Technical Analysis of Ikat from Xuwei No.1 Ancient Grave in Qinghai 1 Province, China

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Research Article

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Abstract

A technical analysis of the ikat ancient grave-Xuwei No.1 excavated fabric from the Dulan site in 2018 is described in the paper. Using a microscope, the weave structure and fibre characteristics of the textile were examined, and it was determined that mulberry silk had been degummed for both the warp and weft yarns, and that warp-dying had been used to create the warp display pattern. Four colours distinguish the patterns: khaki, earth red, indigo blue, and pea green. In chromatographic testing, the dyes were determined to be Rubia tinctorum L., Phellodendron amurense Rupr., Indigo and their mixture of Phellodendron amurense Rupr and Indigo.Through the above research, combined with the burial age, geographical location and other factors, it is considered that the technology of the fabric has the characteristics of the Central Plains and comes from southern China.

1. Introduction

At an elevation of 3400 to 3500 metres, an ancient grave called Xuwei No.1 can be found in Reshui Township, Dulan, Haixi Mongolian and Tibetan Autonomous Prefecture, Qinghai Province. The climate has a plateau-arid continental climate with few rainfalls, plenty of sunshine, and a difference in temperature between daytime and nighttime. The tomb is situated in a valley on the northern bank of the Chauhan Usu River, backed by a mountain and facing the river; the landscape is steep in the north and low in the south.

Public security authorities became aware of tomb-robbing activities within the site area in March 2018. In the same year, a joint archaeological team was formed by the Institute of Archaeology of the Chinese Academy of Social Sciences and the Institute of Cultural Relics and Archaeology of Qinghai Province, with the approval of the State Administration of Cultural Heritage, to carry out rescue excavations of the stolen 2018Xuewei No. 1 tomb. (2018DRXM1)

The burial chamber consists of the main chamber and four side chambers, North 1, North 2, South 1 and South 2, as shown in Fig. 1. The side chambers were connected to the main chamber by an aisle, and textiles and leather were mainly excavated from the north two side chamber. A rectangular wooden bed, 3.06m long from east to west, 2.04m wide from north to south, and approximately 0.5m above the floor of the tomb, was initially covered with wooden planks, but only part of the south-west corner remains due to natural erosion from water, saline and other factors, as well as attack by grave robbers. The silk fabric and leather should have been placed on the wooden bed.

On October 9, 2020, a fragment of tied Ikat fabric, numbered 2018DRXM1NC1:201, was recovered from the northwest corner of the north two side chamber of the tomb, approximately 0.8m above ground level, in silty soil, as shown in Fig. 2. It was initially measured using a portable microscope (Dinolite-AM7515MT8A) and a Martin ruler. The fabric is 23cm wide and 25cm long, with a fabric edge remaining on one side of the fabric, and the fabric edge is 0.2cm wide. The fabric is a simple structure with a warp showing flowers, and the warp is composed of four colours, namely khaki, earth red, indigo blue, and pea

green, knotted and dyed in batches, of which dye overlays should make pea-green of khaki and Indigo, and the weft is earth red making it difficult to glimpse its pattern circulation. The warp and weft thread densities are 34/cm and 22g/cm, respectively, and the projected widths of the warp and weft threads are 0.15mm and 0.25mm, respectively. 1000n/m and 1200n/m for the warp and weft threads, respectively; the twist direction is unknown.

Through further observation of the physical structure of the above textile fragments and examination of the dye composition, this study attempts to identify the types of textile fibres, study their production processes and the historical information contained in the materials, and make a preliminary discussion of their technological origins in order to seek the advice of scholars.

2. Microscopic Observation Of Ikat Textile

The transversely oriented fibres from the 2018DRXM1NC1:201 remnant were selected as the study sample, and cross-sectional sections of the fibres were produced using a rotating wheel slicer (Thermo-HM340E) and a tissue embedding machine (YB-6LB). The micro-physical morphology of the fibres was observed using a 3D video microscope (Leica-DVM6A) to analyze the fibre material.

Microscopic observation reveals a small amount of contamination on the surface of the fibres. Some of which are broken and fragmented due to ageing. The fibre body is smooth, straight, of uniform thickness and fineness, with longitudinal striations and a more regular triangular shape in the fibre's cross-section, with good fullness, as shown in Figures 3 and 4. The fibre cross-sectional morphology is the same as modern silk fibres, and the silk fibres have been reeled and degummed. The fibre morphology of this fabric is very similar to that of the "Kanton fissure" in the Tokyo National Museum, Japan, which is thought to have come from the Guilin region of the Guangxi Zhuang Autonomous Region, as shown in figure 5.

The pixel method [2] was used to separately measure the technical examination of ikat ancient grave-Xuwei No.1 excavated fabric from the 2018 Dulan Qinghai. Also, based on the study by Shunro Bume [3], the pixel method was used to further analyze the cross-section of the fibres of "kanton fissure" in the collection of the Tokyo National Museum, Japan, as shown in Figure 5.

Ten fibre cross-sections were randomly selected for marking, and their cross-sectional data were collected separately, as shown in Figures 6 and 7. The mean value of the single fibre cross-section of the Technical examination of ikat ancient grave-Xuwei No.1 excavated fabric from the 2018 Dulan Qinghai was calculated to be 40.4um^2, with an extreme value of 45.7um^2 and a minimal value of 35.7um^2, and the dispersion of the single fibre cross-sectional area was 12.8um^2. The mean value of the cross-section of a single fibre in the kanton fissure collection in the Tokyo National Museum is 38.1um^2, with a maximum value of 41.2um^2 and a minimum value of 30.1um^2 and the dispersion of the cross-sectional area of a single fibre is 12.2um^2.

A comparison of the two groups of fibres shows that the cross-sectional areas of the individual fibres are relatively similar, both being significantly smaller than those of modern mulberry silk fibres and that the dispersion of the cross-sectional areas of the two groups of fibres is not very different. Therefore, it is inferred that the sericulture and reeling techniques of the two may have originated from the same place.

3. Dye Analysis Of Ikat Textile

Take two kinds of fibre samples, earth red and pea green, respectively, the earth red is labelled as A, and the bean green is labelled as B. They were placed in 1.5mL liquid phase vials, and 200μL of methanol (MeOH) & formic acid (FA) & disodium ethylenediaminetetraacetate (EDTANa2) mixed solution was added; the solution ratio was 2:1:1, at 75 ° C Ultrasonic extraction was performed for 40 min, centrifuged, and the supernatant was taken to obtain a test sample. The fabric dye was analyzed by ultra-high-performance liquid chromatography-quadrupole time-of-flight mass spectrometry (UPLC-Q-TOF-MS). The detection results are shown in Figure 7 shown in Figure 8.

Table 1 Retention of individual substances in samples

Sample number	Retention time /min	Parent ion m/z	Fragment ions m/z	Compounds
A	6.77	239.03□-□	211	Alizarin
	7.27	255.03□-□	227	Purpurin
B	5.50	336.12□+□	292	Berberine
	6.15	329.23□-□	211	Sanleng acid
	7.22	263.08□+□	235	Indigo

The analysis was based on the liquid chromatogram and the retention of each substance in the samples. Sample A in ESI-mode showed an [M-H]-peak at m/z 239.03 at 6.77 min and an [M-H]-peak at m/z 255.03 at 7.27 min. Substance attribution was determined based on the retention time of the pigmented substances in alizarin, and two substances were detected, alizarin and hydroxy alizarin, both of which are major staining components of alizarin.

In sample B in the ESI+ mode, at 5.50 min, there was a [M+H] + peak at m/z 336.12, which is characteristic of berberine. In the ESI- mode, at 6.15 min, there was a [M-H]-the peak of 329.23, which resolved to be trigonelline, and these compounds were mainly derived from the vegetable dye Phellodendron. In addition, at 7.22 min, there was a [M+H] + peak of 263.08, which was analyzed to be Indigo, so sample B was obtained from yellow-dyed Phellodendron blue-dyed Indigo using the overlay dyeing method. This green colour was dyed by dipping the fabric into the container containing the Phellodendron and indigo dyes in several successive stages. According to the book "Tiangong Kaiwou - Zhangshi," "yellow tiller water dye, indigo water cover, now use small leaf amaranth blue decoction water cover, the name of the grass bean green, the colour is very fresh."

Phellodendron and Indigo are more widely distributed, and the dyeing method was quite popular during the Shang and Zhou periods. As for the origin of Phellodendron Bark, it is relatively concentrated, mainly in the three northeastern provinces of China, Shaanxi, Sichuan and Hubei [4]. The Tang dynasty documents record that it was mainly between Sichuan and Shaanxi. For example, in the Yuanhe County annals, " it is recorded that "there is much lacquer and Phellodendron Bark" in the northern Wuxing Mountains of Xingzhou Shunzheng County. Moreover, in the" Tangliu Dian," it is recorded that Phellodendron Bark in "Jinzhou Hanyinjun Tugong "; and in the "Xintang Shu·Dili Zhi" of, it is recorded that "Phellodendron Bark is tributed from the soil of Hanyin County, Jinzhou, its geographical location in present-day Shaanxi Hanzhong, Hanjin, a band. It can be surmised through the above dye composition that the dyes used in this fabric should have come mainly from the inland region.

4. Discussion

For a long time, it has not been easy to form a unified understanding of the origins of tie-dyed fabrics in academic circles. Whether from fieldwork, documentary or physical sources, or linguistic transmission, the conclusions reached vary greatly and have weak arguments to support them, making it difficult to reach a consensus. The main reason for this dilemma is the lack of empirical data. Although there are fabric tapestry excavations from the tomb of Zhengxianwang in Yinchuan, Ningxia [5], the tomb of Xiangjiaxiang Mokeli, Dulan, Qinghai, and the tomb of Xuewei No. 1 in 1982 in Reshui Township, Dulan, Qinghai, there are few reports of textile excavations from the other two tombs, except for the tomb of Zhengxianwang in Yinchuan, Ningxia, where excavation reports are available.

In addition, cotton fabrics of the same type have been excavated at Fustat in Egypt, Sana'a in Yemen and Nahal'Omer in Israel [6], some of which are in the collections of the George Washington University Textile Museum, the Metropolitan Museum of Art and the British Museum [7]. The above empirical sources date from between the 9th and 12th centuries. The Japanese Todaiji temple and Horyuji temple collections of zazen-dyed fabrics have the same material and artistry as those found in the northwest and date to the Middle Tang period (766 AD-835 AD). In contrast, the construction of the 2018 Xuewei No. 1 tomb in Dulan, Qinghai, dates to the mid-8th century AD [8]. Therefore, it can be judged that the Ikat textile fabrics unearthed from the Xuewei No. 1 tomb in Dulan, Qinghai, in 2018 are the earliest archaeological empirical data with a clear provenance so far.

Based on the materials and dyes found in the Ikat fabric, it probably travelled along the ancient Silk Road. The ancient climatic characteristics of this area did not allow for the cultivation and rearing of raw materials for the production of textiles such as mulberry and silkworms. Meanwhile, it also did not have the Rubia tinctorum L, Phellodendron and Indigo. The animals, as mentioned above and plants mostly grow in warm, humid temperate monsoon and subtropical monsoon climates, but this is a highland arid continental climate, with little rain and a significant temperature difference between day and night, so the chances of survival are meagre. As a result, the technical conditions for the production of tie-dyed fabrics were not available in the region, and it was only through the exchange of materials with the outside world

that the conditions for the production of products were available. Compared to the Central Asian region, the Central Plains are more suitable for cultivating and breeding these textile materials.

The earliest record of the Ikat dyeing technique in the Central Plains dates back to the Three Kingdoms period (220-280 AD), when Wanzhen, the governor of Danyang in the State of Wu, wrote in this book, "Nanzhouyiwuzhi" The dyeing of fabric for the Ikat is made from a plant called Gubei, which is a species of plant in the cottonwood family. When the plant is ripe, the fibres of the fruit are goose-feather shaped, with a kernel inside, and the fibres are more delicate than silk". The kernels are removed, and the fibres are spun into yarn, which is dyed in sections and then woven into fabric. In the book "Liangshu·Linyiguo"“Gubei” is the name of a tree that bears fruits that look like goose feathers, and the fibres from the fruits are spun into yarn and woven into cloth with the yarn. If the yarn is dyed in various colours, it can be woven into a tie-dyed fabric." In ethnographic research, it was found that the Lizu people living in Hainan today still retain such weaving techniques [9]. In addition, according to the "Xintangshu·Dilizhi" and the "Yuanhe Tribute contained in the Yuanhejunxiantuzhi, the Huainan Dao, the Jiannan Dao and the Lingnan Dao were all described as having offered Ikat to the central government.

A piece of the tie-dyed fabric supports this in the collection of the National Museum in Tokyo, Japan, called "Guangdong Lie." It was analyzed by Juno Nunome in cross-section and found to be similar to silk fibres produced in the Guilin region of the Guangxi Zhuang Autonomous Region. Tian and Bujie analyzed the composition of the dyestuffs that made up the four fabric colours and concluded that the fabric came from southern China [10]. The dye composition and fibre characteristics were consistent with the Ikat-dyed fabric excavated from the 2018 Xuewei No. 1 tomb in Dulan, Qinghai. Therefore, it is assumed that the fabric also came from southern China.

Conclusions

To sum up, through the analysis of the Ikat-dyed fabric sub-fibres and dyes excavated from Tomb No. 1 of Xuewei in Dulan 2018, the fabric material and dye composition were determined. By analyzing the burial information, ancient documents and ethnographic research results, the origin of the fabric technology was further analyzed, and the technology was considered to be characteristic of the Central Plains region. The fabric was compared with the 'Guangdong Lie' in the Tokyo National Museum, Japan, and the two sets of data were consistent, with the latter being of southern Chinese origin. The examination of the fabric's technical origins reflects the diversity of material sources in the region and demonstrates the critical role of the Qinghai Road in the southern route of the ancient Silk Road during the Tang dynasty (618-907 AD).

Declarations

Availability of data and materials

All data analyzed during this study are included in this published article. Raw data are available upon request.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author's Contributions

LD analyzed and interpreted the data, wrote and edited the article, designed and conducted the experiment and studied scientific literature about the topic. The author read and approved the final manuscript.

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Figures

Figure 1

Ancient grave-Xuwei No.1 from the 2018 Dulan Qinghai top view of the tomb chamber

Figure 2

Ancient grave-Xuwei No.1 from the 2018 Dulan Qinghai Ikat physical picture

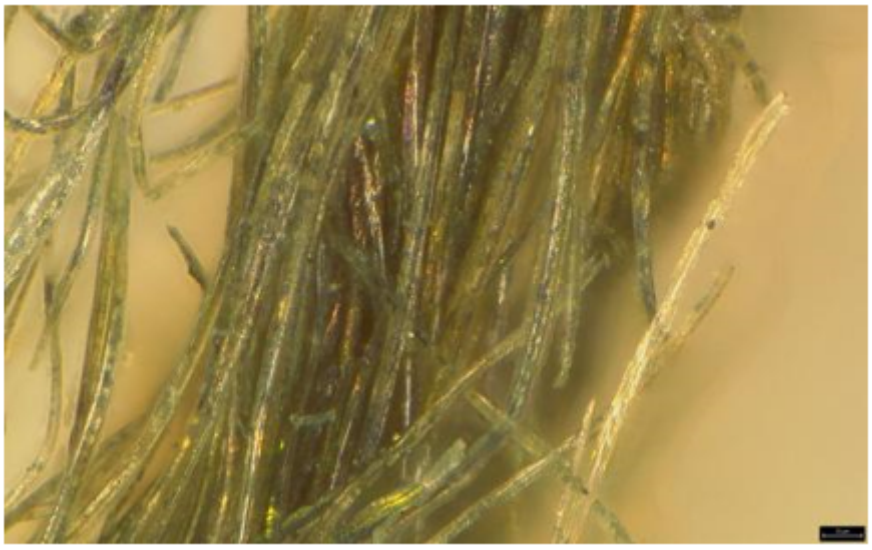


Figure 3

Magnification 400 times of fibre sample

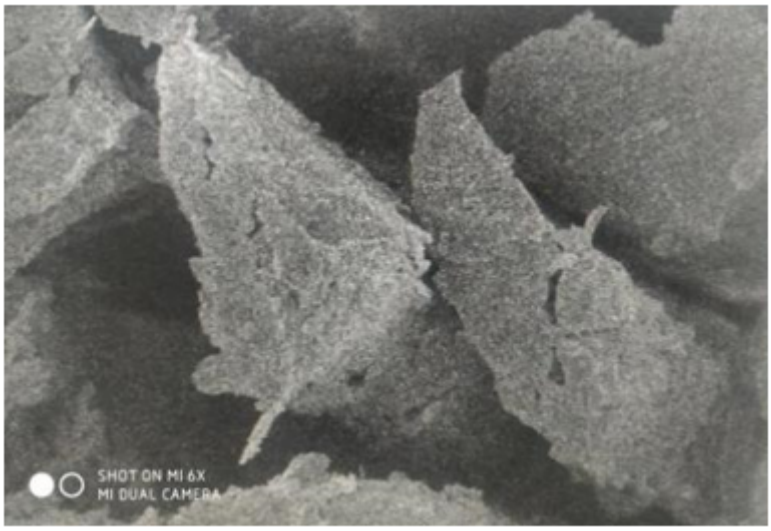


Figure 4

Cross-section of tied Ikat fabric fibres excavated from Tomb No. 1 in Reshui 2018, Xuewei, Dulan, Qinghai

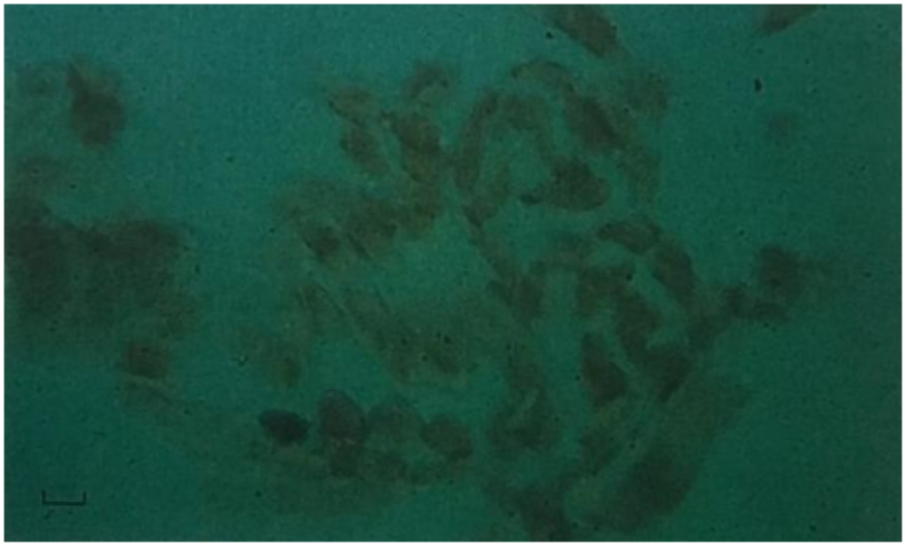
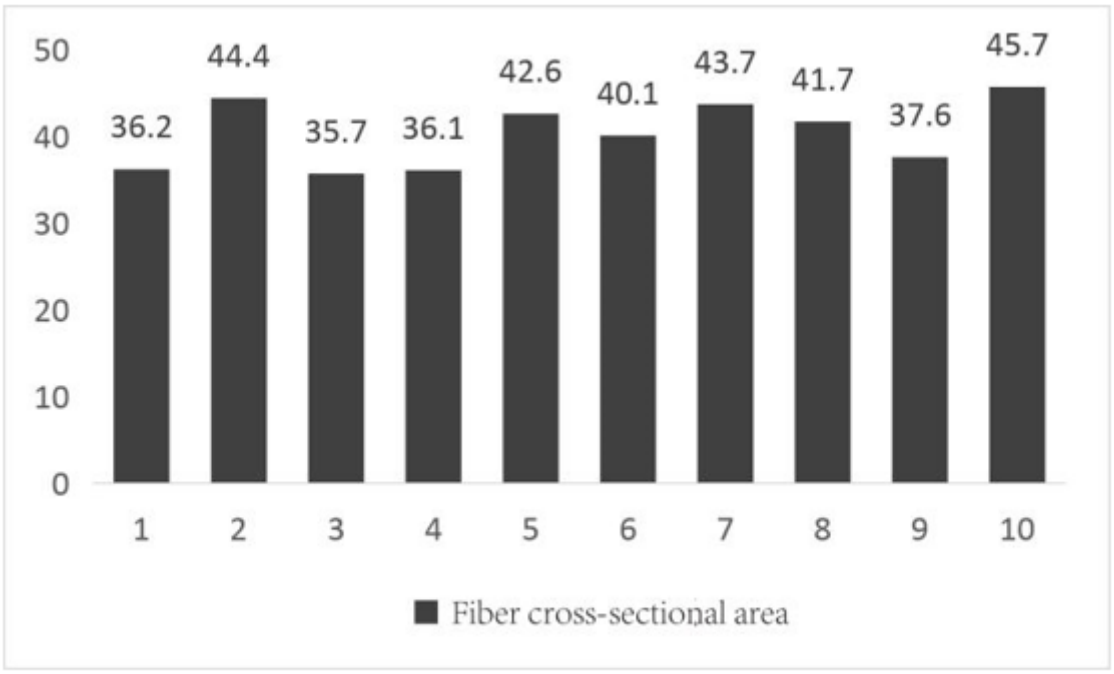


Figure 5

Cross-section of 'Guangdong Lie' fibres in the Tokyo National Museum, Japan



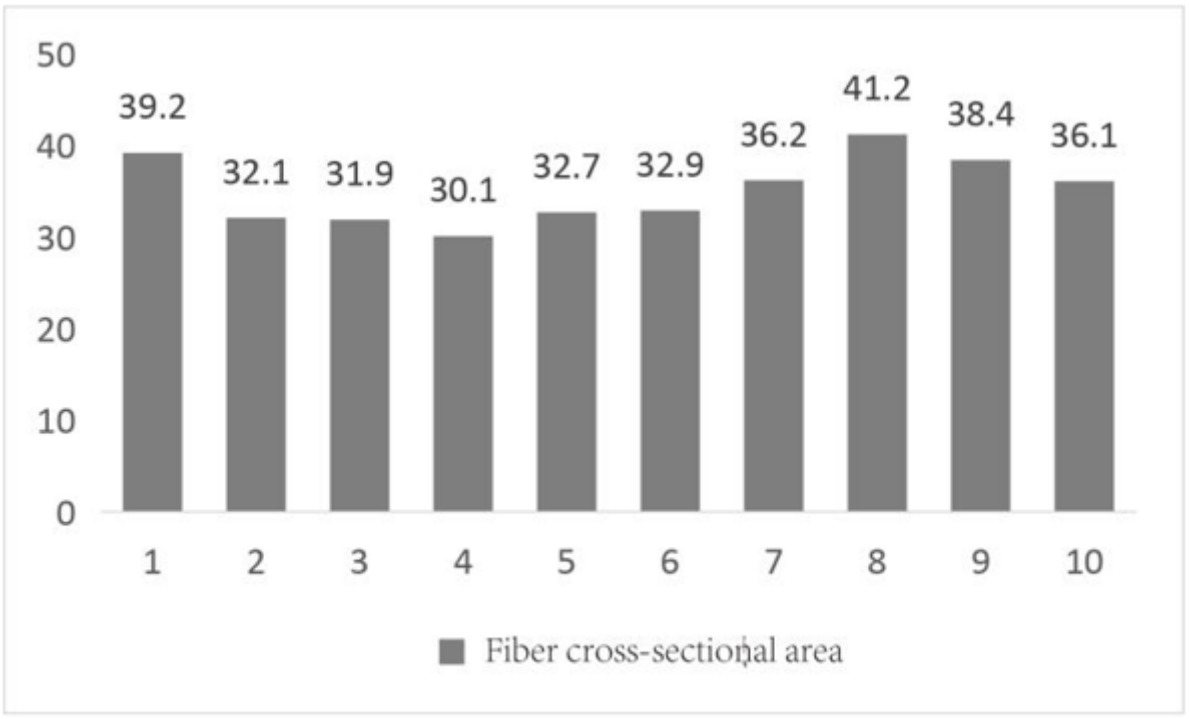


Figure 6

Statistics of the cross-sectional area of the fibres of the tied Ikat fabric excavated from the 2018 Xuewei No. 1 tomb in Reshui in Dulan, Qinghai

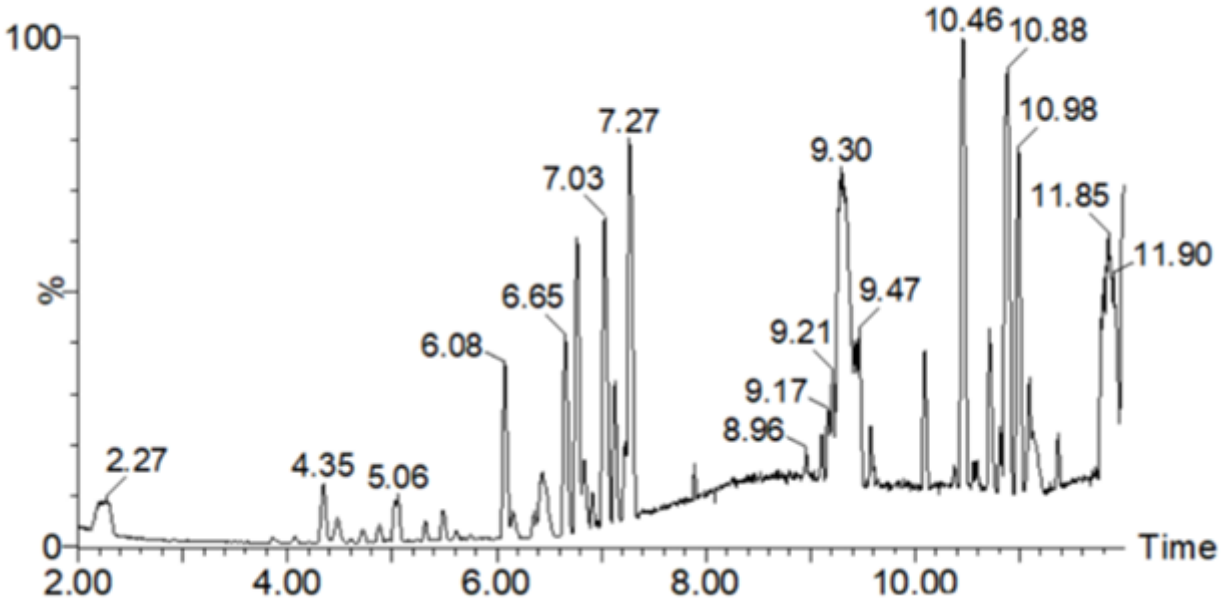


Figure 7

Liquid chromatogram of the red dye test sample

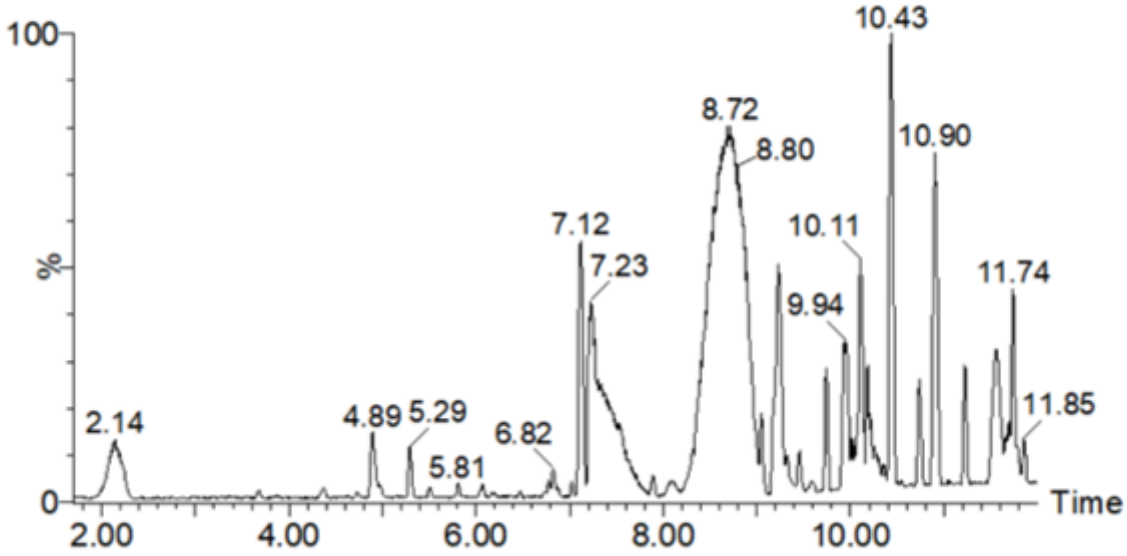


Figure 8

Liquid chromatogram of the green dye sample