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Dye analysis from the little-known bastard hemp (*Datisca cannabina* L.) used in the dyeing of historical textiles and comparison of samples identified in textile cultural heritage

Abstract

The use of colors derived from natural dyes dates back to the dawn of humanity. Initially, people used mineral-based dyes before discovering dyes made from plants and animals to color their surroundings. This study focuses on the characteristics and dye components of bastard hemp (*Datisca cannabina* L.), a plant historically known for producing yellow dyes. It also presents the results of an analysis of silk fabric dyed with this plant. The study is significant as it compares the dye components obtained from the plant with those that remain after dyeing the silk. High-performance liquid chromatography with diode array detection (HPLC-DAD) was employed for the dye analysis. Additionally, the color was measured using a CIEL*a*b* spectrophotometer, assessing both untreated silk fabric and silk that had been treated with an alum mordant before being dyed with bastard hemp. This approach allowed for the identification of visually detectable and numerically documented color differences. Moreover, the study provides comprehensive information on historical textile samples and modern works identified as having been dyed with this plant, along with comparative results. The study further reviews historical textile samples and contemporary research in which bastard hemp has been identified as a dye source, presenting comparative analytical results. By integrating chemical analysis, colorimetric evaluation, and historical evidence, this research offers useful information for textile conservators, restoration specialists, archaeometrists, conservation scientists, and traditional dyers. The findings contribute to a better understanding of the limited but significant historical use of bastard hemp as a yellow dye and support informed decision-making in the preservation and restoration of culturally significant textiles.

Keywords: *Datisca cannabina*, bastard hemp, natural dyeing, textile cultural heritage, dye analysis, colour measurement.

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Introduction

Humans have been fascinated by the colours produced by nature since ancient times, using them in many different areas.[1] Natural colorants obtained from plant and animal sources have been used in for dyeing fabrics and yarns dyeing since the earliest periods of textile civilization.[1–8] Plant dyes are the most commonly used natural source. The different parts of various plant species, such as roots, stems, branches, leaves and fruits, have been used as sources of textile dyes.[1,3,9] Of all the colours, yellow is the one that can be produced from plant sources due to the greatest species diversity.[1,8,10,11]

Natural yellow dyes, composed of polyphenolic compounds produced in nature, are the most common family of dyes. Around 90% of these dyes have a flavonoid structure (Figure 1).[9,12] Until the late 19th century, flavonoid colourants were used as pigments in easel paintings and as mordant dyes in textiles. They were also used to produce green tones by mixing them with a blue-producing plant, such as indigo.[1,3,7,12,13]

Flavonoid dyes are sensitive to light and can easily undergo photooxidation and decomposition into simpler components.[12,14] In general, it has been found that the photo-oxidation rate decreases significantly when the flavonoid molecule contains fewer hydroxyl groups (-OH) and/or is not located in the 3rd position (Figure 1).[9,15] Flavonoids have antibacterial, antimicrobial, anti-inflammatory, antiallergic, antimutagenic, antiviral, and anticancer properties, and act as antioxidants.[16–19] Natural flavonoid compounds are typically found as glycosides, aglycones, or methylated derivatives. Glycosidic flavonoids are found in the tissues of flowers, leaves, and fruits, while aglycone flavonoids are found in woody tissue.[9,20] Flavonoid glycosides are generally water-soluble, whereas flavonoid aglycones that are more polar tend to be water-insoluble.[9,21]

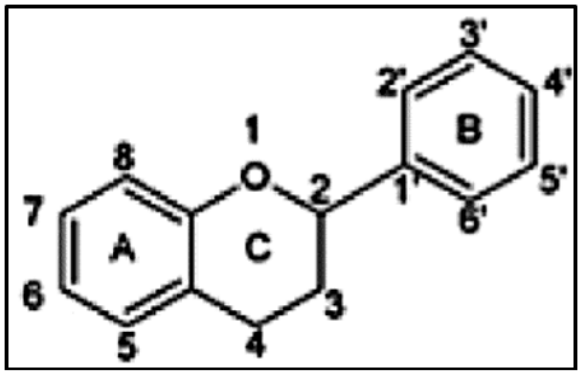

Figure 1 Flavonoid structure.[9]

Bastard/False Hemp (*Datisca cannabina* L.)

The *Datisca cannabina* L. plant, which belongs to the *Datiscaceae* family, is known by various names in Türkiye. The *Datisca cannabina*

L. plant, commonly known as "bastard hemp" or "false hemp" worldwide,[1,4,6,8,9,12] is referred to as "gence",[1,3,19,22,23] "akalbir",[4,9,24] "renkotu",[25] "haçkırık",[26] "cebeli hindi",[1] and "Kazdağı herb",[3] in Türkiye.

Bastard hemp is native to Western Asia, Cyprus, and Crete. It has also been cultivated in India and Italy, and in southern France since the early 19th century.[1,9,19,27] In Türkiye, it is found in the Black Sea region and in western and southern Anatolia.[3,19,22,28] Bastard hemp is a bushy, hairless, perennial plant that resembles the hemp plant (*Cannabis sativa* L.). It can grow up to two metres tall (Figure 2).[1,3,19,22,28] The alternate leaves are pinnate and consist of seven to nine lanceolate leaflets that are pointed and coarsely toothed.[1]

Figure 2 Bastard hemp (*Datisca cannabina* L.).[29]

Bastard hemp has been used as a printing dye for textiles (such as wool and silk) and, in particular, for cotton fabrics as printing dye.[1,3-5,19,30-32] At the same time, this plant has a long history of use in traditional medicine.[30] It has been determined that it has diuretic,[33,34] expectorant, and laxative effects,[33] as well as sedative properties and benefits for rheumatic diseases.[24] In addition, this plant is used in traditional treatment methods for Varroa disease, which is effective in increasing honey yield in beekeeping.[25]

The above-ground parts of the bastard hemp are used for dyeing textiles yellow.[1,3,19,23,26,28] It has also been reported that the roots of the plant are used for dyeing purposes due to the dyes they contain.[1] According to Cardon (2007), late summer is the best time to harvest the plant for dyeing. When used alone for dyeing, the plant produces a yellow colour, but the colour spectrum varies depending on the mordant used.[1] Using an alum mordant [$KAl(SO_4)_2.12H_2O$] produces a bright yellow,[1,3,28,32] whereas an iron mordant produces brown, greenish-brown or khaki colours.[26]

This plant was traditionally used by nomads in northwestern Türkiye for dyeing purposes. Currently, it is known to be used, though infrequently, in carpets and flat weavings, as well as for yellowing fibers in Van, Türkiye.[3,19] A series of dye analyses of Turkish fabrics and carpets revealed that this dye was popular among dyers in the Balıkesir region of western Anatolia. It has also been established that it was used to produce the yellow colour in some carpets and rugs woven in the region. The plant was also used to create the orange colour of a historical carpet.[1,3] Although dyes produced from this plant are known to produce a beautiful golden yellow colour with good washing fastness,[1,19] they are not lightfast.[1,19,28,35,36]

Datisca cannabina has a versatile place in Asian and Mediterranean cultures as a dye in textiles; and in Eastern medicine as a pain reliever, fever reducer, anti-rheumatic drug, and digestive regulator.

The components of the *Datisca cannabina* L.

Hydroalcoholic extracts from the *Datisca cannabina* L. plant are recognised for their high flavonoid content, particularly flavonols such as datiscetin and galangin. These flavonoids are often found in their rutinoside forms, such as galangin and cannabin/isalpinin. The presence of triterpenes has also been reported.[8,37]

Several studies have previously been conducted to isolate dyes from this plant. In 1969, Zapesochnaya et al.[30] reported the presence of datiscetin (3,5,7,2'-tetrahydroxyflavone), galangin (3,5,7-trihydroxyflavone), and cannabin/isalpinin (3,5-dihydroxy-7-methoxyflavone), alongside their 3-rutinosides.[30] In 1974, Pangarova and Zapesochnaya reported 2',3,5-trihydroxy-7-methoxyflavone 3-O-[O-α-L-rhamnosyl-(1→6)-β-D-glucopyranoside], also known as datiscetin 3-rutinoside.[38] In 1982, Zapesochnaya et al.[30] identified datiscin (datiscetin 3-rutinoside), also known as 2',3,5,7-tetrahydroxyflavone 3-O-[6'-(O-α-L-rhamnopyranosyl)-β-D-glucopyranoside]. Datiscin was first isolated from the plant *Datisca cannabina* L. in 1816. Until then, it was the only known glycoside of datiscetin (2',3,5,7-tetrahydroxyflavone) found in the same plant.[39] In 1982, Zapesochnaya et al.[30] determined the structures of two compounds: the new flavonoid glycoside datiscanin and the 2',3,5,7-tetrahydroxyflavone 3-O-β-D-glucopyranoside. Datiscanin is the second identified datiscetin glycoside, after datiscin (datiscetin 3-rutinoside).[40] In 1982, Zapesochnaya successfully isolated the dye galangin (3,5,7-trihydroxyflavone-3-O-β-D-glucopyranoside) from a plant.[41] In addition to these isolated and identified components, various studies have reported the presence of emodin, which has an anthraquinone structure,[6] as well as flavonoid structures such as quercetin and kaempferol (Figure 3).[9,19,22,32]

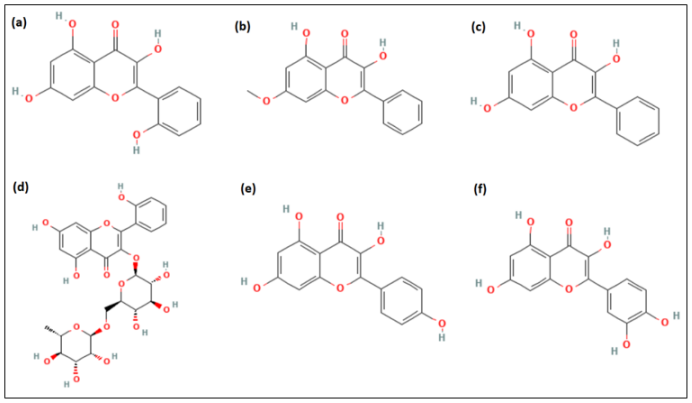

Figure 3 The chemical structure of some components of the bastard hemp (*Datisca cannabina* L.). (a) datiscetin, (b) isalpinin/cannabin, (c) galangin, (d) datiscin, (e) kaempferol, (f) quercetin.

According to the literature, datiscetin is the primary colouring agent found in the bastard hemp (*Datisca cannabina* L.), occurring exclusively in this species and its relatives.[1,3,28,42]

Contemporary dyeing practices and their ımpact on sustainability of *Datisca cannabina* L.

Datisca cannabina L. (false hemp/Kazdağı hemp) is a perennial dye plant used for centuries in traditional textile dyeing, particularly for giving silk and wool fibers bright yellow, olive green, and khaki

tones. The above-ground parts of the plant (leaves and stems) and roots constitute a very strong source of natural dyes due to their rich flavonoid content, especially daticetin, galangin, and kaempferol.

Today, serious ecological problems such as high water consumption and environmental pollution caused by synthetic dye production are leading the industry back towards environmentally friendly alternatives. In this context, natural dyes obtained from plants, insects, and minerals offer a sustainable and "green" solution for the textile sector. Türkiye's diverse climatic conditions and rich biodiversity allow for the widespread cultivation of numerous natural dye plants. Therefore, promoting sustainable practices is of great importance in order to reduce the ecological footprint in textile dyeing and move the sector towards a greener future.[43]

The chemical pollution and high water consumption generated by the textile industry have brought the *Datisca cannabina* plant back into focus in modern and sustainable textile applications. The biggest drawbacks of traditional natural dyeing, such as the inability to achieve a standard color tone and the long, complex processes involved, are being overcome with today's contemporary methods.

In practice, extracts obtained from the plant can be converted into natural organic lacquer pigments in modern laboratories by adjusting pH, particle size, and metal-ligand ratios. These pigments can then be applied to cotton and cellulosic fabrics using a single bath in industrial jet dyeing machines. This shortens processing time and significantly reduces water, time, and energy consumption compared to traditional mordanting processes, resulting in environmentally friendly production.[44]

Chemical analyses methods of characterization

High-performance liquid chromatography (HPLC-DAD), combined with diode array detection, is ideal for identifying natural dyes.[7,45–49] Understanding the chemical composition of paint is important for identification purposes. The identification of natural yellow dyes obtained from textiles is more difficult than that of other colour dyes due to several factors. One of these can dissociate into its primary units in strong acids.[9,47,50] Another factor is that glycosidic-flavonoid dyes are sensitive to light, oxygen, heat and other environmental conditions, making them more susceptible to photooxidation degradation. These dyes may change over time due to ageing, particularly after long periods of use in textile fibres or exposure to UV rays.[9]

The flavonoid content of a plant can vary depending on which part of the plant is examined, when it is harvested, or its growing environment.[9,10]

Recent advances in analytical techniques have helped us to determine the composition of the paint used on historical objects. These techniques can be broadly divided into three categories: 1- Non-invasive techniques, which do not involve sampling. 2- Micro-invasive techniques, which involve the collection of small samples, and 3- Invasive techniques involve sampling.[9]

Non-invasive analysis methods are non-destructive, separation-free techniques that use the colour absorption spectra of an object. They usually involve spectrophotometers that are equipped with optical fibre probes. The most effective techniques in this field are vibrational spectroscopy approaches, such as fibre optic reflection spectroscopy (FORS), near-infrared spectroscopy (NIRS) and mid-infrared spectroscopy (MIRS).[51–55] Minimally invasive techniques use less than 1 mg of collected material for analysis. Surface-Enhanced Raman Spectroscopy (SERS) is the best example of this.[9,56] Examples of invasive techniques where samples larger than 1 mg are taken include separation techniques such as thin layer chromatography (TLC), gas chromatography (GC) and high-pressure/performance liquid chromatography (HPLC).[7,9,13,57–60]

Reversed-phase high-performance/pressure liquid chromatography (RP-HPLC) is commonly used for the precise separation and identification of various dye components. This system is typically fitted with a diode array detector (DAD), which identifies specific peaks that reveal the identity of the separated compounds based on their UV and visible spectra.[9,21,47,61] HPLC-DAD data can be further complicated when the yellow dye used in historical fibres is adulterated with another material, which is very common.[62] To mitigate this issue, a protocol using a mass spectrometry (MS) detector for more accurate analysis has been developed. In some cases, HPLC systems can combine both detectors (HPLC-DAD-MS) to provide greater detail simultaneously.[63]

Invasive techniques can provide significantly more information about dyes than non-invasive techniques. However, non-invasive techniques are generally cheaper, faster, and more direct than other techniques, and do not alter or deplete the textile during analysis. It is essential to create a library of standard dye spectra for identifying natural dyes.[9,47] As part of the standard preparation procedure, dyes are extracted from the fibre using an appropriate solution. The solution is then evaporated, and the dried residue is resuspended in an HPLC-compatible solvent. Yellow dye removal can generally be achieved using acids, organic solvents or agent complexes.[64] The extracted chemical solution must be capable of decomposing the dye-metal complex first. Typically, a strong acid is mixed with polar solvents, such as HCl/methanol/water in a ratio of 2:1:1 (v/v/v).[45]

Materials and methods

Mobile phases, solvents and reference standards

The mobile phases, solvents, and reference dyestuff standard used in this study were provided by the Turkish Cultural Foundation (TCF) - DATU Laboratory in Istanbul, Türkiye. The following chemicals were purchased from Merck (Germany): acetonitrile (LC grade), trifluoroacetic acid (TFA, for synthesis), methanol (MeOH, LC grade) and hydrochloric acid (37% fuming, for analysis). The solvents and mobile phases utilized in this study were of analytical grade and were employed as received. High-purity water was obtained by passing water through a Millipore Milli-Q treatment system (Bedford, MA, USA), and the high-performance/pressure liquid chromatography (HPLC) mobile phase was prepared using this water.

Mordant, bastard hemp plant and silk fabric

In this study, a 20% by volume solution of alum ($KAl(SO_4)_2 \cdot 12H_2O$) was used as the mordant. The alum was obtained from Merck in Germany. A satin-weave, 100% silk fabric (S 4/1(3)) was selected for dyeing with bastard hemp. The technical specifications of the silk fabric were determined they be a warp density of 160 threads per cm and a weft density of 60 threads per cm. The weight of the fabric was 74 g/m². The mordant, silk, and dye plant were provided by the DATU Laboratory of the TCF.

Methods

The process of colouring silk fabric: For this study, a piece of silk fabric measuring 15 cm x 15 cm and weighing 1.10 g was prepared for mordanting and dyeing. First, the fabric was washed in a solution of 1% non-ionic soap in hot water (approximately 60 °C) for 30 minutes. It was then rinsed and dried in open air at room temperature.

Mordanting was then conducted at 100 °C for 60 minutes using a 20% alum mordant with a liquor ratio of 50:1. The fabric was then left in the mordant bath at room temperature overnight.

The next day, an equal weight of bastard hemp was prepared for the dye bath and placed in a dye bath at a ratio of 50:1. The silk fabric, which had been soaked in the mordant solution, was then added to the prepared dye bath. The container holding the dye bath and fabric was placed on a heater and the dyeing process was carried out at 100 °C for 60 minutes with constant stirring. Finally, the silk fabric was removed from the dye bath and washed thoroughly with distilled water. It was then left to dry in the open air. The result is a fabric dyed yellow.

HPLC equipment: The analyses were conducted using an Agilent 1200 Series System (Agilent Technologies, Germany). The system comprises a G1322A degasser, a G1311A quaternary pump, a G1329A autosampler, a G1316 thermocouple controller, and a G1315D diode array detector. Diode array detector (DAD) detection involved scanning wavelengths from 192 to 800 nm with a resolution of 2 nm. Chromatographic peaks were monitored at wavelengths of 255, 268, 276, 350, 491, and 580 nm.

For the analysis, an analytical Nova Pak C18 column (39 × 150 mm², 4 µm, part no. WAT086344, Waters) was used. The analytical column was protected by a guard column with the same stationary phase. The temperature of both columns (analytical and guard) was maintained at 30 °C.

Two mobile phases were utilized for the chromatographic separation of hydrolysed plant and dyed silk samples. Solvent A was a solution of H_2O and 0.1% TFA, and solvent B was acetonitrile (CH_3CN) containing 0.1% TFA. Data acquisition was managed using Agilent ChemStation. The gradient elution program used for dyestuff analysis in chromatographic separation by HPLC–PDA is shown in Table 1.[7,13,59,65]

Table 1 The gradient elution program used for dye analysis

Time (min)	Flow rate (ml/min)	H_2O+0.1 % TFA (v/v)	CH_3CN+0.1 % TFA (v/v)
0		95	5
1		95	5
20		70	30
25		40	60
28	0.5	40	60
33		5	95
35		5	95
40		95	5
45		95	5

Sample preparation for dye analysis: The following steps were taken to analyse the dye plant and the dyed silk. First, the plant material and the dyed silk fabric were weighed. Then, 10.2 mg of finely ground plant material and 3.1 mg of dyed silk fabric were placed in separate conical tubes. The samples were hydrolysed in a mixture of 37% HCl, methanol (MeOH) and water (H_2O) (2:1:1. v/v/v) in glass tubes for exactly eight minutes in a water bath at 100 °C, in order to extract the organic dyes. After being quickly cooled under running cold water, the solution was evaporated to dryness in a water bath at 60–65 °C while a gentle stream of nitrogen was applied. The residues were then dissolved in 400 mL of a mixture of MeOH and water (2:1. v/v). The resulting solutions were centrifuged at 4000 rpm for 10 minutes. After centrifugation, the clear upper layer was carefully transferred into vials. The silk sample (100 µL) and the plant sample supernatant (30 µL) were analyzed.

Colour measurement

Colourimetric measurements of the dyed silk fabric were carried out using a Konica Minolta CM-2300d Spectra Magic NX with a D65 illuminant and a 10° standard observer. In the CIEL*a*b* (1976) colour space, the L* value indicates brightness, the a* value reflects the red–green coordinate (where positive values indicate red and negative values indicate green), and the b* value denotes the yellow–blue coordinate (where positive values indicate yellow and negative values indicate blue).[66]

Results and discussion

Results

The results of the dye analysis: Figure 4 and Figure 5 show the HPLC-DAD chromatograms and spectra obtained from analysing the bastard hemp plant and the silk fabric sample dyed with it. Table 2 provides the retention times and UV–Vis data for the identified dyes (Figure 6).

Table 2 The retention times and UV–VIS spectra (absorbance maxima) of the identified dyes at HPLC-DAD

Serial number	Identified dye	Molecular formula	Colour	Absorbance maxima (nm)
1	datiscetin	$C_{15}H_{10}O_6$	yellow	255, 308 (sh), 346
2	datiscin	$C_{27}H_{30}O_{15}$	greenish	260, 308 (sh), 352
3	datiscetin glycoside	-	-	260, 298 (sh), 304 (sh), 370
4	galangin	$C_{21}H_2OO_1O$	light yellow	264, 288 (sh), 312 (sh), 360

Citation: Torgan Güzel E. Dye analysis from the little-known bastard hemp (*Datisca cannabina* L.) used in the dyeing of historical textiles and comparison of samples identified in textile cultural heritage. *J Textile Eng Fashion Technol.* 2026;12(3):248–256. DOI: 10.15406/jteft.2026.12.00470

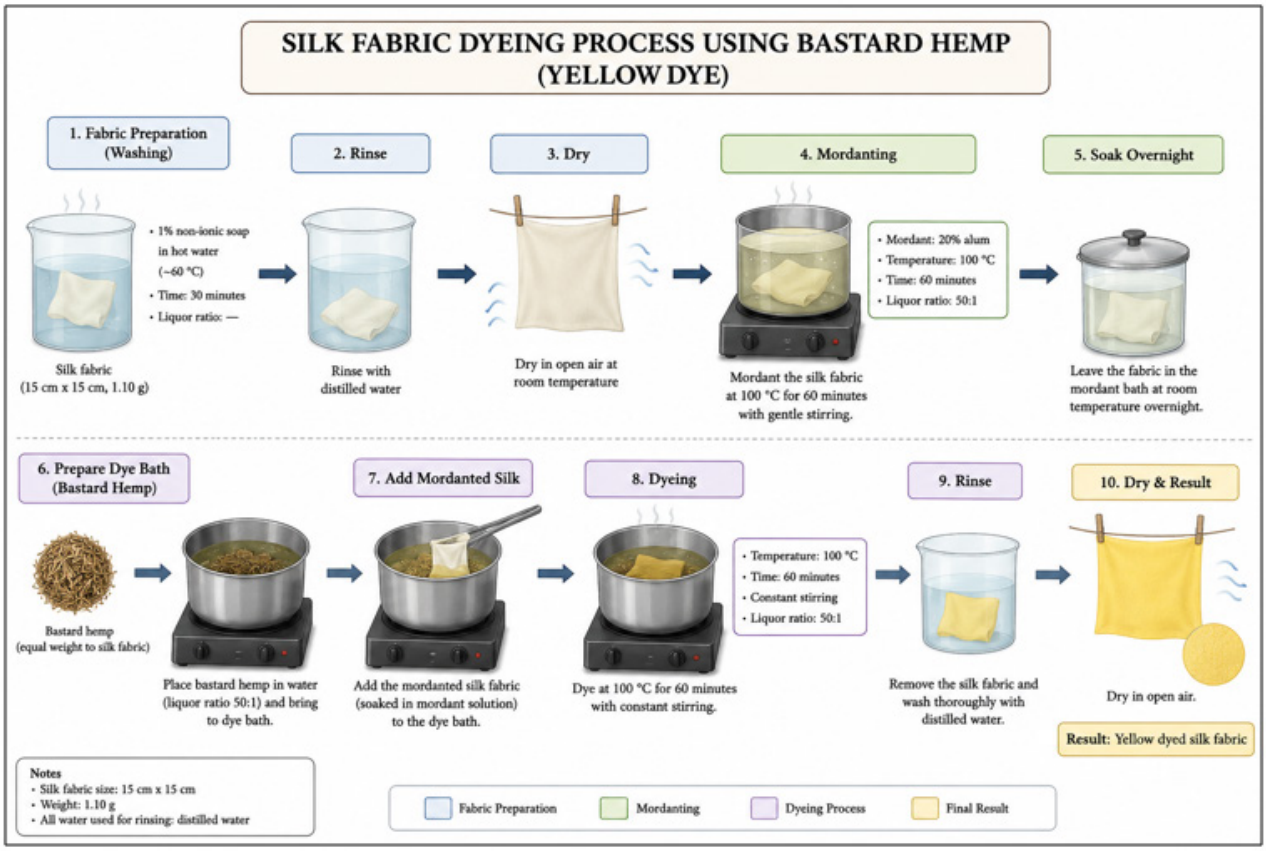

Figure 4 Diagram of a traditional dyeing process using the *Datisca cannabina* L. plant (The diagram was generated with the help of AI.).

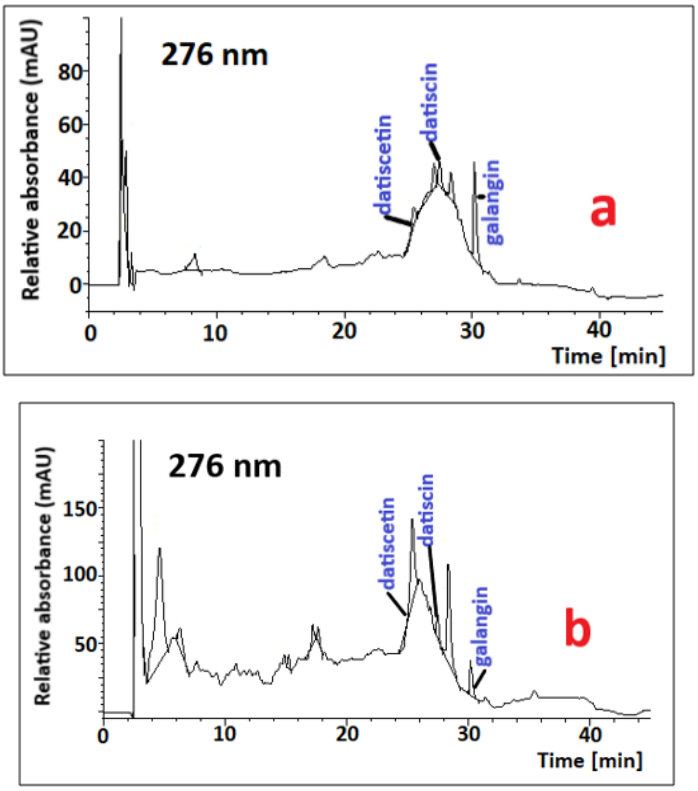

Figure 5 The chromatograms of the (a) bastard hemp (*Datisca cannabina* L.) and (b) dyed silk fabric.

Citation: Torgan Güzel E. Dye analysis from the little-known bastard hemp (*Datisca cannabina* L.) used in the dyeing of historical textiles and comparison of samples identified in textile cultural heritage. *J Textile Eng Fashion Technol.* 2026;12(3):248–256. DOI: 10.15406/jteft.2026.12.00470

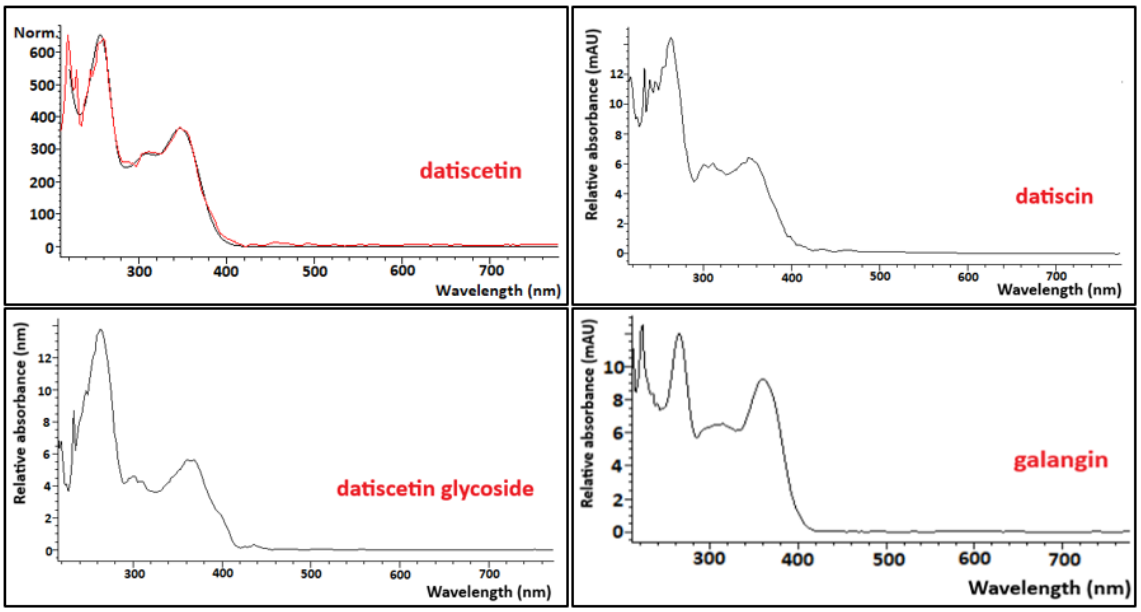

Figure 6 Spectra detected as a result of the dye analysis.

HPLC analysis of the false hemp plant revealed the presence of the dyes datiscetin, datiscin[39] datiscetin glycoside[30] and galangin.[41] In silk fabric dyed with this plant, it was found that all the dyes except datiscetin glycoside bound to the fibre. These results suggest that the main components identified in the plant also bind to silk fibres.

The results of the colour measurement: The main colour values, specifically L*, a*, and b*, were measured using a CIELAB spectrophotometer. Table 3 displays the L*, a*, and b* values for untreated silk and silk fabric pieces that have undergone the mordanting and dyeing processes.

Table 3 The main color values of the fabric pieces that were analysed for colour

Fabric	Colour values		
	L*	a*	b*
Untreated	94.01	0.85	2.79
Mordanted and dyed	88.94	-6.44	34.88

According to the colour measurement results, the yellow hue visible on the fabric after mordanting and dyeing was confirmed as yellow through mathematical analysis. Additionally, it was observed that the fabric's gloss did not decrease significantly following these processes. In the silk fabric dyed with bastard hemp, which imparts a yellow colour, the b* value representing yellow increased considerably, reaching 34.88. At the same time, the negative a* value representing green increased to -6.44 during the dyeing process.

Discussion

In the context of cultural heritage, identifying the origin of dyes used to colour textiles can provide valuable information for chemists, historians, conservators and restorers. Identifying the raw materials used to produce an object can therefore help to determine its production technique, period and location, as well as the social status of its owner.[1,7–9] As some "archaeological textiles", i.e. textiles from prehistoric and historic periods, are rare, it is important to determine their chemical composition for conservation purposes.[5,9]

Studies have shown that research into bastard hemp (*Datisca cannabina* L.) is limited. Although it is not as prevalent as other plants used for dyeing textiles, such as weld (*Reseda luteola* L.), buckthorn (*Rhamnus* sp.), chamomile (*Anthemis* sp.), dyer's greenweed (*Genista tinctoria* L.) and dyer's sumac (*Rhus cotinus*), this plant is known to have been used for this purpose historically, either to produce yellow colours or as a component of green dyes.[1,3,5,7,27,28] This section will discuss historical textiles in which this plant has been identified, along with the different research conducted in this area.

Berghe et al.[67] identified this plant in lampas and velvet fabrics dating from the 15th to 18th centuries in Ottoman palaces.[67]

In 2012 and 2014, Petroviciu et al.[5] analysed 15th- and 16th-century embroidery from the Romanian National Museum. They identified the dye datiscetin in two khaki colours and determined that it was produced from bastard hemp (*Datisca cannabina* L.). The presence of other flavonoid compounds in the same two samples also suggested the use of bastard hemp and weld (*Reseda luteola* L.). Since *Datisca cannabina* L. does not naturally occur in Europe, the researchers concluded that some materials used in embroidery from the 15th to the 18th centuries originated from the East. One instance of *Datisca cannabina* was found in 15th- and 16th-century religious embroidery, while four instances were found in 17th- and 18th-century religious embroidery.[5,27]

Lech (2020) conducted a dye analysis of various colors found in liturgical vestments from 15th to 17th-century church collections in Krakow, Poland. She identified datiscetin dye in two samples of 16th-century green vestments and one from the 17th century. Additionally, Lech detected flavonoid compounds from other plants, as well as anthraquinone and indigoid compounds, in the same samples. The presence of datiscetin confirms that bastard hemp was used as the yellow component to achieve the green color.[42] Lech also discusses this in her study.

Soysaldı et al.[23] performed dye analysis on colored samples collected from carpets and rugs donated to the Ayaş Ulu Mosque, Bünyamin Ayashi Mosque, Şeyh Muhyiddin Mosque, and Killik

Mosque in the Ayaş district of Ankara. The analysis revealed the presence of datiscetin dyestuff in the yellow sample taken from a carpet featuring a carpet border at the Şeyh Muhyiddin Mosque. This finding indicates that the yellow color was achieved using *Datisca cannabina*.[23]

Various studies on *Datisca cannabina*, conducted by Deveoglu et al.,[19,22,32] identified datiscetin-3-*O*-[rhamnosyl(1→6)]glucoside and datiscetin in the chromatogram of the unhydrolysed cannabina extract and datiscetin dye in the analysis of the acid-hydrolysed extract.[19,22,32]

Deveoglu et al.[22] analysed the pigments produced when using different volumes of alum mordant with gallnut (*Quercus infectoria* Olivier) and bastard hemp (*Datisca cannabina* L.) plants. They identified the datiscetin dye from *Datisca cannabina*, as well as derivatives of gallic acid, ellagic acid, and tannic acids. The researchers also performed antimicrobial tests on these pigments to assess their effectiveness against bacteria (gram-positive and gram-negative). The results indicated that the pigments exhibited antimicrobial properties.[22]

In another study, Deveoglu et al.[19] synthesised pigments from bastard hemp using aluminium-, iron- and tin-containing compounds, and analysed the resulting pigments using HPLC, fourier-transform infrared (FTIR), field emission scanning electron microscopy equipped with energy dispersion spectroscopy (FESEM-EDAX) and thermogravimetric analysis (TGA). The HPLC dye analysis revealed datiscetin in the pigments formed with aluminium and tin, and datiscetin, dehydrofisetin and datiscetin glycosides in the pigment formed with iron.[19]

Deveoglu et al.[32] dyed 100% wool yarn using bastard hemp and alum mordant. They then performed a dye analysis on the yarn and identified datiscetin as the dye component. This paper reports on a similar study. Here, 100% silk fabric was used for dyeing instead of wool yarn. However, the analysis results revealed the presence of additional dye components belonging to datiscin, galangin, and datiscetin glycoside, in addition to datiscetin.[32]

Conclusion

The discovery of taxonomic chemical markers - chemical compounds that are unique to particular plants or raw materials - is vital for preserving and restoring cultural heritage objects. By identifying these markers, scientists can accurately recreate traditional recipes and gain valuable insights into historical techniques and knowledge.[8]

This study involved dye analysis and colour measurement of the bastard hemp (*Datisca cannabina* L.) plant and the silk fabric piece that was dyed using it. The dye analysis revealed the active dye components in the plant, including datiscetin, datiscin (a datiscetin glycoside), galangin and an unidentified datiscetin glycoside.

This study is important because there are few modern studies in the literature on dyeing textiles with bastard hemp. It sheds light on the dyeing potential of bastard hemp, both chemically and practically. Furthermore, identifying a limited number of dye components from the bastard hemp (*Datisca cannabina* L.) plant in historical textiles is another aspect of this study. This study:

1) It could serve as a reference for archaeometrists and textile conservationists when determining the dye source in historical yellow yarns.
2) For dyers and natural dyers, understanding the chemical background of traditional methods could help to develop more controlled and long-lasting natural dye processes.
3) For chemists, the metal-chelating properties and thermal stability of compounds such as datiscetin may be of interest, offering potential applications not only in textiles but also in pigment production and materials science.

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The declaration of ethics committee approval

This study does not require ethics committee approval or any special permission.

The declaration of research and publication ethics

In the writing process of this study, international scientific, ethical and citation rules were followed, and no falsification was made on the collected data. *Journal of Textile Engineering & Fashion Technology* and editorial board bear no responsibility for all ethical violations that may be encountered. All responsibility belongs to the corresponding author and this study has not been evaluated in any academic publications other than *Journal of Textile Engineering & Fashion Technology*.

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Conflicts of interest

No conflict of interest or common interest has been declared by author.

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