed a color matching style that symbolized nobility and splendor. Royal colors such as Chinese red and bright yellow became symbols of traditional Chinese auspicious colors, reflecting the mutual influence between traditional color concepts and royal exclusive colors. (Yang, 2010)(Figure 7)

Figure 7. Dragon robe made of brocade

3.2 Summary of plant-dyed Yunjin chromatogram

The traditional color system of Yunjin is extremely rich, mainly divided into three color systems: red-orange, yellow-green, and blue-purple. Most of the names of these colors originated from ancient times, and were named after animals, plants, or place names, showing the wide application of plant dyes in Yunjin. Since the Ming Dynasty, the Jiangnan region has developed a complete plant dyeing system, and many Yunjin colors are still used today. The Jiangning Weaving Bureau established in Nanjing during the Qing Dynasty not only undertook the important task of dyeing and weaving Yunjin, but also had a deep connection with the family of Cao Xueqin, the author of "Dream of Red Mansions". The three generations of the Cao family served as the governor of Jiangning Weaving, frequently receiving the emperor's southern tour and living a luxurious life, which made Yunjin production prosperous, and this was also one of the reasons why the Cao family's property was confiscated. Cao Xueqin was familiar with the colors, craftsmanship, and materials of Yunjin since he was a child, which made "Dream of Red Mansions" not only a literary classic, but also an important material for studying Yunjin and plant dyeing.

In Dream of the Red Chamber, Cao Xueqin showed the colors and gorgeous patterns of brocade at that time through the detailed description of the costumes of the characters in the Jia family. Jia Baoyu's "two-color gold butterflies with flowers and bright red arrow sleeves", Wang Xifeng's "red satin jacket with gold butterflies with flowers", Xue Baochai's "rose purple two-color gold and silver thread waistcoat" and Qingwen's "peacock fur coat" mentioned many times in the book are all typical brocade fabrics

of the Qing Dynasty. The colors involved in these costumes are rich and varied, including bright red, silver red, peach red, jade red, crabapple red, moon white, willow yellow, autumn fragrance, emerald green, stone blue, lotus blue, etc. The red series is particularly common, symbolizing the prominent status of the Jia family and reflecting the importance of red in the imperial brocade of the Qing Dynasty. (Sun, 2010)(Figure 10)

The classification and record of colors in the Qing Dynasty were meticulous, especially in Li Dou's "Yangzhou Shufanglu", which gave a detailed explanation of the color names. The book describes colors such as "Yubai" as white-green, "Chuluyin" as light red-white, "Mihe" as light yellow-white, and "Tuorong" as dark yellow-red. These descriptions not only help us understand the specific characteristics of colors, but also reveal the strict hierarchy of colors in Yunjin. The royal colors of Yunjin are also divided into "Shangyong" and "Guanyong", which correspond to the exclusive use of the royal family and senior officials respectively, showing that the traditional royal colors of Yunjin have formed a systematic and strict hierarchical norm in the Qing Dynasty.

Through the detailed descriptions in "Dream of Red Mansions", combined with the color naming and hierarchical norms of the Qing Dynasty, we can see that Yunjin not only shows visual beauty as a fabric, but also strictly reflects the symbolic meaning of the social hierarchy through colors and patterns.

Table4: Commonly used plant dyeing names for Yunjin

Commonly used plant dyeing names for Yunjin	
Yellow series (yellow brown)	Beige, bud yellow, locust yellow, sunflower yellow, goose yellow, gardenia yellow, bean yellow, regular yellow, bright yellow, golden yellow, apricot yellow, honey persimmon yellow, eggplant ash, grapefruit yellow, yellow croaker, agarwood, chestnut yellow, Tibetan camel, brown, brown yellow, ochre, antique bronze, snuff
Red series (Orange/reddish brown)	Beauty Face, Water Red, Concubine Red, Pink, Peach Red, Silver Red, Big Red, True Red, Honey Red, Crimson Red, Tooth Red, Apricot Red, Vermilion Red, Persimmon Red, Southern Red, Seal Red, Brick Red, Scarlet, Bean Grey, Coral, Fish Red, Pomegranate Flower Red, Shark Color, Deep Crimson, Red Sauce, Date Sauce.
Green series	Tianshui Blue, Jade Color, Grass Green, Sprout Green, Bean Green, Pine Green, Autumn Fragrance, Fragrance Color, Crab Green, Pine and Cypress Green, Broad Green Fruit Green, Oil Green, Official Green, Old Green, Scallion, Bamboo Green, Scallion Green, Emerald Green, Tea Green, Dark Green, etc.

Commonly used plant dyeing names for Yunjin	
Blue purple series	Moon white, ancient moon, bright moon, lake color, iron gray, tile gray, silver gray, pigeon gray, feather gray, grape gray, lotus root, navy blue, vat green, swallowtail green, Beijing blue, Tibetan blue, Pinlan, emerald blue, peacock blue, crab green, stone green, crow green lotus, jujube sauce, purple sauce, reed sauce, scorpion green, Beijing sauce, ink sauce, etc.
black	Black color

Note. Commonly used plant dyeing names for Yunjin

Conclusion

Through the analysis of the application and evolution of plant dyes in Yunjin, this study draws the following conclusions:

This study systematically analyzes the plant dyeing process, color characteristics and design innovation of Yunjin, enriches the research system of Yunjin from the perspective of plant dyeing, makes up for the lack of attention to this process in previous studies, and expands the research dimension of Yunjin in the protection of intangible cultural heritage.

This study shows that plant dyeing, as an important source of Yunjin color system, not only gives Yunjin rich and diverse tones, but also provides a practical basis for its restoration and innovative design. By combining plant dyeing with traditional Yunjin craftsmanship, the application scenarios of Yunjin culture in modern society are further expanded,

helping to expand the cultural consumer group and enhance the cultural added value and market competitiveness of Yunjin products.

This study fills the gap of insufficient attention to plant dyeing technology, emphasizes its ecological value, and provides theoretical support for the sustainable development of Yunjin dyeing technology. Through the exploration of innovative design and high-end customization, the study has opened up a new path for the protection and modernization of intangible cultural heritage, and promoted the widespread application of Yunjin in contemporary art design and cultural industries.

Discussion

1. Unique system of Yunjin color

The color system of Yunjin is not only one of the important manifestations of its artistic value, but also reflects the cultural connotation of traditional Chinese colors. The color of Yunjin gradually developed and improved in the Yuan, Ming and Qing dynasties, forming a royal color system that is both gorgeous and elegant, showing a unique symbol of hierarchy and aesthetic value. However, with the popularization of modern industrialized production, the inheritance of traditional Yunjin colors faces challenges, especially the acquisition of natural dyes and the loss of traditional craftsmanship. These problems have posed a severe test to the protection of intangible cultural heritage.

2. The impact of plant dyeing on Yunjin

As an important part of the Yunjin color system, plant dyeing brings natural and environmentally friendly color characteristics to Yunjin fabrics. Studies have found that plant dyeing not only provides a variety

of colors, but also has the characteristics of health and environmental protection. Compared with synthetic dyes, it is non-toxic and harmless, and is more in line with modern ecological and environmental protection needs. However, the large-scale production of plant dyes faces problems such as scarcity of raw materials and complex dyeing processes, which limits its wide application in modern Yunjin production.

3. Combination of traditional craftsmanship with modern needs

This study provides a perspective combining archaeology and technology from the evolution of color systems to the ecological characteristics of plant dyeing technology, and provides new theoretical support for the color research of Yunjin. At the same time, it lays the foundation for the ecological design of Yunjin and the promotion of intangible cultural heritage in the future. However, the protection of intangible cultural heritage still faces many obstacles, such as the lack of interest of the younger generation in traditional craftsmanship and the market's dependence on low-cost synthetic dyes. Future research needs to further explore how to promote the sustainable development of Yunjin while protecting traditional skills and combining modern technology and market demand.

Research Recommendations

Based on the results of this study, the following suggestions are put forward:

1. Increase the cultural promotion of Yunjin color and plant dyeing

In order to let more people understand the unique color system of Yunjin and its cultural connotation, it is recommended to display the

historical evolution of Yunjin color and the natural characteristics of plant dyeing through exhibitions, lectures and interactive experiences, so as to enhance the public's awareness of intangible cultural heritage and protection.

2. Support in-depth research on plant dyeing technology

As an important part of Yunjin, the richness of its dyeing technology deserves further study. It is recommended to support in-depth research on plant dyeing formula, color stability, durability and other aspects to provide scientific basis for future ecological dyeing and promote the modernization of traditional crafts.

3. Promote the application of Yunjin color in education

It is recommended to include Yunjin color and plant dyeing in art education courses, and let students understand the ecological characteristics and cultural value of traditional crafts through a combination of theoretical teaching and practical operation. This will not only help cultivate the interest of the new generation in intangible cultural heritage, but also lay the foundation for the inheritance of traditional dyeing technology.

4. Encourage interdisciplinary research and enrich the understanding of traditional color systems

It is recommended to carry out interdisciplinary collaborative research, such as combining Yunjin color and plant dyeing with materials science, ecology and other fields, to explore the ecological characteristics of plant dyes and their sustainable application in modern design, so as to promote the innovative development of traditional crafts in a modern context.

5. Establish a Yunjin color and plant dyeing database

Establish a database covering the history of Yunjin color, plant dyeing formula, color characteristics, etc., so that researchers and practitioners can refer to it and promote academic exchanges and technology promotion. This database can also serve as a resource platform for intangible cultural heritage to promote the long-term protection and dissemination of Yunjin culture.

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