

The Coupling Analysis of Inheritance and Innovation of Knot Dyeing Based on Mathematical Modeling and Finite Element Analysis

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Abstract. With the deepen extension of archaeological findings and folk research, tie-dyed research has once again become a focus of cultural studies, its studies find that dye technique has a wide range of existence and exuberant vitality in the worldwide. First to expound the research and origin of dye, further analysis of China's traditional dye study, the use of mathematical modeling in-depth analyzes the Silk Road knot dyeing art's inheritance and innovation, through the analysis of sublimation of dye art and digestion and beyond of modern art concepts, trying to realize the ancient dyeing on the comprehensive research to make positive exploration.

Introduction

Dyeing valerian is the ancient silk printing and dyeing process general, up to now the study of dyeing is still in its infancy stage, lots of basic knowledge is not unified, tie-dyed origin problem has many variants, such as Egypt, India, Java, China and so on, in which the Egyptian referred to "textile printing" that was edited by British L. W. C Meyers, as early as 1500 BC knot dyeing technology had matured; India referred that American scholar Vivian Stein wrote "Batik as a Hobby" and Dumas Carter wrote "The invention of printing in China", thinking that the birthplace of cotton was India, therefore, the dyeing operation of cotton fabric may be also India that is the beginning; in the archaeological evidence, early prints were found in the discovery of Dunhuang cave, enough to prove that Chinese printing and dyeing had been established. In the printing and dyeing products of Dunhuang and Turpan, they had adopted the mordant and anti color agent, which thus proved that during the Han, Jin, southern and Northern Dynasties, Chinese were known to use resists, so the dye originated in China was an indisputable fact [1,2]. At the same time Sano Fuji wrote "staining entry" in Japanese and ISE arch wrote "batik techniques", the batik had already appeared approximately 2500 years ago, which born in India. American Ernst Mueh Ling wrote "The Book of Batik", he thought that the batik was originated in Java, because people travelled there after 1515 AD, it was spread around the world [3].

Chinese traditional dye research status and problems

A. Analysis of Chinese traditional dye research status

The anti staining technology of Chinese ancient textiles are called "dye", the most famous of resist dyeing process has four kinds, which are the ancient Chinese textile technology and the outstanding representative of art, its specific as shown in Figure 1.

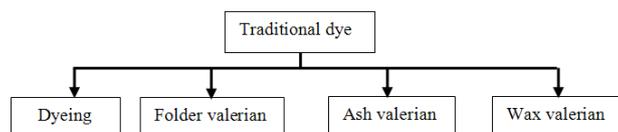


Figure 1. The most famous of resist dyeing process classification

In Figure 1, the most famous prevent dyeing process is respectively dyeing, wax valerian, folder valerian and ash on dye in the dyeing technology of Chinese ancient textile, which are known as "four valerians".

Since the last century fifty's, the Xinjiang's Turpan region and Gansu's Silk Road have unearthed a large number of tie-dyed textiles and loss of overseas Dunhuang dye artifacts, which study a new

focus of stained valerian culture in recent years [4]. In China, many scholars on the traditional dye art and restoration work of cultural connotation have made unremitting efforts and positive depth excavation work, the study of Chinese traditional dye has three centers at present, the specific distribution is shown in Figure 2.

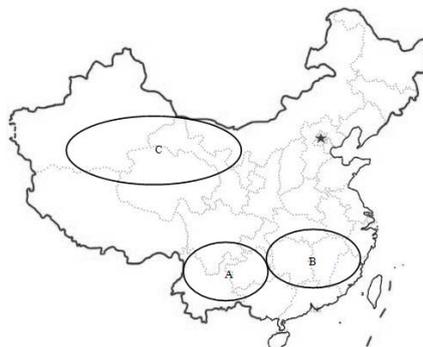


Figure 2. The distribution of Chinese traditional dye valerian study

In Figure 2, the study of Chinese traditional dye has three centers at present. A center is the southwest ethnic minority region, which is the traditional dye's most prosperous region of the world recognized, and is also core area of Chinese traditional dye research in recent years; B center is the Jiangnan region, the larger of its influence is Zhang Qin's "China blue folder valerian", which devises a set of processes that makes unprecedented detailed record on the Jiangnan region's folder valerian raw materials, printing and dyeing, graphic, the folk culture of the blue folder valerian endemic region as the history analysis of social and cultural [5,6]; C centre is Xinjiang and Gansu, from two aspects, Dunhuang and along the silk road is a flourishing region of knot dyeing art. Up to now, the dye is still the world's oldest knot dyeing art treasures on the ancient Silk Road; finally, the Dunhuang mural, Dunhuang as the Silk Road of the center as well as its profound culture background for the study of dye presence environmental, spread ways, and the process of evolution provide a valuable of image and rich information [7].

B. *Current Chinese traditional dye research problems*

In the present study, it can be clearly seen the problem of existence, on one hand, the dye culture has extended to other cultural industry momentum, which is expected to form a new economic point of growth. With the acceleration of modernization course, returning to the nature and understanding of origin are further enhanced, so tie-dyed culture is once again paid attention to people. For example, due to the attention of various government sectors, dye cultural tourism is just unfolding in the southwest and Jiangnan region. On the other hand, the relative isolation of tie-dyed research has also become the main bottleneck of knot dyeing art. The northern region is due to the history interrupt of dye culture, in order to restore the lost technology as research center [8]; the dye culture of the southern region does not interrupt, however its development is declining day by day, its current research is to protect existing techniques as studying emphasis; from the view of studies, academic focuses on the finishing, mining, reproduction of the traditional craft work for the study of dye, which seldom considers the application of these results, making the innovation of traditional dye becomes the research blind area. The dye culture carries out docking of tradition and modern, to realize the overall consciousness of tie-dyed cultural resources comprehensive development has not formed [9].

The significance of the regional culture characteristics in the art of dyeing art

A. *Historical development of dyeing valerian art*

From the historical development vein of knot dyeing art, tie-dyed began in the Qin Dynasty, the later Tang Magao's "the now note" was recorded by Qin Shihuang's dye. Although the knot dyeing technology had appeared in Qin and Han period, it was very rare. Currently the found tie-dyed products are also rarely, in the Qin Han period, it explains that the knot dyeing technology is still at the initial stage. The northern and Southern dynasties dye has been widely used in clothing. "Sui Shu-food goods will" records that Sui ordered the production of colored folder valerian flower skirt

of thin silk, to reward Gong and all the officials mother wife. Xinjiang Turpan Astana tomb unearthed the folder valerian of Sui Kai Huang six years (AD 586 years), the ground around appeared the small white flowers in sky blue silk, to like the stars, which explained that knot dyeing technology has reached a very high level in the Sui Dynasty. In the period of the Tang Dynasty, in addition to women's dress, tie-dyed can be made into furniture decorations, Japan Nara Masa bin institute has a variety of dye screen in Tang dynasty. Thus, the Tang dynasty in the dyeing and printing technology has been quite mature. After the mid-Tang, the wearing tie-dyed products become a social trend [10]. In the Tang Dynasty ancient paintings, such as Zhou Meng's "flower Shi figure", Zhang Xuan's "exercising map" as well as tie-dyed products can be widely used in the some pottery figurines and Guo Huang Tang Dynasty Murals.

B. Analysis of Gansu regional culture characteristic in dye

The area of Gansu is the development of mature location in the history of the Tang period knot dyeing art. The dye works has been spread so far during the Han and Tang dynasties, the viewer can understand its deep artistic style and exquisite production process. Ming and Qing's dye works are mainly with gentle light, it is on behalf of the region that is south and southwest Guizhou area. Compared with the dye works of Ming and Qing, Gansu area passed down from the Han and Tang Dynasties era of the dye works, its artistic style can be heavy and magnificent to summarize. As Tang, Tang tie-dyed pattern was colorful works, grand and magnificent, the dye works of Silk Road region is more frontier customs mainly, the spectacular, sunset walk of travel team etc, they gave all works depict on the thick exotic. Of course, this is due to cultural opening of specific historical era to reality bring, it is the national spirit and culture results. This open, thick and masculine of the Han and Tang Dynasties spirit, let us also so magnificent dye works, gorgeous and shine.

C. Characteristics of Gansu regional culture in the importance of knot dyeing art

Gansu regional culture resources are abundant, which is the ancient Chinese and Western cultural's interchange. Gansu is center area as the Silk Road culture, Dunhuang and along the Silk Road are flourishing region of the ancient traditional dye art. On one hand, the ancient Silk Road found dye objects, up to now it is still the world's oldest and most exquisite knot dyeing art. On the other hand, Dunhuang fresco represents Gansu grotto art that true records of knot dyeing art precious images. In addition, through Gansu throughout's history and folk custom activity of the ancient Silk Road, its profound cultural background provides a wealth of literature and culture for the environmental presence, spread ways and evolution. The national essence culture is accumulated deep, the main national essence culture is shown Figure 3.

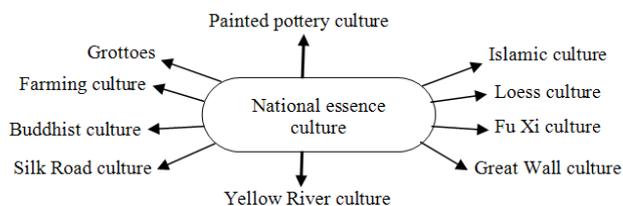


Figure 3 Main national essence culture of Gansu areas



Figure 4 Tube dye works

In Figure 3, the Gansu region's Silk Road culture, Yellow River culture, farming culture, Buddhist culture, Islamic culture, loess culture, Fu Xi culture, grottoes, painted pottery culture, Great Wall culture and other national essence culture, which are accumulated deep, to reflect the rich local characteristics. Many art lovers and literatures all use their brushes, lens and written to record this nature and give the mankind of exotic scenery.

In Figure 4, these become the unique Gansu area's visual symbols and modeling principle, forming a unique charm of culture morphology. The difficulty of this process makes Gansu culture become a kind of cultural nutrition after fusion and digestive, which can be enrich the dye works. The vast desert sands, the residual Xia beautiful, road sand greenish yellow and peak stones ups and downs are let all the people walking on the Silk Road are shocked.

Analysis of the target optimization of knot dyeing art inheritance and innovation

A. Mathematical modeling analysis of knot dyeing art heritage and innovation

For the innovative research of knot dyeing art, it includes the inheritance and breakthroughs of traditional dye technique, and also includes the tie-dyed culture arts' continuation and updating, to analyze Silk Road knot dyeing art heritage and innovation based on mathematical modeling, (x, y) and (u, v) are respectively said knot dyeing art inheritance and innovation index, $f(x, y)$ and $g(u, v)$ are respectively said the corresponding effectiveness index of knot dyeing art inheritance and innovation, (x_0, y_0) and (u_0, v_0) are respectively said having index before knot dyeing art inheritance and innovation; in the Silk Road knot dyeing art heritage and innovation, apparently hoping knot dyeing art gets optimum development through the inheritance and innovation, namely from inheritance angle, it should be maximize $f(x, y)$. From the angle of innovation, it should be maximize $g(u, v)$, at the same time it also need to consider some constraint conditions, the multi-objective optimization problem of knot dyeing art heritage and innovation is the following:

$$\begin{aligned} & \text{Max} \quad \{f(x, y), g(u, v)\} \\ & \text{st} \quad \begin{cases} x+u = x_0+u_0 \\ y+v = y_0+v_0 \\ f(x, y) \geq f(x_0, y_0) \\ g(u, v) \geq g(u_0, v_0) \quad x, y, u, v \geq 0 \end{cases} \end{aligned} \quad (1)$$

In formula (1), $f(x, y)$ is continuous, nonnegative and monotonically increasing for the respective variable; for the different two constants C_1 and C_2 , the indifference curve $f(x, y) = C_1$ and $f(x, y) = C_2$ are disjoint, then to get the knot dyeing art inheritance and innovation in multi objective optimization problems is an effective solution to meet the necessary conditions:

$$x + u = x_0 + u_0, \quad y + v = y_0 + v_0 \quad (2)$$

$$\frac{\partial f}{\partial x} \cdot \frac{\partial g}{\partial v} = \frac{\partial f}{\partial y} \cdot \frac{\partial g}{\partial u} \quad (3)$$

$$f(x, y) \geq f(x_0, y_0), \quad g(u, v) \geq g(u_0, v_0) \quad (4)$$

In formula (1), (2), (3) and (4), they can solve all effective solutions that can constitute finite segments as shown in Figure 5.

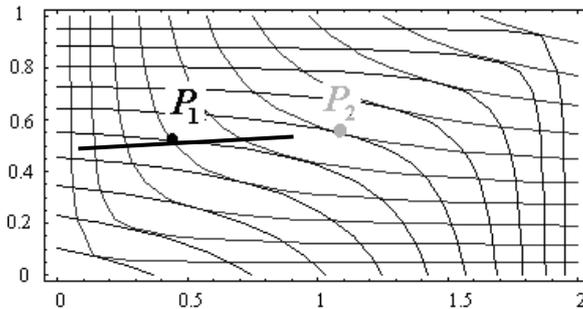


Figure 5 The corresponding effect effective index map of knot dyeing art heritage and innovation

In Figure 5, P_1Y and P_2 can form a straight line, which is the optimization knot dyeing art inheritance and innovation. In terms of creative techniques, we can carry out knot dyeing art innovation from the two aspects of dyes and art.

B. Resources mining of knot dyeing art inheritance and creative innovation

1) The dye innovation creation of knot dyeing art inheritance and innovation

Knot dyeing art inheritance and innovation creation can be combined with contemporary biological manufacturing technology, natural dyes carry out the depth of the development and reconstruction, using biological engineering method carries out cultivation for dye raw materials plants. Its advantage not only brings the development of planting industry, but also has indirect support role for the pharmaceutical industry that can drive the development of other related industries. From the dye extracting process, the contemporary biology technology can make up traditional printing dyeing technology's defect, such as pigment extraction, dyeing dissolution, fabric color fully absorb and other aspects, more importantly is that the use of modern technology, the process is simple and low cost, it also determines its broad application prospects.

2) Art form innovation of knot dyeing art heritage and innovation creation

Knot dyeing art inheritance and innovation creation can absorb on the light and shadow color feeling in Western painting, which can be linked color performance with dye valerian craftsmanship in Western painting, emphasizing color imagination and paying attention to light and shadow, at the same time paying attention to color the psychological effect can find abstract visual symbol from point, line, plane and color, to change people's aesthetic tendency, and gradually to form of dye unique cultural language. People should fully absorb and draw lessons from the western modern design concept, starting from the rules of constituting a formal beauty, in-depth study of dye technique's development and application. From the art creation of the methodological proceed, through the knot dyeing art form of perception, understanding, and then to complete the dye sublimation of art and modern art concepts of digestion and beyond, finally to realize the ancient knot dyeing art comprehensive revitalization.

Conclusion

Inheritance is the foundation, and historical research is the foundation of craftsmanship and cultural heritage. Therefore, we have a responsibility to Chinese traditional culture as the focus; to accumulate and extract genes of traditional dyeing skills and spiritual symbol as the purpose; the accumulation of national culture deep dots make it into modern and future trend of valuable genes for direction; from the shape representation, connotation and aesthetic point of view, to explain the traditional knot dyeing art and the new life of the culture; from the shape representation, connotation and aesthetic perspective, comprehensive exploration, explanation of ancient knot dyeing art, thus completing the Silk Road knot dyeing art's heritage and innovation docking. The study of Knot dyeing art opens a long of the area that is neglected by people for the development of Gansu cultural resources, and provides a new bright spot for the promotion prosperity of culture industry, but also runs into the future to provide a good opportunity for the ancient knot dyeing art. On the basis of the inheritance of the traditional dye techniques, the mood artistic conception of Chinese traditional painting is in combination with modern art, the concept of modern art, thought and the spirit of dye traditional culture are organically combined. Through the personality manifestations to reach the strong artistic effect, the ethnic traditional culture is reinterpreted and positioned in the art, so that the modern knot dyeing art works exude Chinese culture broad and inclusive national charm.

Acknowledgments

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