Dyes and Dyeing in the Ming and Qing Dynasties in China: Preliminary Evidence Based on Primary Sources of Documented Recipes

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Colour has long held special significance in Chinese culture, especially for textiles in the Ming (1368 - 1644) and Qing (1644-1911) Dynasties, the period when imperial handicrafts reached their production peak. This paper makes the first attempt to compare systematically historical Chinese records of textile dyeing to understand its practice. The paper presents research into the dyes and dyeing methods recorded in four important historical manuscripts of dye recipes from the periods of interest by examining the range and frequency of dyes and dyeing methods using statistical analysis methods. Issues such as the reliability of the historical resources of dyeing, the combination of raw materials, factors affecting the choices of dyes and dyeing methods and advances in dyeing are discussed. The findings of this research significantly promote the knowledge of textile dyeing for historical Chinese textiles research. They also have important implications for the understanding of world textile dyeing history.

Keywords: Chinese dye manuscripts; Historical materials and methods; Textiles; Archive.

INTRODUCTION

In different parts of the world, textile dyeing not only was an important part of the material basis and life cycle of textiles but also had close relationship with costume colour fashion, decrees on textiles, domestic and international trade, as well as the development of techniques and production organisation in the society.[1] China, owning one of the longest recorded histories of textile manufacture , has developed prosperous textile traditions and dyeing techniques.[2] During the Ming (1368-1644) and Qing (1644-1911) Dynasties, the flourish of world trade significantly promoted the exchange of raw materials, products, and techniques.[3] Research on Chinese textiles of this period will greatly contribute to better understanding of the landscape of the world textile history, *e.g*. similarities and differences in textile dyeing in different parts of the world, and mutual influences and exchanges of textile dyeing among different regions.

In ancient China, costume colour was an important symbol for social hierarchy.[4] As early as the Sui and Tang Dynasties (581-907), a colour grading clothing system called *pin se fu* 品色服 was formed and then developed continually in the dynasties that followed. In the Ming Dynasty, as regulated in *Yu fu zhi* 輿服志 (Record of the proper carriage and attire), the imperial colours were identified as *xuan* 玄 (reddish black), *huang* 黃 (yellow) and *zi* 紫 (purple) , and their use was prohibited for officials and common people. The colours of court dress were graded from high to low into *fei* 緋 (red), *qing* 青 (dark blue) and *lv* 綠 (green).[5] The costume colour grading system reached its peak in the Qing Dynasty, reflected by more colour grades. For example, in *Huangchao liqi tushi* 皇朝禮器圖示 (Illustrations of Imperial Ritual Paraphernalia), it was regulated that *minghuang* 明黃 (bright yellow) should be used only for the court robes and dragon robes of the emperor and the empress (FIG. 1), and *xinghuang* 杏黃 (apricot yellow) only for the court robe and mang robes of the crowned prince (FIG. 2). Other princes were entitled to *jinhuang* 金黃 (golden yellow) (FIG. 3), while imperial family members of lower ranks were permitted *lan* 藍 (blue) and *shiqing* 石青 (azurite blue) (FIG. 4) .[6]

Research of Chinese textile history began in 1930s from official decrees of costumes and the evolution of designs, and expanded to the production, trading and collection of the textiles as well as textile handicrafts, which pioneered industrialisation in the Ming Dynasty.[7] Since 1980s, among textile historians and historians in science and technology, there has been growing interest in textile dyes and dyeing practices of ancient China, based mainly on historical records of dyes and dyeing in works on textile production and techniques in general, as well as works in herbal medicine and agriculture, local chronicles, dictionaries, essays, *etc*. Pioneering research by Weiji Chen on the development of dyeing techniques in ancient China based on the above kinds of primary historical literature laid a solid foundation.[8] This was followed by research on raw materials and dyeing processes.[9] The use of historical dyes was interpreted through current knowledge in modern chemistry and textile production.[10] Different steps in the dyeing process including scouring, bleaching, dyeing and finishing were investigated individually.[11] Research by Feng Zhao provided further essential understanding about spatial and temporal variations of dyes and dyeing in ancient China with reference to cultural and geographic regions, provincially divided dyeing practices and the development of dyeing through exchanges between different dyeing regions.[12] Within the past ten years or so, documentary research has been complemented by chemical analysis of dyed archaeological and historical Chinese textiles which has revealed the plant sources for the dyes.[13] At the same time, investigations into traditional dyeing methods and use of natural dyes through textile handicrafts and ethnobotany has brought technical insight into raw materials, facilities and detailed procedures for dyeing.[14] The colouring properties and the fastness of the dyes have also been explored in depth.[15]

Although the evidence for raw materials, dyeing techniques and chemistry in Chinese dyeing history has advanced considerably in recent years, the chronologies of developments and advances in dyeing in the Ming and Qing Dynasties, during which natural dyeing in China reached its peak, remains unclear. Knowing which dyes were used when is essential context for researching historical and archaeological Chinese textiles, to interpret status and significance, to ascertain place and period of origin and alteration, and to assess colour-fastness for material preservation.

The research presented here is a preliminary investigation that begins to answer questions about changes in Chinese dyes and dyeing methods between 1368 and 1850, in an important historical period of textile dyeing and clothing colour grading in China. Based on the examination of the reliability, content and style of four important historical Chinese dyeing manuscripts, the frequency and range of dye sources and dyeing methods recorded in these documents were identified and compared using an established research methodology for historical dyeing.[16] Dye recipes in the four documents were analysed for similarities and differences in their raw materials, dye combinations, and dyeing sequences, in order to provide a clearer picture of advances in dyeing in this period.

DOCUMENTARY RESOURCES

The authors extensively searched for original documents, copies of original documents and transcriptions of dye recipes in the catalogues of the Ancient Books Reading Room of Peking University Library and Shanghai Library, and in several electronic databases of historical books in Peking University Library, especially *Zhongguo jiben guji ku* 中國基本古籍庫 (Chinese Classic Ancient Books Database). Published articles on historical dye recipes were also accessed.

The majority of texts was written in historical Chinese, which is different from modern Chinese in wording and grammar and made it challenging to understand the texts accurately, but this was overcome by consulting classical Chinese dictionaries and relevant studies such as studies on historical plants and historical unit of measure. A separate investigation into plant names and their corresponding botanical species has been undertaken.[17] Besides, research methodologies for history of science and technical art history were used for the better interpretation of historical records, including experiments replicating historical dyeing processes and the study of raw materials through current knowledge in modern chemistry.[18]

We selected manuscripts with numerous dye recipes for further investigation, these being considered the most systematic and therefore suitable for comparative and comprehensive analysis. Four historical manuscripts with numerous dye recipes were consequently selected, as presented in TABLE 1. These manuscripts were evaluated by authorship, purpose, content, and readership to judge their relevance and reliability.

TABLE 1. Historical manuscripts and dye recipes

Title	**Date**	**Author**	**District**	**Overview**
Duoneng bishi 多能鄙事 (Various arts in everyday life)[19]	early Ming Dynasty	(shown as) Liu Ji (1311-1375)	probably southeast China	An integrated work of crafts in everyday life.
Tiangong kaiwu 天工開物 (Chinese Technology in the	late Ming Dynasty (first published in 1637)	Song Yingxing (1587-1666)	across China	An integrated work on agriculture and handicrafts.

Seventeenth Century)[20]				
Neiwufu quanzong dang'an, Zhiranju buce 內務府全宗檔案，織染局簿冊 (Complete File of the Imperial Household, Volume of the Weaving and Dyeing Bureau)[21]	Qing Dynasty (1754)	Probably someone in the Weaving and Dyeing Bureau.	Official weaving and dyeing bureau located in the Jiangnan area or in Beijing	Official record of the Imperial Weaving and Dyeing Bureau.
Bu jing 布經 (The cloth classic)[22]	Qing Dynasty (Jiaqing period to Daoguang period, 1795-1850)	Craftsmen who have extensive experience in dyeing and weaving.	Songjiang (currently in southwest Shanghai)	A work on the handicraft of cotton cloth.

Two manuscripts are of the Ming Dynasty - *Duoneng bishi* 多能鄙事 (Various arts in everyday life, FIG. 5) and *Tiangong kaiwu* 天工開物 (Chinese Technology in the Seventeenth Century, FIG. 6). Both are works on various crafts published for the general public. The difference is that the former was compiled as a popular book while the latter was a more rigorous manuscript recording and discussing contemporary science and technology. Specifically, *Duoneng bishi* was a *ri yong lei shu* 日用類書, a book on daily crafts in various aspects arranged according to categories. *Ri yong lei shu* began in the Southern Song Dynasty (1127-1279) and became popular in the Ming Dynasty. Such books were produced mainly for low rank literati or the squire class for commercial purpose.[23] These books reflected the life of low rank literati and common people and conveyed the practical experience of craftsman, usually compiled from various sources by low rank literati or bookstore owners because most craftsmen could not read or write at that time.[24] Liu Ji, a very famous military strategist, politician and thinker in the early Ming Dynasty, was shown as the author of *Duoneng bishi*, but probably he was not the author of this book as the names of celebrities were often printed on *ri yong lei shu* as authors to attract readers.[25] Most book workshops and stores were located in southeast China and because it was more convenient to record local resources, this is also likely to be the origin of the described activities.[26] Regarding the date of *Duoneng bishi*, since some dyeing sections were also recorded in another *ri yong lei shu* of the Yuan Dynasty (1271-1368) called *Jujia biyong shilei quanji* 居家必用事類全集 (Guide to domestic operations), it can be surmised that relevant records in *Duoneng bishi* reflects dyeing activities in the Yuan Dynasty or in the early Ming Dynasty.[27]

The other selected manuscript of the Ming Dynasty, *Tiangong kaiwu*, was written by Song Yingxing, a member of the literati in the late Ming Dynasty. Taking the pragmatic stance started in the mid Ming Dynasty, he believed that techniques made the most contribution to the country and people.[28] *Tiangong kaiwu* was based on his investigation into agriculture and handicrafts across all of China, and written for those involved in these professions and who wanted practical technical details. This instilled high credibility and authenticity in these records.[29] The book was also an unprecedented initiative in its systematic and extensive descriptions of science and techniques, including advanced scientific and technological achievements that had rarely been recorded.[30]

In contrast to the two manuscripts of the Ming Dynasty, the two manuscripts of the Qing Dynasty, *Neiwufu quanzong dang'an, Zhiranju buce* 內務府全宗檔案，織染局簿冊 (Complete File of the Imperial Household, Volume of the Weaving and Dyeing Bureau, abbreviated as *Zhiranju buce* in the following text) and *Bu jing* 布經 (The cloth classic) are both specialised books on textile handicrafts. They were probably only intended for internal circulation within institutes, being written by experts in the field or recorded by literati based on interviews and investigation and therefore reflecting practical dyeing activities to a large extent, in terms of the selection of raw materials, their amounts used and colours obtained. The *Zhiranju buce* manuscript is one of several documents produced by the Imperial Household Agency which functioned to serve the imperial family by recording the materials used for court textiles. The other manuscript, *Bu jing*, is a professional manuscript on textile handicrafts, originating in Songjiang (currently in the southeast of Shanghai) and likely to be written by a senior craftsman with a certain extent of literacy.[31] This manuscript was used for teaching, and records practical experience and tips in aspects of cotton textile production such as choosing raw material, dyeing and finishing.

These four manuscripts, written based either on investigation into dyeing practice or on practical dyeing experience, all convey the actual dyeing practices of their time, and from different parts of China. *Duoneng bishi* and *Bu jing* originated from southeast China, the location of the most important centres for weaving and dyeing with both silk and cotton, and *Zhiranju buce* from an official weaving and dyeing bureau in the Jiangnan area (roughly the lower valley of Yangtze River) or in the capital Beijing.[32] *Tiangong kaiwu* spanned practices across China. Regarding historical reliability, *Duoneng bishi* and *Tiangong kaiwu* were written for general use, thus the records may be incomplete and may contain some errors, so analysis of these documents requires extra attention by today's researchers. *Zhiranju buce* and *Bu jing* were written by experts in the field for professional use and thus they are relatively more reliable.

Historical dye recipes

Dye recipes were recorded in the four selected manuscripts - *Duoneng bishi*, *Bu jing*, *Zhiranju buce* and *Tiangong kaiwu* – with their content and documentation styles reflecting difference in purpose and authors' degrees of knowledge. An overview of the content and style of the dye recipes recorded in the four manuscripts is presented in TABLE 2.

TABLE 2. An overview of dye recipes recorded in the four manuscripts

Title	**Textile**	**Number of colours with dye recipes**	**Number of dyes used**	**Do recipes give quantities?**	**Do recipes give the sequence of using dyes?**
Duoneng bishi	silk cloth	13	14	Yes, most	Yes
Tiangong kaiwu	Silk cloth and cotton cloth	27	13	Inconsistent (some recipes indicate 'deep' or 'lightly' dyeing.)	Yes
Neiwufu quanzong dang'an, Zhiranju buce	silk yarn	40	11	Yes, all	No
Bu jing	cotton cloth	66	18	Yes, all	No

Firstly, in terms of contents, the dye recipes in these manuscripts differ from each other especially in terms of fabric type and colours obtained. The dyes in the recipes are applied to two fibre types - silk and cotton. Cotton was a major clothing material during the Ming and Qing Dynasties, replacing two other plant fibres, hemp and ramie. Silk had been, and remained, the preserve for most high-status clothes.[33] There is no distinction in the recipes between the dyes and dyeing methods for silk and cotton. This lack of distinction seems unusual because silk is proteinaceous while cotton is cellulosic and more crystalline, which makes the dyer resorting to different dyeing methods and cotton relatively more difficult to dye than silk.[34] It is possible that some distinctions between dyeing silk and cotton such as different temperatures and time durations were not recorded. Cloth is predominant, except in the *Zhiranju buce*, which is for yarn. Yarn dyeing is more difficult but produces textiles of a better quality. Research on the history of textile industry in Jiangnan area by Bozhong Li shows that the change from cloth dyeing to yarn dyeing took place in the mid-Ming Dynasty and after that yarn dyeing became a main technique in this area.[35] Moreover, in the aspect of colour range, *Duoneng bishi* is mainly for a series of brown colours, that is, a mixture of black with red or yellow, while the other manuscripts cover the entire colour range. Brown was a popular colour among common people in the Yuan Dynasty, when *Jujia biyong shilei quanji*, the prototype of *Duoneng bishi* in the aspect of dyeing, was published, because at that time common people were prohibited from wearing some bright colours.[36] Dark colours were also more practical because they showed less dirt. Therefore the workshop(s) that these dye recipes originated from were probably for common people. The number of colours obtained and dyes used in these dye recipes are discussed further below.

Secondly, in terms of recording styles, there are records with measurements and detailed instruction on dyeing sequences and also relatively brief records presenting only raw materials for dyeing. In the two Qing Dynasty documents, quantities of raw materials are described clearly but the dyeing sequences are not given. The reason may be that these dye recipes were used only for the preparation of raw materials, or that there were some fixed regulations for dyeing sequence that the craftsmen memorised with no need to record them.

Other historical sources recording dyes and dye recipes

In addition to the four manuscripts with numerous dye recipes described above, other sporadic records of dyes and dyeing methods were found and consulted. Dye recipes were recorded in a manuscript of central government and other specialised manuscripts including *Zhusi zhizhang* 诸司执掌 (Responsibilities of All the Ministries, 1393), *Gujin yitong daquan* 古今醫統大全 (Medical Complete Book, from the Past to the Present, 1557) and *Yecan lu* 野蠶録 (Record on Wild Silkworm, 1902). Dyes were also recorded in local chronicles and warehousing inventories such as *Huizhou fuzhi* 徽州府志 (Chronicle of Huizhou Prefecture, Hongzhi period 1487-1505) and *Daming huidian* 大明會典 (Collected Statutes of the Ming Dynasty, Ming Dynasty). Moreover, in *Wuli xiaoshi* 物理小識 (Small knowledge of the principle of things, late Ming Dynasty), dyes for certain colours were enumerated with some criteria for choosing dyes.[37] These records were used in this study as a complement. Further research on these records is needed to know more comprehensively about the choice and use of dyes in the Ming and Qing Dynasties.

The above research results of primary sources dye recipes not only provide solid foundation for detailed studies of dyeing techniques, but is also of great reference value for research on other techniques of textile production during the Ming and Qing Dynasties, and for investigating other techniques recorded in the four historical manuscripts. These research results also reflect to some extent how knowledge and skills of textile techniques were disseminated within the industry and to the public, which is an important part of research on history of technology. Further research can be undertaken on other historical Chinese manuscripts containing dye recipes to better understand these records and reveal historical practice of textile dyeing.

SOURCES OF THE DYES

Before the invention of synthetic dyes in 1856, natural materials were used worldwide for dyeing, mostly the roots, barks, wood, fruits and flowers of plants, but also lichens and scale insects.[38] The choice and use of dyes are important elements in deciding the quality of textiles in terms of colour and light-fastness, as well as in the evolvement of costume colour fashion.[39] Changes in the use of dyes also reflect the availability of resources, dye trade and spread of dyeing techniques, both domestically and internationally.[40] For these reasons, identifying known dyes in historical textiles plays an important research role for primary material evidence of use. The frequency of occurrence of the dyes recorded in the four selected Chinese manuscripts was counted to find out which dyes were commonly used and what dyes were obsolete with comparison to dyes in earlier periods.[41] Factors affecting choices of dyes were investigated with reference to today's current knowledge of dyeing properties, colouring effects and fastness of these dyes.

Commonly used dyes

TABLE 3 summarises the dyes named in the dye recipes of the four manuscripts at the centre of this study. Eight dyes were frequently recorded: sappanwood, safflower, smoketree, Chinese cork tree, pagoda bud, indigo, Chinese gallnut and acorn cup. The botanical sources of these dyes, as well as the specific parts of the plants used, are also listed in TABLE 3 and photographic images presented in FIG. 7. The juice of dark plum (smoked plum) is always used with safflower because it contains fruit acids that usefully act as an assistant in safflower dyeing.[42] It should be noted that in the full colour range, there are no single direct natural sources for light-stable green dyes (the green colorant from chlorophyll is unstable).[43]

TABLE 3. Common dyes identified in the dye recipes

Dye name	**Most likely botanical source[44]**	**Part for dyeing**	***Duoneng bishi* (for silk cloth)**	***Tiangong kaiwu* (for silk & cotton cloth)**	***Bu jing* (for cotton cloth)**	***Zhiranju buce* (for silk yarn)**
Acorn cup	*Quercus acutissima* Carr. and *Quercus wutaishanica* Mayr.	acorn cup	•	-	•	•

Chinese cork tree	*Phellodendron chinense* var. *glabriusculum* C.K. Schneid. and *Phellodendron chinense* Schneid.	bark without cork	-	•	•	•
Chinese gallnut	Caused by the parasitism of insects *Melaphis chinensis* Bell or *M. paitan* Tsai & Tang	gallnut	•	•	•	•
Indigo	Mainly *Strobilanthes cusia* (Nees) Kuntze, *Persicaria tinctoria* (Aiton) H.Gross, *Indigofera tinctoria* L. and *Isatis tinctoria* L.[58]	leaf	-	•	•[a]	•
Pagoda bud	*Styphnolobium japonicum* L.	bud	•	•	•	•
Safflower & dark plum	*Carthamus tinctorius* L. and *Prunus mume* (Siebold) Siebold & Zucc.	flower, fruit	-	•	•	•
Sappanwood	*Caesalpinia sappan* L.	heart-wood	•	•	•	•

Smoketree	*Cotinus coggygria* var. *cinerea* Engl.	heart-wood	•	•	•	•

aSome dye recipes in *Bu jing* involves fabrics with various shades of blue backgrounds which are prepared in advance, for which indigo is highly probably the source, but from several botanical varieties.[45]

Sappanwood, pagoda bud, smoketree and Chinese gallnut were recorded in all the four manuscripts, while safflower, Chinese cork tree and indigo were recorded in three of them, but not *Duoneng bishi*. This can be explained by *Duoneng bishi* being an account for common people, who most frequently utilised brown colours. Safflower was a colour preserved for high ranking classes, while Chinese cork tree and indigo do not contribute to dyeing brown.[46]

Each dye manuscript mentions several dyes exclusive to it. In total, 18 'exclusive' dyes were found across all the manuscripts. Of these, 13 were tannin dyes. Dyes containing tannin were used extensively, mainly because common people were not allowed to wear bright colours, as recorded in the official decree 'The Record of Proper Carriage and Attire' of several dynasties.[47] Tannins are naturally abundant in tree bark, shells and leaves, and therefore a cheap and readily-available dye.[48] They produce light brown colours that can be darkened with ferrous sulphate, as exemplified in *Tiangong kaiwu* where lotus seed shell is used with sappanwood and ferrous sulphate. Tannins in cotton dyeing usefully enhance chemical bonding interaction between the fibres and the dye; and in silk dyeing they add weight to the fibres and improve physical properties.[49] Of all the tannin dyes given in the manuscript recipes, Chinese gallnut is the most common, followed by acorn cup. Acorn cup was first used in the Zhou Dynasty but replaced later by Chinese gallnut which contains up to 60-70% tannin by weight.[50] In addition, some 'exclusive' raw materials were recorded to be used for special purposes. For example, in a recipe in *Duoneng bishi*, mulberry bark and lotus leaf were used to make stronger cloth, and how this works is not yet explained. Another example is that in a recipe in *Bu jing* ink and cinnabar are used to produce red ink. Further research on the 'exclusive' dyes is needed to fully understand their uses and this may also help attribute the place and period of dyed textiles.

The dyes in the manuscript recipes are all easy to use, although safflower and indigo require preparation. For safflower dyeing, a large amount of florets are needed because they yield only 0.3 to 0.6% of red components.[51] According to *Zhiranju buce*, the weight of safflower needed for pure red dyeing is ten times the weight of fabric. The process of separating its red components from yellow ones using water, acids and alkalis was complex and time-consuming but necessary for a good quality safflower red. In ancient China, when safflower had just been introduced to the Central Plains along the silk route from the areas of northern Egypt and the Near East around the 3th century AD, the dyeing technique was not good enough and dyed fabrics tended to be orange.[52] From around the Tang Dynasty, the technique developed and a crimson colour called *da hong* 大紅 (pure red) or *zhen hong* 真紅

(true red) was achieved. This became an important and popular colour in the court of the Ming Dynasty (FIG. 8)[1] because colour purity was advocated in the authoritative theory *Wu Xing* (the Five Elements) and the corresponding theory the Five Colours. Indigo dyeing was also complex, involving vat fermentation from the leaves of several plants, and the chemical processes of reduction and oxidation.[53] The introduction of indigo producing technique to the Central Plains of China was around the Wei, Jin and the Southern and Northern Dynasties (220-589AD).[54] From then on, indigo producing and dyeing became popular and were recorded in detail in many manuscripts including *Qimin yaoshu* 齊民要術 (Main techniques for the welfare of the people, 533-544) and *Tiangong kaiwu*.[55] Indigo was not only the best source for blue, but also important for dyeing with other dyes to create purples and greens.[56]

Obselete dyes

Some dyes that had been commonly recorded in earlier periods rarely appear in the dye recipes studied: gardenia (mainly *Gardenia jasminoindes Ellis f. longicarpa* Z. W. Xie et M. Okada., fruit) and turmeric (*Curcuma longa* L., rhizome) were only mentioned in one of the documents, while munjeet (also known as Indian madder, mainly *Rubia cordifolia* L., root) and gromwell (mainly *Lithospermum erythrorhizon* Siebold & Zucc., root) were not referenced at all (FIG. 9).[57] The main reasons may be as follows. Gardenia was cultivated and used for dyeing since the Qin and Han Dynasties (221BC–220AD), but because of its poor light-fastness, it was replaced by pagoda bud.[58] Turmeric dyes bright yellow, but also has poor light-fastness.[59]

Munjeet had been a main red dye for long period of the Western Han Dynasty (202BC-9AD), but was superseded by the more beautiful colour of safflower even though safflower was less colour-fast.[60] Gromwell was, and remains today, a popular regional dye for purple, and it was popular in the state Qi (currently in Shandong Province) in the Spring and Autumn and Warring States Period (770-221 BC).[61] Though gromwell is one of few dye plants for purple and was available for the Ming Court, it was not used in these dye recipes, probably because the main dye component of gromwell, shikonin, has poor water-solubility and needs special methods for extraction, dyeing and post-processing.[62] Studies in natural dyes in the field of textile industry also found that temperature above 75℃ affects its dye components and makes a dull colour.[63] Instead, the four manuscripts describe achieving purple by dyeing sappanwood with a mordant, which is ferrous sulphate in *Tiangong kaiwu* and alum in *Bu jing*, or by multi-dyeing with red and blue dyes, which allows the dyer better control for various purple shades.

Criteria for choosing dyes

In *Wuli xiaoshi*, dyes are criticised for poor colouring effects and fastness, and also damage to the textile by Chinese gallnut and ferrous sulphate. These are all important factors and consistent with current understanding of the choices for European dyes.[64] Overall, several criteria for choosing dyes in ancient China can be summarised. Since colour is an important symbol of social status in ancient China, as mentioned above, to obtain good shades is vital. This is the reason why safflower outweighed munjeet. Fastness is an important indicator of the lifespan of dyed textiles, which led to the abandonments of gardenia and turmeric in dyeing. Availability is also an essential factor. Once dyes and dyeing skills are learned and affordable, the difficulty of dyeing and prices are not as decisive as colouring effect for people's choice, as in the cases of safflower and indigo. Sometimes colouring effects outweigh fastness, as the case with safflower for imperial use, but sometimes the opposite is true, as in the cases of turmeric and gardenia. Changes in the choice and use of dyes resulted from craftsmen's increasing knowledge of the properties of dyes as well as exchanges of raw materials and techniques with other countries.

DYEING TECHNIQUES

Understanding dyeing techniques is central to our understanding of how textile colour was obtained and interpretation of colour in the Ming and Qing Dynasties. The whole process of dyeing usually involves scouring, bleaching dyeing and finishing. Before dyeing, scouring is undertaken to remove sericin of silk fibres, pectin of cotton fibres and other impurities so that dyes bond with the fibres more evenly and penetrate deeper. Bleaching is carried out to further remove colourants in the fibres. Dyeing is to extract colourants from dye sources and then to fix them on fibres. The main additives of dyeing are mordants, usually minerals, to enhance or modify the dyed colours and to help fix the dyes on the fibres. These are achieved through chemical complexation: the metal ions of mordants contain empty electron orbitals, which enable bonding with unshared electrons of the dye molecules and the fibres. After dyeing, finishing is undertaken to improve some properties of dyed textiles such as appearance and feel.[65] The use of dyes and mordants is a key part of dyeing and thus was recorded the most detailedly. Therefore, this was set as the focus of this section. The dye recipes in the manuscripts were examined in detail to extract and compare information based on the number of dyes and the type of dye-bath additives used, and the sequence of adding and combining dyes, additives and fabrics in the dye bath.

Dyes for single dyeing

All the common dyes identified in the manuscripts can be used alone for dyeing. TABLE 4 presents the frequency of these dyes used for single dyeing, the dye bath additives used with them, and the colours that can be achieved. Sometimes additives are necessary to enhance or fix the dye, the most important being a mordant, usually a mineral salt, to achieve a certain colour shade and improve the fastness of the dye. As the colourants of safflower and indigo have special chemical properties, these two dyes are used respectively by acidic dyeing and vat dyeing.[66]

TABLE 4. Summary of the records of single dyeing

Dye	**Frequency for single dyeing**	**Main additives**	**Main type of dyeing**	**General colours achieved**
Acorn cup	2	ferrous sulphate	mordant dyeing	black
Chinese cork tree	5	sometimes with 'gang zhi' (unidentified)	direct dyeing	yellow
Chinese gallnut	6	ferrous sulphate	mordant dyeing	black or grey
Indigo	4	none	vat dyeing	blue
Pagoda bud	5	alum or ferrous sulphate	mordant dyeing	yellow and green
Safflower	10	dark plum and alkali	acidic dyeing	red
Sappanwood	3	alum or ferrous sulphate	mordant dyeing	brown and purple
Smoketree	5	alum or ferrous sulphate	direct dyeing and mordant dyeing	yellow

Turmeric	1	none	direct dyeing	yellow

Dyes for multi dyeing

Often two dyes are mentioned in the manuscript recipes, and several recipes mention three dyes. TABLE 5 presents the statistical results and colour outcomes of this use of two dyes, termed combination dyeing.

TABLE 5. Summary of the dye recipes with two dyes[a]

	Smoketree	**Chinese cork tree**	**Pagoda bud**	**Turmeric**	**Gardenia**	Indigo	Chinese gallnut	Acorn cup
Sappanwood	**1 red**		**1 red**	**1 orange**		8 purple and pinkish grey	8 red and brown	1 brown
Safflower	**3 red**			**3 red**	**1 cream**	1 purple	2 grey and black	
Pagoda bud	**1**	**1**					4	

	yellow	**yellow**					green and yellowish grey	
Smoketree								1 brown
Indigo		5 green	6 green				1 black	

[a]In this table, the first row and the first column show dye names. Cells in the other rows and columns show the combination of the two dyes in the row and column where the cell is located, presenting the colour(s) obtained by combining these two dyes and the frequency of occurrence of this combination recorded in the four manuscripts. To present clearer, the combinations of red and yellow dyes are in bold font.

Four key observations were made about the combination of multiple dyes. Firstly, red and yellow dyes are used together to dye red shades. In one case, apricot yellow is obtained by multi-dyeing of sappanwood and turmeric. The combination of dyes enriches the number and range of colours achieved, proven by the abundance of colour names of multi dyeing. Sometimes it saves expenditure. For example, *Tiangong kaiwu* records that smoketree can be used for 'bottoming' in safflower dyeing, that is, dyeing a ground colour with smoketree before using safflower. Occasionally two yellow dyes are used together to obtain various yellow shades.

However, the two red dyes, sappanwood and safflower, are not used together, probably because safflower dyeing was too precious to use for colours other than crimson.

Secondly, indigo is often used with sappanwood to make such colours as purple, and with yellow dyes including Chinese cork tree and pagoda tree to dye greens. Indigo is used very often in multi dyeing for these colours because few dyes produce satisfactory and stable purple or green colours alone, as discussed in the previous sections.[67] Indigo is used with safflower only once, probably for the same reason of maintaining the pure colour of safflower mentioned above. Another reason might be the dissolution of the red components of safflower by lime in the alkaline reduction dyeing process of indigo.[68]

Thirdly, dyes containing tannin such as Chinese gallnut, acorn and acorn cup are usually used with ferrous sulphate to darken the shade of other colours in multi dyeing processes.[69] This combination is often used with sappanwood, and less often with other dyes to make dark colours, because red enriches the dark colours from tannin and ferrous sulphate.

Fourthly, dye recipes that involve three dyes or more are mostly in *Zhiranju buce* and *Bu jing*. For brown colours, usually ferrous sulphate with either sappanwood or Chinese gallnut ensures a dark colour, with pagoda bud and Amor cork tree to adjust the shades. For green, dark blue and black colours, indigo is combined with a yellow dye and a dye containing tannin. Sometimes ferrous sulphate is also added with tannin to darken the green (obtained by blue and yellow dyes). In this way, dark colours with rich tones are achieved.

Mordanting

In the studied documents, alum and ferrous sulphate are often used as mordants. In three documents (*Duoneng bishi* excepted), alum is mainly associated with sappanwood and pagoda bud, while ferrous sulphate is often with Chinese gallnut and other dyes containing tannin such as lotus shell and chestnut shell in *Tiangong kaiwu*. This is consistent with historical dyeing practice of using alum to brighten up the colour of dyed textiles and ferrous sulphate to darken the colour.[70]

In *Duoneng bishi*, alum and ferrous sulphate are used together in individual dye recipes with sappanwood, smoketree or Chinese chastetree (*Vitex negundo* variants) leaves, both with and without acorn cup (TABLE 6). Where acorn cup is added, the colour darkens, judging from the colour names in the recipes. The use of a single dye with both mordants of alum and ferrous sulphate is unique, with the entry 'Method of using ferrous sulphate' indicating that ferrous sulphate be added little by little to achieve an ideal shade. This method was not recorded in the other three documents. Instead, to achieve a dark shade, a dye containing tannin is usually present with ferrous sulphate. This perhaps resulted from decreasing the amount of ferrous sulphate needed with the tannin, to prevent fabrics from being damaged in the dyeing process and degrading rapidly afterwards.[71] In addition to these two mordants, other mordants and additives are used in some dye recipes. For example, when dyeing with smoketree, sometimes alkali solution such as plant ash solution and lye is added to adjust colour.

Dyeing sequences

The manuscript recipes usually involve several dyes and mordants to dye a certain colour. A proper sequence of adding and combining dyes, additives and fabrics in the dye bath enables good colouring effects and the formation of firm connections among dyes, additives and fabric fibres. The dyeing processes are described in *Duoneng bishi* and *Tiangong kaiwu*, the two dye recipes of the Ming Dynasty. Since these records are not always specific or articulate, key words, integrated understanding and practical considerations from dyeing experience were used to elucidate the dyeing sequences presented in TABLE 6.

TABLE 6. Dyeing sequences in *Duoneng bishi* and *Tiangong kaiwu*

Colour	**Pre-mordanting**	**Dyeing/ Simultaneous mordanting**	**Over-dyeing**	**Post-mordanting**	**Added but unclear when**	**Dyes used together or separately**	**Mordanting**
***Duoneng bishi* (for silk cloth)**							
zao he 棗褐 (jujube brown)	sappan-wood (second decocti-on) and alum	sappanwood (first decoction)		ferrous sulphate added to dye bath		— (Only one dye is used.)	pre-mordanting (with dyes present) and post-mordanting
jiao he 椒褐 (pepper brown)	sappan-wood (second decocti-on) and alum	sappanwood (first decoction)		ferrous sulphate	acorn cup	unclear	pre-mordanting (with dyes present) and post-mordanting
ming cha he 明茶褐(light tea brown)	alum	smoketree		ferrous sulphate added to dye bath		—	pre-mordanting and post-mordanting (with dyes present)
an cha he 暗茶褐 (dark tea brown)	alum	smoketree		ferrous sulphate added to dye bath	acorn cup	unclear	pre-mordanting and post-mordanting (with dyes present)
jing he 荊褐 (jing brown)	alum	leaf of *Vitex negundo* variants[72]		ferrous sulphate		—	pre-mordanting

ai he 艾褐 (wormwood brown)	alum	leaf of *Vitex negundo* variants		ferrous sulphate	acorn cup	unclear	pre-mordanting
xiao hong 小紅 (light red)	pegoda bud then alum	sappanwood (second decoction) and lead oxide	sappan-wood (first decocti-on)			dyed separately	post-mordanting and pre-mordanting (with dyes present)
xiao hong 小紅 (light red) (2)		pegoda bud and sappanwood				two dyes in the same dye bath	not mentioned
zhuan he 磚褐 (brick brown)		*jiang cha* 江茶 (probably *Camellia sinensis* (L.) Kuntze		ferric oxide[73]		—	post-mordanting
qing zao 青皂 (black)		Chinese gallnut, ferrous sulphate, leavened Chinese gallnut (fermented Chinese gallnut and other materials) and *Fraxinus chinensis* Roxb.[74]				three dyes in the same dye bath	one bath-mordanting
bai meng si bu 白蒙絲布(white)		oyster and clam shell ash				two dyes in the same dye bath	none

tie li bu 鐵驪布 (black) (2)		mulberry bark and lotus leaf				two dyes in the same dye bath	none
zao jin sha 皂巾紗 (black) (3)	with acorn cup in iron pot	black bean and pomegranate peel				three dyes in two dye baths	one bath-mordanting
jiu zao pi se 舊皂皮色 (black) (4)		*ni fan* 泥矾 ('mud mordant', unidentified), *bai yao jian* 百藥煎 (leavened Chinese gallnut as its main component) and *ji shui* 虀水 (mixed liquid)				—	one bath-mordanting
***Tiangong kaiwu* (for silk & cotton cloth)**							
cha he se 茶褐色 (tea brown)		lotus shell		ferrous sulphate		—	post-mordanting
zi se 紫色 (purple)		sappanwood		ferrous sulphate		—	post-mordanting
jin huang se 金黃色(golden yellow)		smoketree		plant ash, then alkali		—	none
ou he se 藕褐色 (lotus root brown)		sappanwood		lotus shell and ferrous sulphate		dyed separately	one bath-mordanting
mu hong se 木紅色(wood red)		sappanwood		alum and Chinese gallnut		dyed separately	one bath-mordanting
bao tou qing se 包頭青色(black)		chestnut shell or lotus shell		iron ore and ferrous sulphate		—	post-mordanting

you lv se 油綠色 (light green)		pagoda bud		ferrous sulphate		—	post-mordanting
xuan se 玄色 (black) (2)		indigo		Chinese gallnut and ferrous sulphate		dyed separately	one bath-mordanting
da hong se 大紅色(pure red)		smoketree (optional)	safflower			dyed separately	none
tian qing se 天青色 (deep-sky blue) and *pu tao qing* 葡萄青 (grape blue)		indigo	sappan-wood			dyed separately	none
xuan se 玄色 (black)		indigo	smoke-tree, strawbe-rry bark, *etc*. separately			dyed separately	none
da hong guan lv se 大紅官綠色 (official green)		pagoda bud	indigo		alum	dyed separately	not sure, probably post-mordanting for pagoda bud
dan qing se 蛋青色 (egg-shell blue), *e huang se* 鵝黃色 (goose yellow) and dou lv se 豆綠色(bean green)		Chinese cork tree	indigo			dyed separately	none

There are both similarities and differences in the dyeing stages for dyes and mordants between the dye recipes in the *Duoneng bishi* and *Tiangong kaiwu*.

The first issue is the timing of using two or more dyes. In *Duoneng bishi* some dyes are used together in the same dye bath, especially dyes with similar dye components, *e.g*. oyster and clam shell ash containing calcium carbonate, and mulberry bark and lotus leaf containing tannin.[75] In contrast, in *Tiangong kaiwu*, dyes are always used in separate dye baths. One reason is that dyes with similar dye components are not used in the same dye recipe any longer. Another reason may be to prevent competition between different dyes during dyeing processes. Though dyeing all the dyes at once is much simpler and saves time and labour, it is less controllable for colour production. As to the sequence, usually lighter dyes are prepared first followed by darker dyes, *e.g.* dyeing Chinese cork tree or pagoda bud followed by indigo, and dyeing indigo followed by sappanwood. This would help control the shade by preventing the darker colours from saturating the lighter ones. However, multi-dyeing with indigo in *Bu jing* is just the opposite: the blue background is prepared before other dyes are applied to dye green and purple colours. This probably reflects that the dyers were supplied pre-dyed blue cloth.

The second issue is the timing of adding mordants. On one hand, in *Duoneng bishi*, pre-mordanting, post-mordanting and one-bath mordanting methods are all used. Usually alum is used as a pre-mordant to prepare fabrics for taking colours, while ferrous sulphate is used as a post-mordant for 'saddening' dyed fabrics, resulting in darker and duller shades.[76] The method of one-bath mordanting is applied in three dye recipes for black respectively using three dyes. One-bath mordanting saves time, labour and expense but needs greater dye quantity and the colour obtained is superficial.[77] Moreover, in *Duoneng bishi*, sometimes dyes are present in a pre-mordanting bath (usually the second decoction of a dye) or a post-mordanting bath (the mordant added directly to the dye bath). In one recipe, pre-mordanting and post-mordanting are both used, probably to further enhance the interaction between the mordant, dyes and fabrics. By contrast, mordants in *Tiangong kaiwu* are used relatively simply. In single-dye recipes, usually the method of post-mordanting is used to adjust colours and achieve better fastness. In dye recipes with two or more dyes and one of them being Chinese gallnut, the Chinese gallnut is used in the second dye-bath with a mordant to sadden the fabrics. This method simplifies the dyeing process and is perhaps employed because it achieves similar colouring effect as using the dye and mordant separately.

The dyeing sequences therefore appear to have depended largely on the combination of dyes and mordants and their dyeing properties, based on their performance in dyeing as well as resulting colour. Generally speaking, the one-bath method (either for dyes or for dyes and mordants) saves time, labour and expense but necessitates greater quantities with risk of poor dyeing results. The method of using dyes and mordants in separate dye baths is more time consuming but a better colouring effect is obtained.

COLOUR ENRICHMENT

Besides improvements in colours and fastness, an increasing palette of colours over the time reflects advances in dyeing in China in this period. The enrichment of costume colour greatly contributed to colour fashion and enabled increasingly detailed colour decrees.[78] As discussed above, colour and fastness were mainly achieved by the adoption and abandonment of dyes and some dyeing skills. Colour enrichment from an increasing colour palette is now discussed. To study the differences in dyeing among these manuscripts to know how dyeing advanced, dye recipes were further analysed statistically in terms of the combinations of dyes and mordants and variations in the quantity of raw materials.

TABLE 2 demonstrates a marked increase in the numbers of colours described, from 13 in *Duoneng bishi* to 66 in *Bu jing* 500 years later. This mainly results from increased variations in the combination and quantity of dyes and mordants rather than an expansion of the range of dyes used. First, variations in the combination of raw materials extend the colour range dramatically. Taking the combined raw materials recorded in *Tiangong kaiwu* and *Bu jing* as an example (FIG. 10), the number of dyes used in the two manuscripts are respectively 13 and 18, but the total number of variations in the combination of dyes and mordants increases significantly from 17 in *Tiangong kaiwu* to 33 in *Bu jing*. The number of variations in single-dye recipes using different dyes increases from 7 to 12, combinations of two dyes from 7 to 14, combinations of three or more dyes from 1 to 3, and with different mordants from 2 to

4. Thus the number of variations for combining raw materials nearly doubles, contributing to an increase in achievable colours.

Second, variations in the quantity of raw materials also accounts for an increased range of colours. Dye recipes with the same combination of dyes and mordants but with varied amounts achieve colours of the same hue and different tones, thus extending the palette. FIG. 11 exemplifies this with three dye recipes in *Bu jing* for obtaining three shades by varied combinations of safflower and turmeric. Red is created by doubling the amounts of the two dyes for pink. To obtain orange, the same amount of safflower is used as for pink, but the amount of turmeric is increased by 60%.

Significant changes in colour enrichment over the period of study become apparent when dye recipes with the same dyes and mordants but with different amounts are compared (FIG. 12). To illustrate this clearly, dye recipes with the same combination of dyes and mordants but with different amounts were grouped together. As shown in FIG. 12, comparing *Duoneng bishi*, *Tiangong kaiwu* and *Bu jing*, the three dye manuscripts with full texts accessible, the number of such dye recipe groups increases from 0 to 13 and the total number of dye recipes in these dye recipe groups increases from 0 to 46. Accordingly, the percentage of dye recipes with distinct combinations of dyes and mordants decreased from 100% to 50%. Altogether, dyers became more capable of controlling colouring effects by varying the combinations of dyes and mordants and changing quantities, resulting in an extended colour palette.

Besides, the refining of the technique for yellow silk in the Ming Dynasty also contributed to this by making the dyeing of light colours possible.[79]

CONCLUSION

This research provides preliminary evidence about dyes and dyeing techniques in the Ming and Qing Dynasties through a comprehensive comparative study of dyes and dyeing methods in four selected primary source historical manuscripts. By identifying and establishing that the *Duoneng bishi* and *Tiangong kaiwu* manuscripts were written for general dyeing use, and *Zhiranju buce* and *Bu jing* manuscripts were written by dyeing experts in the field for professional use, the records in these four manuscripts offer broad insight into actual dyeing practice over this 500 year period. The dye recipes in these manuscripts vary in both content and recording style. The recipes in *Duoneng bishi* provide a rare insight into the colour range, dyes and dyeing methods for ordinary people rather than higher status textiles.

Regarding the dyes, sappanwood, safflower, smoketree, Chinese cork tree, pagoda bud, indigo, Chinese gallnut and acorn cup were recorded most frequently. With respect to dyeing, all of these common dyes were used for single dyeing, that is on their own. The combination of multi dyes was applied to enrich colours and sometimes save costs. Red and yellow dyes, and two yellow dyes were frequently used together, but multiple red dyes were not combined because pure red colours were desired. Indigo was often used with sappanwood, Chinese cork tree and pagoda tree to achieve purples and greens. Tannin-containing dyes were applied extensively, usually with ferrous sulphate to make dark colours. The combination of specific dyes needs further investigation in the aspect of their colouring effects and interaction in the dyeing process. Regarding mordants, alum was used mainly with sappanwood and pagoda bud, while ferrous sulphate enhanced the dark colours of tannin-containing dyes.

Variations in dyeing sequences of dyes and mordants were identified between the recipes of *Duoneng bishi* and *Tiangong kaiwu*. In *Duoneng bishi*, some dyes were used together in a single dye-bath, especially those with similar dye components, while in *Tiangong kaiwu*, dyes were always used in separate baths. Usually lighter dyes were created first followed by darker dyes to control the shade by preventing darker colours from saturating lighter ones. The *Duoneng bishi* recipes showed that alum was normally a pre-mordant and ferrous sulphate a post-mordant, with one-bath mordanting favoured for dyes with similar dye components. By contrast, *Tiangong kaiwu* recipes tended towards post-mordanting for single-dyeing to adjust colours and achieve better fastness. When Chinese gallnut was used with another dye, it was usually added in a second dye-bath with a mordant to 'sadden' the colour and simplify the dyeing process.

The overall picture is that the choice of dyes in the Ming and Qing Dynasties largely depended on colouring effects, fastness, availability, and sometimes on special functions. Although the dye recipes studied are isolated treatises with differing levels of completeness and reliabilities, the study still usefully provides the first overview of advances in dyeing over the Ming and Qing Dynasties including improved colour and fastness, and expanded range of colour, through adoption and abandonment of dyes and dyeing skills, and by variations in the combination and quantity of dyeing materials.

Through this research, a new framework for studying Chinese textile history through advances in dyes and dyeing techniques has been initiated by critical evaluation of historical dyeing documents in terms of materials, methods and the practice of dyeing. This archival research greatly complements chemical research on dyes and dyeing methods of Ming and Qing textiles. These research results are of great importance for better understanding of the colour effects and qualities of textiles in ancient China and their evolutions. They also vitally contribute to research in textile production, and knowledge of its role in the political, economic and social context. Besides, knowledge of the characteristic dye sources and dyeing methods can complement world textile history in terms of the exchange of the raw materials and techniques of dyeing between China and other places of the world, and possible provenance of textiles based on dyes. Knowledge of the dye sources and their chemical properties is also helpful for the conservation and preservation of Chinese textiles of the Ming and Qing Dynasties. It is to be noted that most red and pink shades of these textiles were dyed with safflower, which is not light-fast, and thus light exposure on these shades needs to be limited to prevent rapid fading.

Further research by experimental dyeing to recreate historical Chinese processes and investigate the properties of dyes and the dyeing techniques will advance understanding and evaluation of the historical dyeing processes, especially regarding the quantity of raw materials and dyeing conditions by combined literature and experimental research. Investigation into the rare dyes, mordants and additives will also extend knowledge about dye sources and raw materials, complimented by research into the origin, species, cultivation, processing, and social background to know more about historical dyeing activities. Continued chemical analysis of dyes in well-provenanced historical textiles as primary material evidence will supplement the incompleteness of literature and reveal whether historical records are consistent with actual practice. Moreover, research on dye workshops for different social classes and of different regions will further contribute to in-depth knowledge of dyeing practice. Further research on how dyeing was practiced in workshops and its relationship with industrialisation, economy development and politics will be very helpful for better understanding of the role of textile production in the evolvement of the society.

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dyeing. Cotton is mainly composed of cellulose, whose basic unit is cellobiose. Cellulose does not contain as much polar groups as silk does, and therefore their bonds formed with dye molecules are weaker. Some methods can be used to improve the effect of cotton dyeing, *e.g.* using tannin to enhance the connections between cotton fibres and dyes.

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LIST OF TABLES

No.	Caption
TABLE. 1.	Historical manuscripts and dye recipes
TABLE. 2.	An overview of dye recipes recorded in the four manuscripts
TABLE. 3.	Common dyes identified in the dye recipes
TABLE. 4.	Summary of the records of single dyeing
TABLE. 5.	Summary of the dye recipes with two dyes
TABLE. 6.	Dyeing sequences in *Duoneng bishi* and *Tiangong kaiwu*

LIST OF IMAGES

<table>
<tr><th>No.</th><th>Caption</th><th>Preference for published size</th></tr>
<tr><td>FIG. 1.</td><td>Bright yellow embroidered silk court robe with dragons among clouds. Made for a dowager empress, empress or first rank imperial concubine, 18th century. © Jacqueline Simcox Ltd</td><td rowspan="4">Quarter page or half page each image; ideally the four images to be presented together.</td></tr>
<tr><td>FIG. 2.</td><td>Apricot yellow embroidered silk court robe with dragons among clouds. Made for the wife of a son of the emperor, 19th century. © Brandt Asian Art</td></tr>
<tr><td>FIG. 3.</td><td>Man's golden yellow embroidered silk court robe with dragons among clouds. © The Palace Museum</td></tr>
<tr><td>FIG. 4.</td><td>Man's blue silk kesi court robe with dragons among clouds, early 19th century. © Jacqueline Simcox Ltd</td></tr>
<tr><td>FIG. 5.</td><td>A page of dye recipes in Duoneng bishi. © National Library of China collection, Beijing</td><td>quarter page</td></tr>
<tr><td>FIG. 6.</td><td>A page of dye recipes in Tiangong kaiwu. © National Library of China collection, Beijing</td><td>quarter page</td></tr>
</table>

FIG. 7.	Eight common plants used in the dye recipes of the Ming and Qing Dynasties. From left to right, from top to bottom: safflower (*Carthamus tinctorius* L.) © Yaxing Xu, sappanwood (*Caesalpinia sappan* L.) © Lifei Su, smoketree (*Cotinus coggygria* var. *cinerea* Engl.) © First author, pagoda bud (*Styphnolobium japonicum* L.) © Hongyi Zhou, Chinese cork tree (*Phellodendron chinense* Schneid.) © Yongfu Xu, indigo (*Strobilanthes cusia* (Nees) Kuntze) © Guanling Sun, acorn cup (*Quercus acutissima* Carr.) © Bing Liu and Chinese gallnut © First author	full page
FIG. 8.	Woman's red silk robe embroidered with roundels of flowers and butterflies, 19th century. © Jacqueline Simcox Ltd	quarter page or half page
FIG. 9.	Eliminated dyes. From left to right, from top to bottom: gardenia (*Gardenia jasminoindes Ellis f. longicarpa* Z. W. Xie & M. Okada.) © First author, turmeric (*Curcuma longa* L.) © Guanling Sun, munjeet (*Rubia cordifolia* L.) © Yao Zhou and gromwell (*Lithospermum erythrorhizon* Siebold & Zucc.) © Yao Zhou	half page
FIG. 10.	Comparison of the number of variations in single- and multiple-dye recipes in the *Tiangong kaiwu* and *Bu jing* manuscripts. © authors	quarter page
FIG. 11.	A dye recipe group in *Bu jing* for three colours from different combinations of safflower and turmeric. The weight unit of safflower is 10 jin and the weight unit of turmeric is liang (1 jin = 16 liang). © authors	quarter page
FIG. 12.	Comparative variations in dye recipes and dye-mordant combinations among the *Duoneng bishi*, *Tiangong kaiwu* and *Bu jing* manuscripts. © authors	quarter page

Colour figure

Click here to download Colour figure Fig. 1. Bright yellow robe .tif

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Click here to download Colour figure Fig. 2. Apricot yellow robe.tif

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Click here to download Colour figure Fig. 3. Golden yellow robe.tif

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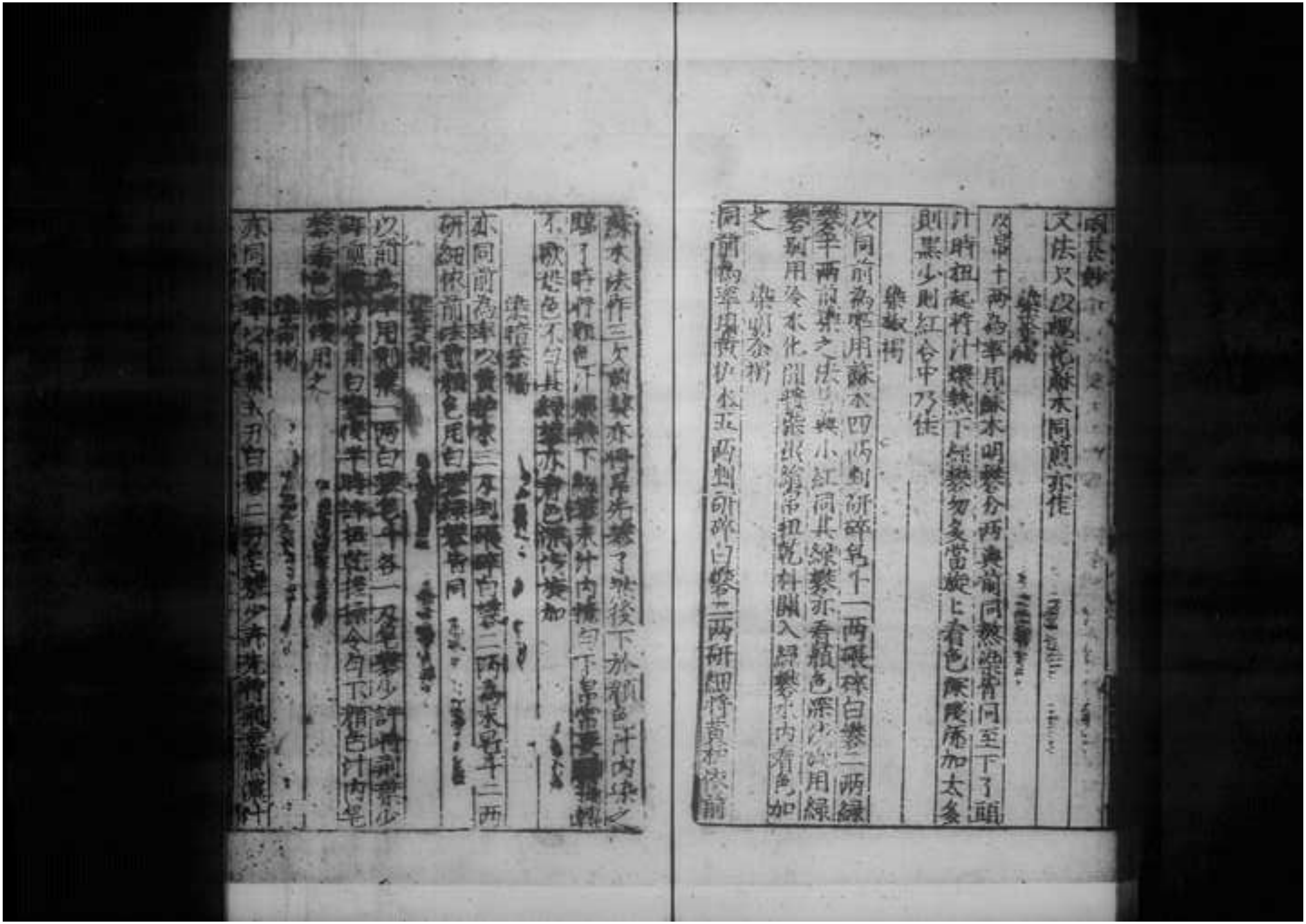
Click here to download Colour figure Fig. 4. Blue robe3.tif

Non-colour figure

Click here to download Non-colour figure FIG. 5. A page of dye recipes in Duoneng bishi.tif



又法只以礬花蘇木同煎亦作

染茶褐

以帛十兩為率用蘇木明礬各兩與前同熬染皆同至下了頭汁時扭起將汁燥熱下綠礬勿多當旋上看色深淺添加太多則黑少則紅合中乃佳

染藕褐

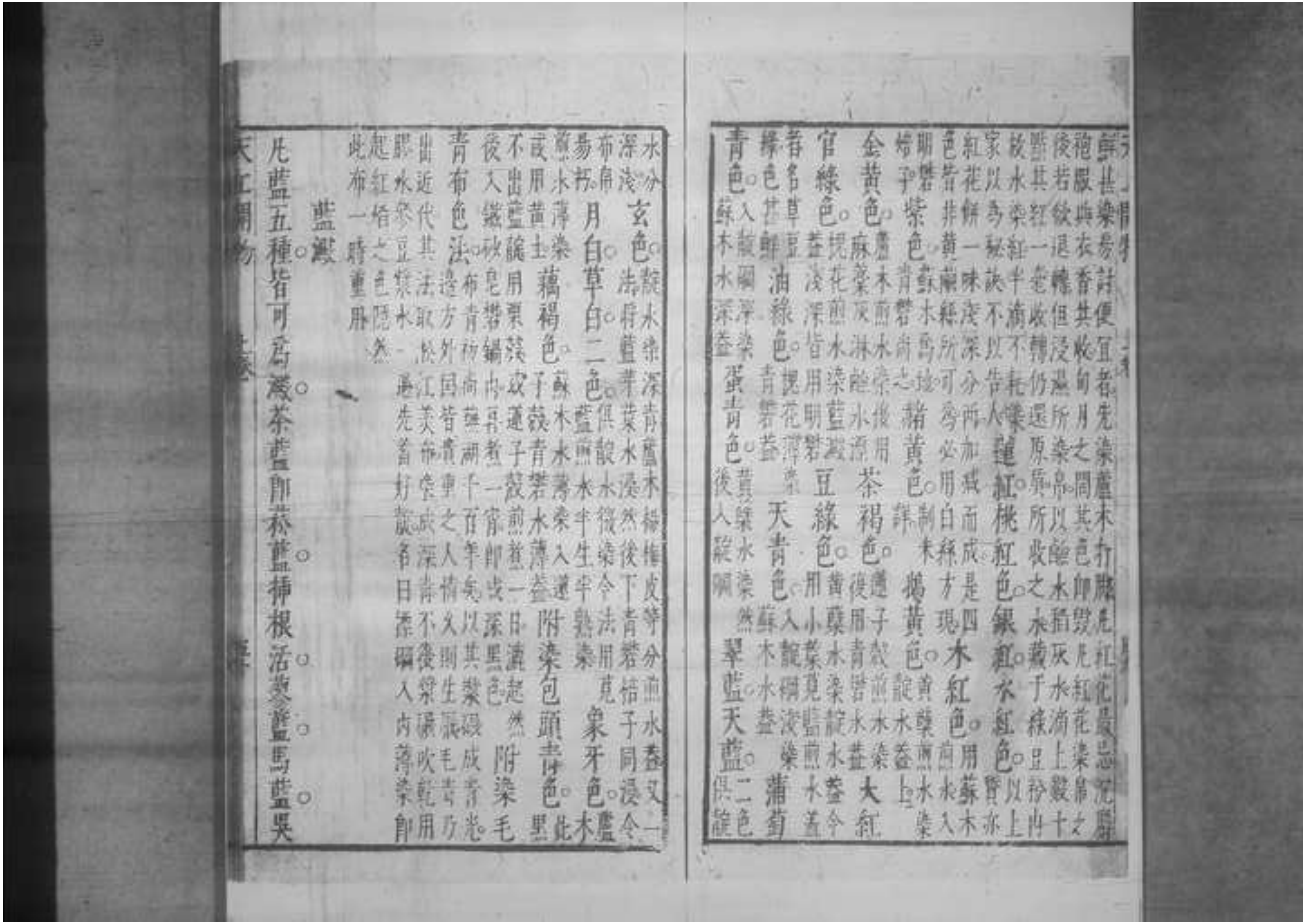
以同前為率用蘇木四兩剉研碎包下一兩研碎白礬二兩綠礬半兩前染之法與小紅同其綠礬亦看顏色深淺用綠礬須用冷水化開將染成綢帛扭乾抖擻入綠礬水內看色加之

染明茶褐

同前為率用黃栌木五兩剉研碎白礬二兩研細將黃栌木煎

Non-colour figure

Click here to download Non-colour figure FIG. 6. A page of dye recipes in Tiangong kaiwu.tif



鮮甚染房討便宜者先染蘆木打腳凡紅花最忌沉麝袍服與衣香共收旬月之間其色即毀凡紅花染帛之後若欲退轉但浸濕所染帛以鹼水稻灰水滴上數十點其紅一毫收轉仍還原質所收之水藏於綠豆粉內放出染紅半滴不耗染家以為秘訣不以告人○蓮紅○桃紅色○銀紅○水紅色○以上質亦紅花餅一味淺深分兩加減而成是四色皆非黃繭絲所可為必用白絲方現○木紅色○用蘇木煎水入明礬棓子○紫色○蘇木為地青礬尚之○赭黃色○制未詳○鵝黃色○黃檗煎水染靛水蓋上○金黃色○蘆木煎水染復用麻稿灰淋鹼水漂○茶褐色○蓮子殼煎水染復用青礬水蓋○大紅官綠色○槐花煎水染藍澱蓋淺深皆用明礬○豆綠色○黃檗水染靛水蓋今用小葉莧藍煎水蓋者名草豆綠色甚鮮○油綠色○槐花薄染青礬蓋○天青色○入靛缸淺染蘇木水蓋○蒲萄青色○入靛缸深染蘇木水深蓋○蛋青色○黃檗水染然後入靛缸○翠藍○天藍○二色俱靛水分深淺○玄色○靛水染深青蘆木楊梅皮等分煎水蓋又一法將藍芽葉水浸然後下青礬棓子同浸令布帛易朽○月白○草白○二色俱靛水微染今法用莧藍煎水半生半熟染○象牙色○蘆木煎水薄染或用黃土○藕褐色○蘇木水薄染入蓮子殼青礬水薄蓋○附染包頭青色○此黑不出藍靛用栗殼或蓮子殼煎煮一日漉起然後入鐵砂皂礬鍋內再煮一宵即成深黑色○附染毛青布色法○布青初尚蕪湖千百年矣以其漿碾成青光邊方外國皆貴重之人情久則生厭毛青乃出近代其法取松江美布染成深青不復漿碾吹乾用膠水參豆漿水一過先蓄好靛名曰標缸入內薄染即起紅焰之色隱然此布一時重用

藍澱

凡藍五種皆可為澱○茶藍即菘藍插根活○蓼藍○馬藍○吳藍

天工開物 卷上

Colour figure

Click here to download Colour figure Fig. 7. Chinese cork tree.tif

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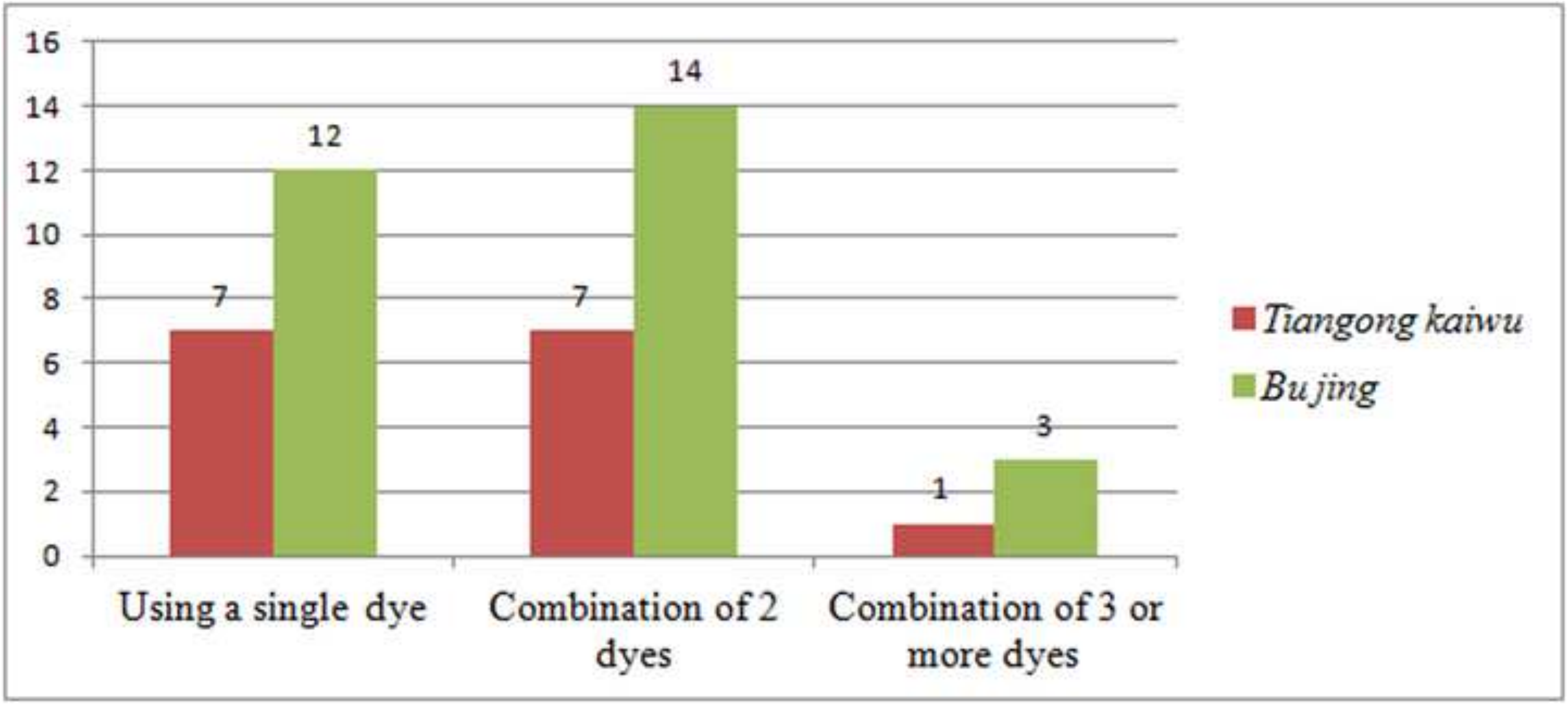
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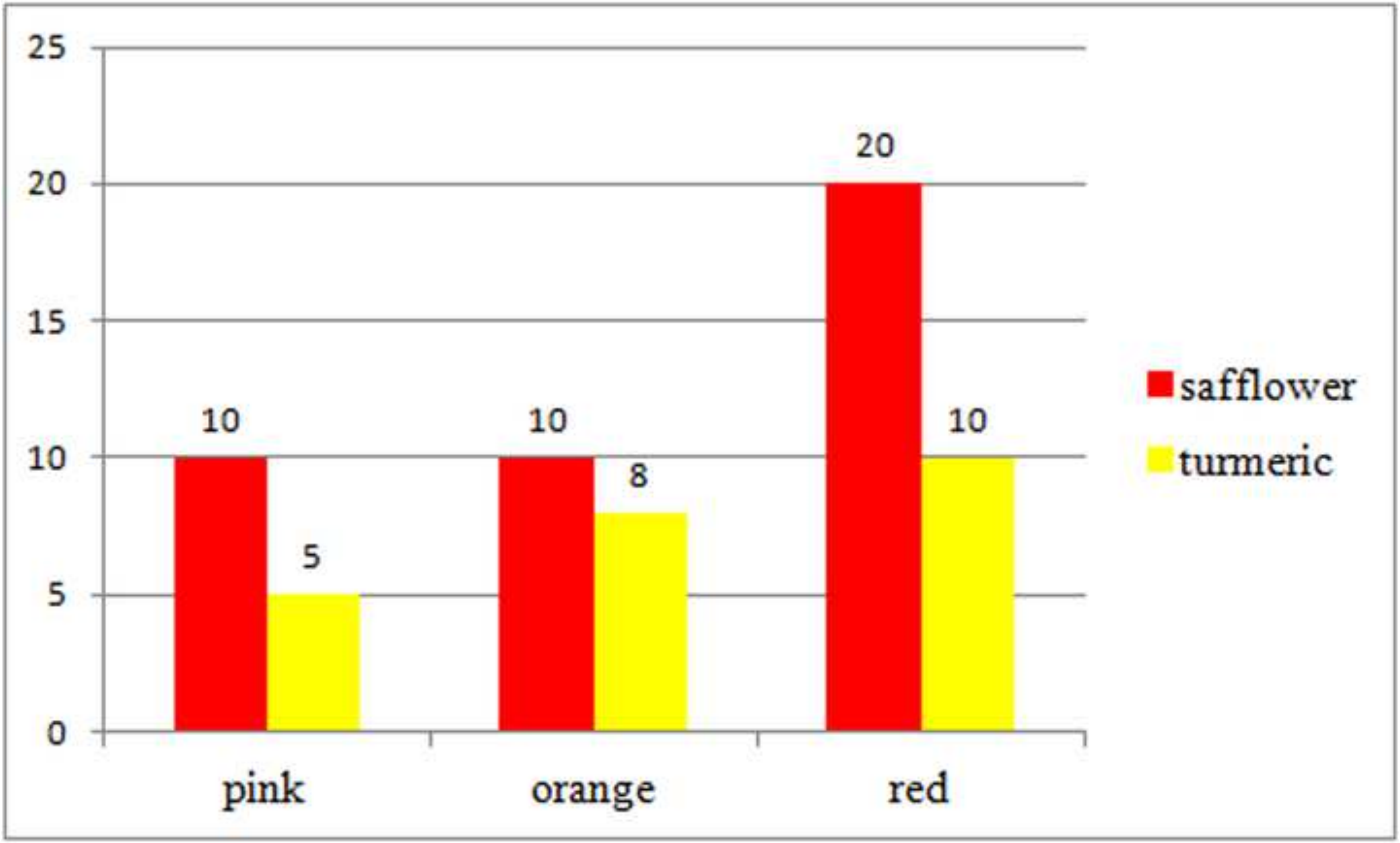
Using a single dye
Combination of 2 dyes
Combination of 3 or more dyes
Tiangong kaiwu
Bu jing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Colour figure

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