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Yellow Dyes of Historical Importance. IV. Sourcing and Consumption of Yellow Dyes by the Dyeing Company of Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore in Florence (1483–1498)

Dominique Cardon^{1*} and Ingrid Houssaye Michienzi²

This article is dedicated to the memory of John Edmonds

Abstract This article offers a direct insight into the importance of yellow dyestuffs in the dye company of Francesco di Giuliano Salviati in Florence, specialised in fast mordant dyes (*arte maggiore*) at the end of the 15th century. It is based on evidence provided by the study of three manuscript account books, respectively dated from 1483 to 1486, from 1486 to 1491 and from 1490 to 1498, preserved in the Archivio Salviati, at the Scuola Normale Superiore in Pisa (Italy). A patient deciphering of the books provides exceptionally precise information on what dyestuffs were bought and used; in what quantities each year; how and from where they were obtained; and at what prices. Four yellow dye plants figure in the books and are discussed in this article: sawwort, *Serratula tinctoria* L.; weld, *Reseda luteola* L.; young fustic, *Cotinus coggygria* Scop.; and *guilicie*, a still non-identified plant. Reasons for the use of these plants are proposed and the differences in the colours obtained from sawwort or weld are evidenced by our dye experiments and spectrorimetric measurements of the resulting yellow and green samples of wool broadcloth. This study of the three Salviati books reveals that the provenances and consumption of yellow dyestuffs can, and should, be used as indicators of the development of textile production and the evolutions of international markets for European broadcloths.

Introduction

The three previous parts of this long-term multidisciplinary study of yellow dyes of historical importance consisted of historical and chemical surveys of yellow dye plants mentioned in the technical and commercial literature from southern Europe.¹ This fourth part offers a direct insight into the importance of yellow dyestuffs in a Florentine dyeing company that specialised in fast mordant dyes (*arte maggiore*) at the end of the 15th century. It is based on evidence provided by the study of three manuscript account books preserved in the Archivio Salviati, at the Scuola Normale Superiore

in Pisa (Italy). The Archivio Salviati is one of the most important archives in Europe for economic and social history. It contains thousands of account books and documents written between the 14th and the 17th century concerning textile production, banking and long-distance trade with many places in Europe and beyond. The present study is but a small part of a vast interdisciplinary research programme based on the study and publication of the archive, under the acronym ENPrESa.² Our contribution to this joint effort includes a focus on the documents that concern the history of dyeing.

The three account books mentioned above are the only documents relating to the dye company



Figure 1 The blue book, labelled A (*Libro azzuro, seg. A*), Reg. 394 in the Salviati Archive, Pisa, registrations from November 1483 to the end of December 1486. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, *Libro azzuro, segnato A*, Reg. 394)



Figure 2 The yellow book, labelled B (*Libro giallo, seg. B*), Reg. 395 in the Salviati Archive, registrations from December 1486 to November 1491. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, *Libro giallo, segnato B*, Reg. 395)

of Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore in Florence that have been preserved. Francesco's father, Giuliano Salviati, together with two of his uncles, Iacopo and Alamanno, was engaged in the production of wool broadcloth of high and medium qualities while Iacopo Salviati was also involved in the production of silk textiles. Francesco, through his dye company, thus completed the activities of an important family business that operated in textile production.

The first two books – Reg. 394, *Libro azzuro, segnato A* (Fig. 1), corresponding to the years 1483 to 1486, and Reg. 395, *Libro giallo, segnato B* (Fig. 2), corresponding to the years 1486 to 1491 – record all the company's commercial dealings organised by products and providers (buying dyes and mordants, paying furnishers, dyers, local custom duties etc.). The third book, Reg. 396, is a *Giornale* (Fig. 3), in which all the daily commercial activities were recorded from 1490 to 1498. No book on the technical aspects of the dyeing activity of the firm having been preserved, all that can

be known about the company, therefore, is what dyestuffs were bought and used; in what quantities each year; how and from where they were obtained; and at what prices. All this information allows a better understanding of the nature of the dyeing in which the company specialised.

The lack of any mention of blue dyestuff, either woad or indigo, shows that the company did not include a vat-dyeing division; it obviously specialised in dyeing with fast dyes in boiling baths. On the one hand, the commodities most frequently purchased in large quantities included the typical ingredients of mordanting baths as described in contemporary Italian treatises and regulations on dyeing – alum (*alume*), tartar (*gromma*) and bran (*crusca*) – and on the other, red and yellow dyestuffs. Red dyestuffs recorded include madder (*robbia*), kermes (*grana*), a local *Porphyrophora* sp. 'cochineal' (*chermisi di Marche*), sappanwood (*verzino*), processed orchil and orchil-producing lichens



Figure 3 The *Giornale*, diary, Reg. 396 in the Salviati Archive, recording all daily activities from October 1490 to June 1498. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, *Giornale*, Reg. 396)



Figure 4 Sawwort plant, *Serratula tinctoria* L. (Photo © Dominique Cardon)

(*oricello* and *raspa*). Four yellow dyestuffs appear regularly in the three books: sawwort, *guilicie*, weld and young fustic.

Sawwort

The first yellow dye plant mentioned in the company's books, *cerretta* (sawwort, *Serratula tinctoria* L.) (Fig. 4) is a tall perennial herb with deciduous upper parts that wither and disappear in the autumn; new leaves do not appear until mid-spring, followed later by floral stems. All of the plant is used for dyeing except the perennial underground part. Sawwort has never been cultivated and had to be collected in its natural habitats during the summer months.³

Sawwort is the second dyestuff mentioned in the earliest of the three books, the *Libro azzurro*. It appears initially on folio 4, left and right, immediately following the first double page which is dedicated to the purchases of madder. On the left

page (Fig. 5) are recorded all the purchases of sawwort made by the company between November 1483 and December 1486. The first four entries, shown in Figure 6, record purchases of various quantities, all made on the same day – 20 November 1483 – from two types of providers: large amounts were obtained from two distinct middlemen who must have gathered together all the sawwort collected in their area, while smaller quantities were brought by villagers who came to sell plants that they probably harvested either themselves or with a group of relatives.

The following is a transcription of these first records of sawwort purchases and a translation into English. They will serve as representative examples for all entries because all are in the same standardised and much abbreviated format:

3518 Cerretta per nostro chonto de' dare, a di 20 di novembre 1483, F. dieci s. XVI d. I a oro larghi, per L. 61 s. 12 piccioli, per lib. 3 518

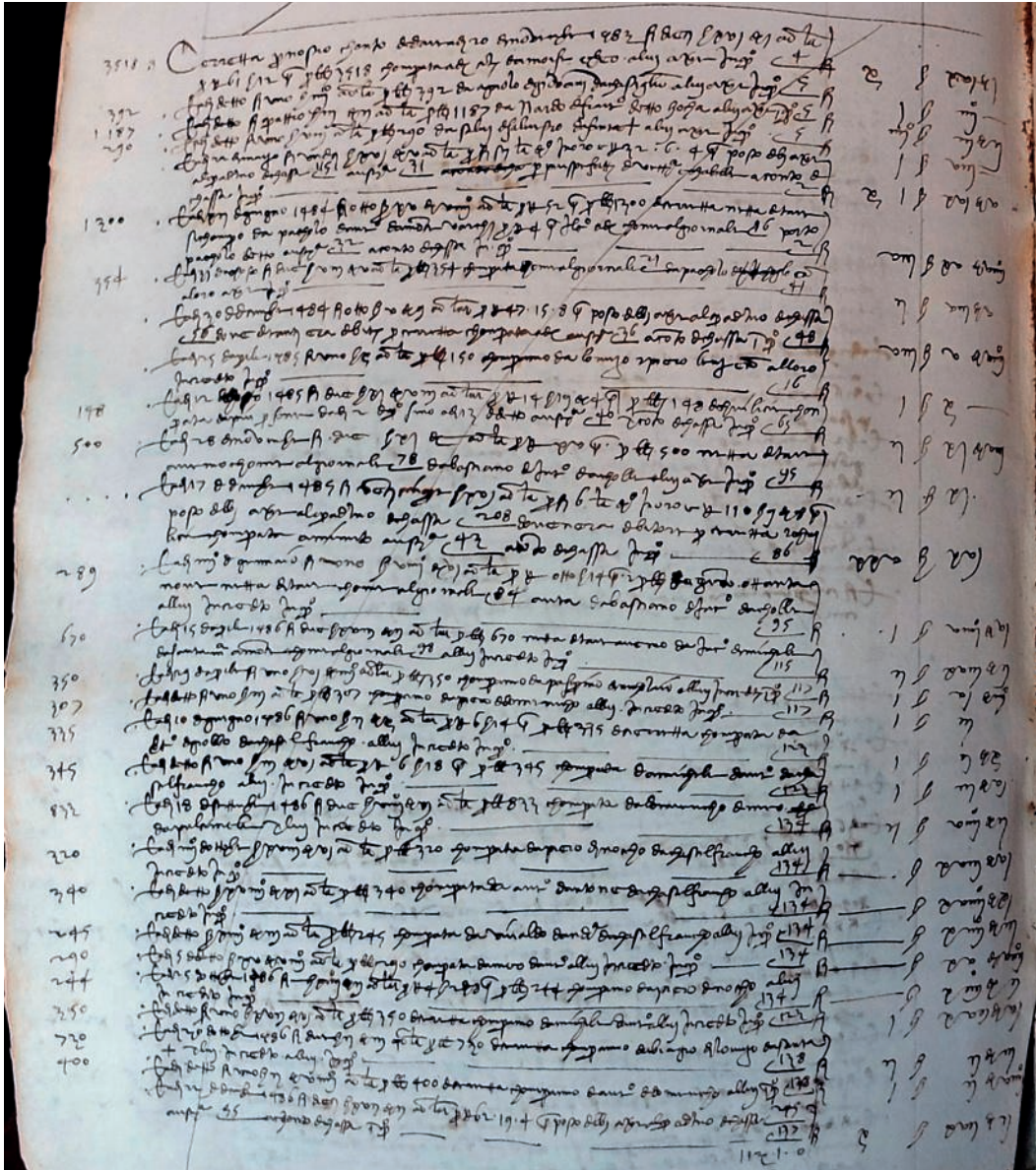


Figure 5 ‘Cerretta per nostro conto’, folio 4, left page, of Libro azzuro, seg. A, Reg. 394 in the Salviati Archive, recording purchases of sawwort from November 1483 to the end of December 1486. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, Libro azzuro, segnato A, Reg. 394)

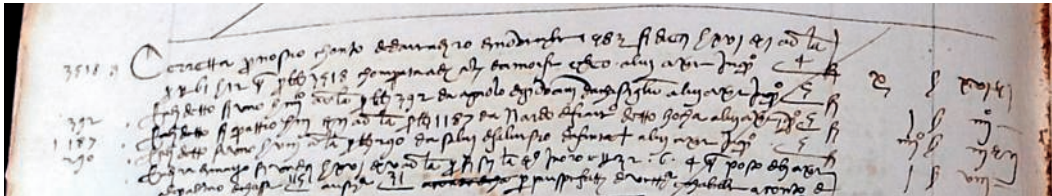


Figure 6 Detail of the first four entries concerning sawwort, on folio 4, Libro azzuro, seg. A, Reg. 394 in the Salviati Archive. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, Libro azzuro, segnato A, Reg. 394)

Table 1 Weights of yellow dyes bought by Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore from 1483 to 1495, in Florentine pounds (upper line) and converted into kilograms (lower line).

| Year | Sawwort + <i>guilicie</i> | Weld | Young fustic |
|----------------------------|-----------------------------------|---------------------------------|--|
| 1483 | 5,387 lb ¹ 1,826 kg | – | 2,820 lb 956 kg |
| 1484 | 1,654 lb ² 561 kg | 24,232 lb 8,215 kg | 4,063 lb 1,377 kg |
| 1485 | 650 lb ³ 220 kg | 40,823 lb 13,859 | – |
| 1486 | 6,048 lb ⁴ 2,050 kg | 17,062 lb 5,784 kg | 7,815 lb 2,649 kg |
| 1487 | 7,911 lb 2,682 kg | 33,837 lb 11,471 kg | 1,042 lb 353 kg |
| 1488 | 7,668 lb 2,599 kg | 42,519 lb 14,414 kg | 2,098 lb 711 kg |
| 1489 | 5,495 lb 1,863 kg | 31,002 lb 10,510 kg | 7,116 lb 2,412 kg |
| 1490 | 2,310 lb 783 kg | 37,947 lb 12,864 kg | – |
| 1491 | – | 46,169 lb 15,651 kg | 829 lb 281 kg |
| 1492 | – | 51,155 lb 17,342 kg | 5,103 lb 1,730 kg |
| 1493 | – | 49,429 lb 16,756 kg | 16,550 lb 5,610 kg |
| 1494 | – | 52,525 lb 17,806 kg | – |
| 1495 | – | 9,411 lb 3,190 kg | 6 <i>miglia</i> (6,000 sticks) |
| Total over 12 years | 37,123 lb 12,585 kg | 436,111 lb 147,842 kg | 47,436 lb 16,080 kg + 6 <i>miglia</i> + 6,000 sticks |

Notes: Kilogram totals may not be exact because of rounding. Purchased on: ¹ 20 November; ² 12 June and 31 August; ³ 25 April and 28 November; ⁴ between 4 January to 30 October (three intermediary purchases, in April, June, September).

chomperata a *denari contanti* da Moise ebreo; a lui *avere in questo* c.4. F. X s. XVI d. I 392 E a di detto F. uno s. IIII° a *oro larghi per lib.* 392 da Agnolo di Giovanni da Chastiglione; a lui *avere in questo* c.5. F. I s. IIII° 1187 E a di detto F. quattro s. III d. II a *oro larghi per lib.* 1 187 da Nardo di Francesco detto Hocha; a lui *avere in questo* c.5 F. IIII° s. III d. II 290 E a di detto f. uno s. VIII a *oro larghi per lib.* 290 da Salvi di Salvestro da Santa †; a lui *avere in questo* c.5 F. I s. VIII

[3518⁴ Sawwort for our account has to give, on day 20th of November 1483, ten florins *a oro larghi*, 16 *soldi*, 1 *denaro*, for 61 L. 12 s. of *Piccioli*,⁵ for 3,518 pounds, bought in cash

from Moise, Hebrew; to him to have in this book at folio 4: F. X s. XVI d. I. 392 And on the same day one florin *a oro larghi*, 4 *soldi*, for 392 pounds, from Agnolo di Giovanni, from Castiglione; to him to have in this book at folio 5: F. I s. IIII. 1187 And on the same day four florins, 3 *soldi*, 2 *denari a oro larghi* for 1,187 pounds from Nardo di Francesco, called Hocha; to him to have in this book at folio 5: F. IIII° s. III d. II 290 And on the same day one florin *a oro larghi*, 8 *soldi*, for 290 pounds, from Salvi di Salvestro, from Santa Croce; to him to have in this book at folio 5: F. I s. VIII]

Entries in the three books allow the reader to follow the consumption of sawwort by the company from

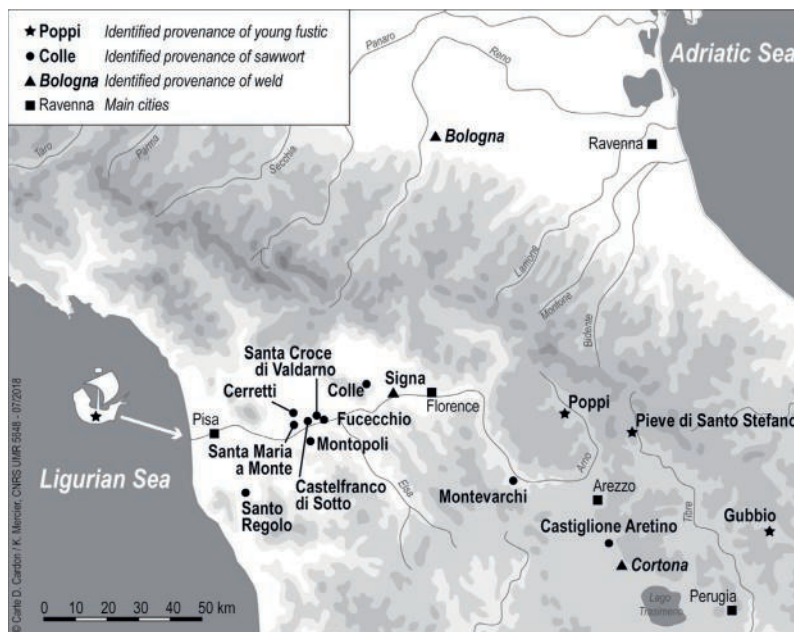


Figure 7 Provenances of sawwort, weld and young fustic in the three account books of the dyeing company Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore in Florence (1483–1498). (Map © Dominique Cardon and Karyn Mercier, CIHAM/UMR5648 CNRS)

the second half of November 1483 to mid-September 1490 (Table 1, second column from left).

Over the years, 28 providers from 10 different villages or small towns (Fig. 7) supplied the company with sawwort loads ranging in weight from 180 pounds (61 kg) to 5,000 pounds (1,695 kg).⁶ Some suppliers appear only once in the records; others brought two or three loads of sawwort during the same year but do not reappear later; while some were the only providers from their village, coming back for two or three years, bringing their yearly crop of sawwort all at once or in two or three deliveries. None of the villages, however, provided loads of sawwort regularly every year for the whole period. And no mention of sawwort is to be found after September 1490. Explanations for this are proposed below in connection with a comparison between the company's purchases of sawwort and those of weld.

The quantities purchased every year seem impressive at first sight, especially considering that the average weight of a plant of sawwort when dried is about 13.5 g. In 1487, for example, approximately 198,670 plants were collected to obtain the roughly

2,680 kg of dry sawwort bought by Francesco Salviati. The total weight of sawwort purchased between 1483 and 1490 represents approximately 932,200 plants.

In contrast to the details of dyestuff purchases, no information is provided in the Salviati account books on the colours for which sawwort was used or on how much textile would have been dyed with such large quantities of the dyestuff. To answer these questions, quantitative data given above have to be related to other sources, namely two tariffs of the Florentine wool dyers, dated 1428 and 1463. The former sets the price paid to have a fine wool broadcloth dyed green 'with 80 pounds of sawwort' (*Panno verde fine con 80 lbr. di Cerretta, L. 6 s. 10'*). The 1463 tariff mentions a wider range of colours for which sawwort was used, and that the price had increased, but the quantity of sawwort remains the same: *Pani Verdi, tanè, gialli, fiordilino e fiordipescho o ranci con 8 lbr. d'allume pro panno e 80 lbr. d'erba ceriecte, L. 7 s. 15'* ('To dye broadcloth green, tan, yellow, flax-flower, peach-flower or orange, with 8 pounds of alum and 80 pounds of sawwort per piece, L. 7 s. 15').⁷ If 80 pounds was the standard



Figure 8 Field of weld (*Reseda luteola* L.) in Charente-Maritime (West France) at the beginning of the 21st century, (Photo © Couleurs de Plantes, Rochefort, published by permission of Anne de la Sayette)

weight of sawwort used to dye a good quality cloth, the total amount purchased by Francesco Salviati's company would have allowed 464 cloth pieces to be dyed one of the colours listed.

Guilicie

One entry, on the same page of the *Libro azzurro* as the records of purchases of sawwort transcribed above, mentions purchases of a different yellow dye plant, *guilicie*, during the first two weeks of August 1485:

148 E a dì 12 d'aghosto 1485 F. due s. XI d. VIII a oro larghi per L. 14 s. 19 d. 4 piccioli per lib. 148 di ghuilicie chonperata da più persone de dì 2 di questo a dì 13 di detto; a uscita c. 40, a conto di chassa in questo, c.65. F. II s. XI d. VIII

[148 And on the 12th of august 1485, two florins a oro larghi, 11 soldi, 8 denari, for 148 pounds of *guilicie* bought from several different persons from the 2nd of this month to the 13th; put on the *uscita* book c. 40, on the cash account in this book c. 65. F. 2 s. 11 d. 8]

The total quantity is not very large, only about 50.2 kg; the price though is much higher – about three times more expensive than the average price

of sawwort that year. The inclusion of this record among the purchases of sawwort suggests that *guilicie* was obtained in much the same way as sawwort, i.e. collected in its natural habitats, and had the same uses. The botanical identity of the plant, also mentioned as *erba quilitia* and *guilitia* in other historical sources connected with dyeing, has not been clarified since the first paper on the topic of 'yellow dyes of historical importance' which discussed this issue extensively.⁸ The three Salviati books unfortunately do not help in this respect because this unique entry concerning the plant does not mention providers' names or from where they came.

Weld

Gualda or *erba gualda* (weld, *Reseda luteola* L.) (Fig. 8) is a tall biennial herb; to obtain reliable crops, therefore, it needs sowing and cultivation. *Gualda* is frequently mentioned in the three books, from the beginning of 1484 until the end of 1495. The huge quantities purchased show convincingly that it was by far the main yellow dyestuff used in Francesco Salviati's dye-works (Table 1, third column from left).

Weld arrived as whole cartloads of bales of dry plants weighing 207 pounds (70 kg) on average. The company obtained its weld from four places but it actually came from only three centres of production (see Fig. 7). The largest and most regular providers were located in Cortona, which appears to have been a major production centre. From 1485 to 1495, Francesco di Vangelista and Company, the most important of the weld suppliers, sent the dyestuff to Francesco Salviati's company in Florence nearly every month (Fig. 9). The total yearly amounts varied from 2,790 pounds (945 kg) in 1485 to 33,136 pounds (11,230 kg) in 1490. The total quantity of weld purchased during that period from Cortona amounted to 247,519 pounds (83,910 kg). Cortona also appears in the three Salviati books as a principal centre of production for madder, huge quantities of which were bought by the company. Although only 57 out of 225 entries concerning purchases of madder mention its provenance, half the madder bought from that group came from two companies based in Cortona.

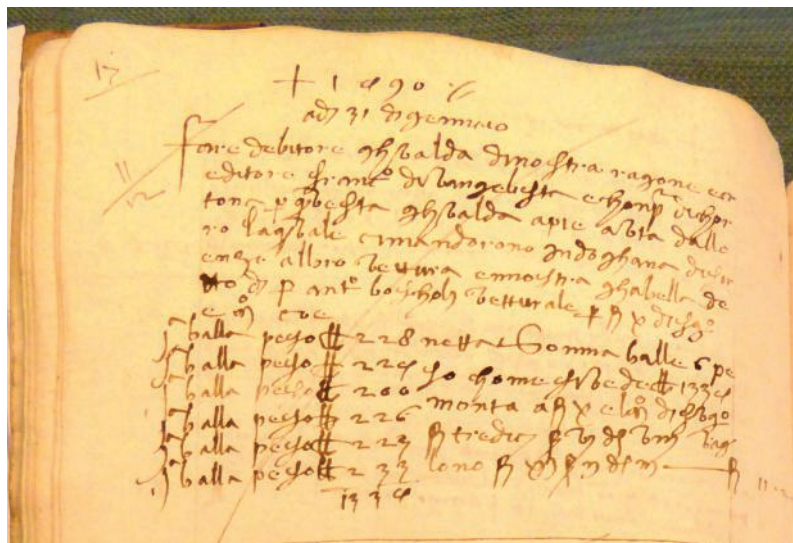


Figure 9 Record of an important purchase of 1,334 pounds (452.893 kg) of weld, *ghualda*, from Cortona, on 31 January 1490. The seller, Francesco di Vangelista, is one of the main providers of dye to Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore. The dry weld arrived packed in six bales weighing from 68 to almost 77 kg each. Folio 17v of the *Giornale*, Reg. 396 in the Salviati Archive. (Photo: Dominique Cardon © Archivio Salviati presso Scuola Normale Superiore, *Giornale*, Reg. 396)

Weld was also purchased from suppliers based in Prato and Vernia, near Florence. In Prato, one family provided a total amount of 21,246 pounds (7,200 kg) of weld over the entire period 1484–1495. During the same time, one single provider in Vernia sold a total quantity of 10,657 pounds (3,610 kg) of weld to the company. In both cases, however, records clearly show that this weld, called '*erba bolognese*' or '*gualda bolognese*', actually came from Bologna. Altogether, the purchases of weld from Bologna amounted to 31,903 pounds (10,815 kg). The last provenance mentioned, Signa, also near Florence, appears to have been a centre of production albeit of lesser importance than Cortona and Bologna. Three providers (producers?) from Signa sold a total of 14,125 pounds (4,790 kg) of weld to the company in 1484, and then again in 1487 and 1488. An account book from the dye company of Raffaello di Francesco de' Medici, dated 1502, also mentions weld from Signa ('*erba signesa*'), which confirms that this city was a centre of production.⁹

Weld is not mentioned in the tariffs of the Florentine wool dyers of 1428 and 1463; these

sources mention only sawwort as the dyestuff to be used for yellows and greens. But an earlier tariff of July 1375 indicates that to dye *tintillani* broadcloths green, 100 pounds of 'herb' must be used ('*Viridi cum 100 lbr. Erbe*').¹⁰ A parallel to this recipe appeared later in the *Plictho* of Gioanventura Rosetti, which contains a recipe 'To dye yellow' with '*lire 100 de herba gualda*'.¹¹ Both sawwort and weld are occasionally called 'herb' in the context of yellow and green dyeing: '*erba gualda*' or '*erba cieretta*'.¹² Assuming that the 'herb' mentioned in the tariff of the Florentine wool dyers of 1375 is meant to designate weld and that 100 pounds is adequate to dye a piece of cloth yellow, or green on a blue ground, the total amount purchased by the company would have allowed approximately 4,360 cloth pieces to be dyed yellow or green.

Weld versus sawwort

No weld purchase is recorded for 1483. In the seven-year period from 1484 to 1490, during which both plants were bought and presumably used, the

Table 2 Average prices of yellow dye plants purchased by Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore in denari for 100 pounds.

| Year | Sawwort | Weld | Young fustic |
|-------|---------|------|--------------|
| 1483 | 78 | – | 235 |
| 1484 | 163 | 169 | 167 |
| 1485* | 200 | 377 | – |
| 1486 | 83 | 341 | 165 |
| 1487 | 97 | 186 | 257 |
| 1488 | 141 | 234 | 259 |
| 1489 | 131 | 241 | 263 |
| 1490 | 100 | 236 | – |
| 1491 | – | 225 | 197 |
| 1492 | – | 232 | 118 |
| 1493 | – | 213 | 200 |
| 1494 | – | 203 | – |
| 1495 | – | 200 | – |

* In 1485, *guilicie* was purchased once at a price that would amount to 419 denari for 100 pounds. This is the only time that *guilicie* was recorded as a separate purchase. The other two occurrences mention *guilicie* bought together with sawwort.



Figure 10 Yellow and green wool broadcloth dyed with weld (*left*) or with sawwort (*right*) placed on a sample of the light blue cloth used for the two greens. Blue wool broadcloth had been dyed in a woad vat by the late John Edmonds, following a Florentine recipe dated 1418. (Photo © Dominique Cardon)

company purchased about 10,760 kg of sawwort and 77,100 kg of weld; sawwort provided 12.2% and weld 87.8% of the total. The average consumption per year can be calculated as approximately 1,535 kg of sawwort and 11,015 kg of weld. Sawwort is no longer mentioned in the books after the end of 1490, but the increase in the purchases of weld the following year, 1491, more than compensated for the lack of sawwort: about 2,785 kg more weld was bought than during the previous year. Why was weld used to a much greater extent than sawwort? The reason is definitely not economic as weld was always more expensive than sawwort and most of the time, significantly so (Table 2).

These data make it obvious that Francesco Salviati had at least one good reason to use sawwort, namely that its cost was much lower than that of weld as a source of yellow and green dyes. Incidentally, this implies that the villagers who collected the plants in their natural habitats (probably mostly women and children) were very poorly paid. The fact that sawwort disappeared from the Salviati books after 1490 is therefore puzzling. Could it indicate that the resource was being exhausted or at least becoming less easily available? Concrete support for this hypothesis – such as company records indicating whether the habitats had been over-exploited and then recovered after the 5–8 years during which sawwort was not listed in the book entries, or if the earlier resources were tapped again at a later date – is absent. A suggestion that this was actually what happened is provided by the account books of a later Florentine dye company, that of Raffaello de' Medici, which record that he bought sawwort on several occasions. Indeed, it was the very first raw material purchased by the firm on 20 May 1502.¹³

Following the same line of thought, if weld, although more expensive, was used in quantities so much larger than sawwort, it was highly likely that it was a more reliable resource, potentially available in any required amount. Recent agronomic research has shown that yields of dry plant per hectare can be in the order of 5,000 kg.¹⁴ Cultivation ensured that weld could be easily collected and delivered in big consignments whenever needed. Another explanation for the disappearance of sawwort from the later Salviati registers, therefore, may simply be that the development of weld cultivation made collecting sawwort from many different locations unnecessarily cumbersome. Ready availability of weld did not make it significantly cheaper, however.

Yellows and greens from sawwort and weld: chromatic characteristics

In addition to the practical issues of sourcing and logistics, other explanations for the choices between the two plants must not be excluded. One possibility to consider is that they may have been related to the chromatic characteristics of the yellow and green colours obtained by dyeing with the two plants.

Table 3 Chromatic characteristics of yellow and green dyes from weld and sawwort.

| Colour and dye source | L* | a* | b* | C | h° |
|--|-------|-------|-------|-------|--------|
| Yellow of weld | 66.56 | 0.81 | 70.09 | 70.09 | 89.34 |
| Yellow of sawwort | 67.77 | 1.84 | 75.47 | 75.49 | 88.60 |
| Green of weld on light blue from the woad vat | 48.67 | -9.0 | 48.32 | 49.15 | 100.55 |
| Green of sawwort on light blue from the woad vat | 49.08 | -9.18 | 51.51 | 52.32 | 100.11 |

To check this hypothesis, samples of the same type of wool broadcloth – some undyed and others already dyed a light blue in a woad vat by following a medieval recipe¹⁵ – were washed and mordanted with 16% alum and 1% crude tartar. Half of these samples were dyed with sawwort and the other half with weld in dye baths prepared with weights of dry plant equal to the weights of dry textile to be dyed. The heating of mordant and dye baths and the treatment of the samples of broadcloth in them were conducted under strictly identical conditions for each of the two yellow dyes.

After being washed and allowed to dry in the shade, the samples (Fig. 10) were measured in order to obtain chromaticity coordinates. These data are expressed according to two complementary systems proposed by the Commission Internationale de l'Éclairage (CIE, or International Commission on Illumination): CIE $L^*a^*b^*$, and CIE $L^*C^*h^*$. The measurements were performed with a Datacolor microflash colorimeter. Reflectances of the samples were measured between 400 and 710 nm (at 10 nm intervals), using diffuse illumination geometry and a 45°/0° measuring head; specular reflectance was excluded. The colorimetric data corresponding to the CIELab and CIELCh systems were obtained for a CIE 10° standard observer and standard illuminant D65, which corresponds to daylight and is commonly used for textiles. The measured surface area was 59 mm² (8.7 mm diameter aperture). Each sample was measured at three different locations. The values presented here (Table 3) are average values calculated from the data obtained by the three measurements.

In the CIELab and CIELCh systems, colour is defined by three co-ordinates:

- Lightness or L^* on the axis of greys (from black, corresponding to $L^* = 0$, to white, corresponding to $L^* = 100$)

- On the a^* axis, green (negative values of a^*) is opposed to red (positive values of a^*)
- Along the b^* axis, blue (negative values of b^*) is opposed to yellow (positive values of b^*)

The same system can be expressed in terms of lightness, chromaticity, C^* and hue angle, h :

- Lightness is as described above
- C^* describes the chromaticity or colourfulness, based on a given level on the axis of greys ($C^* = 0 =$ no saturation; $C^* = 100 =$ maximum saturation)
- h° defines hue angle or colour around a circle ($0^\circ =$ magenta red; $90^\circ =$ yellow; $180^\circ =$ green; $270^\circ =$ blue; $359^\circ =$ nearly magenta red)

Table 3 shows that the broadcloth dyed yellow with sawwort is slightly lighter and redder than the yellow obtained with weld; it is somewhat more yellow and more saturated. Considering hue, the yellow dyed with weld is an almost perfect yellow, while the yellow of sawwort is very slightly orange. The greens obtained with the two dyestuffs are very similar. The sawwort green is very slightly lighter, greener and more yellow; it is more saturated, but the hues of the two greens are nearly identical. Both greens are very yellow greens.

The somewhat superior yellowness and colourfulness of sawwort, as evidenced by these measurements, could explain why the tariffs of the Florentine wool dyers of 1428 and 1463 mentioned that 80 pounds of sawwort were used to dye a piece of fine wool broadcloth green, while 100 pounds appears to have been the standard weight for dyeing cloth green with weld. These quantities probably corresponded to proportions of dyestuff with respect to the weight of broadcloth to be dyed that were less significant than in our experiments described above, where the yellow dye baths may also have been too concentrated.

Young fustic

Scotano (young fustic, *Cotinus coggygria* L.) is a small deciduous tree or shrub, the heartwood and branches of which are used for dyeing. Like sawwort, it was collected in its natural habitats. It was purchased by Francesco Salviati's company almost every year, most often in smaller quantities than weld. It came in bundles (*fasci*) of branches or thin trunks, counted in *miglia* (1,000 sticks) or measured by weight (Table 1, fourth column from left).

It could be bought in two forms: '*sodo*' (whole sticks) or '*tagliato*' (rasped). Names of various regular employees of the company are mentioned in the books in connection with the rasping (*tagliatura*) of young fustic. Young fustic was purchased both from providers in hilly areas along the Apennine range where the tree is abundant (see Fig. 7), and from other dye companies and Florentine producers of silk textiles (*setaioli*), who used a lot of young fustic for dyeing silk. One big consignment of 73 bundles and one load (*fardello*) of unrasped young fustic with a total weight of 16,562 pounds (5,615 kg), which was registered as 16,550 pounds (5,610 kg) in Francesco Salviati's account book, was obtained in 1493 from the company of Alamanno and Iacopo Salviati through the Salviati branch in Pisa. It was most probably imported by ship from Provence, a region frequently mentioned in medieval merchants' books in connection with young fustic; *scotano provenzalesco* is listed among the commodities sold by the hundred (*centinaio*) in Pisa in Francesco Balducci Pegolotti's *Pratica della mercatura*.¹⁶

Like sawwort, young fustic was cited as a source of yellow colorants in the tariff of Florentine wool dyers of 1428, but it appeared in connection with a range of colours that are quite different from the yellows and greens of sawwort and weld. Combined with a little madder (10 pounds or 3.39 kg), 60 pounds (20.3 kg) of young fustic were required to dye a piece of fine broadcloth *garofanato* (carnation colour[?]), *tanè* (tan colour) or *rancio* (orange).¹⁷ The Archivio Datini in Prato holds records of actual dyeing processes for broadcloth, some of which are dated 1396 and document the use of young fustic for still more shades: *dorè* (golden), which requires 25.5 pounds (8.64 kg) of young fustic per cloth piece; *pelo di leone* (lion's coat), which requires 27 pounds (9.15 kg) per piece

of cloth previously dyed Turkish blue (*turchino*) in the woad vat; and *cotognino* (quince colour), which requires 23 pounds (7.8 kg) per piece of cloth previously dyed *alazato* blue in the woad vat.¹⁸ On the basis of these data, the total amount of young fustic purchased by Francesco Salviati's company could have been used to dye from 790 up to 2,060 cloth pieces, depending on the colours produced.

Conclusion

The significance of the quantitative data obtained through the careful deciphering of the three books from the dye company of Francesco di Giuliano Salviati e Comp., tintori d'Arte Maggiore is easier to understand when the numbers are arranged in the two comparative tables. This provides immediate recognition of the importance of the different sources of yellow dyestuffs used by the company. The quantities recorded in Table 1 are impressive, especially when taking into account the fact that Francesco Salviati's dye company was neither the only nor the most important one in Florence at the time; in the three books, at least 30 other dyers then trading in Florence are listed.

The precise data provided by these three books give an astonishing insight into the huge requirements for dyestuffs that accompanied the massive development of wool broadcloth production in many parts of Europe during the later Middle Ages. The parallel development of the cultivation of the most important dye plants – woad for all shades of blue and blue grounds, madder for all colours needing some red – has so far been studied to a much greater extent than the sourcing of yellow dyes. The three Salviati books reveal that the provenances and consumption of yellow dyestuffs can, and should, also be used as indicators of the development of textile production. In this case, the huge quantities of yellow dyes bought by Francesco Salviati between 1483 and 1495 provide new evidence to confirm the significant rise in Florentine broadcloth production which, Hidetoshi Hoshino has argued, took place in the second half of the 15th century, in contrast to Alfred Doren's vision of the '*decadenza*' of this industry during that period.¹⁹ Hoshino attributed this new development largely to the conquest of the large markets of the Ottoman Empire by Florentine merchants.

The increased need for yellow dyes, necessary to produce greens on various blue grounds, supports this view. The demand was most likely due to the popularity of the various shades of green among the predominantly Muslim populations of the Ottoman Empire, for whom green is the colour preferred by the Prophet Muhammad. An illustration of this has been provided by Ingrid Houssaye Michienzi's recent study of three account books written between 1491 and 1493 in Ottoman Constantinople by Giovanni di Marco Salviati, a distant cousin of Francesco, who imported large quantities of cloth pieces from Florence. Their colour was not always mentioned but, out of 261 pieces for which it was described, 35% were different shades of green, 2 pieces (0.8%) were lemon yellow (*limon*), and 6 more were dyed colours typically obtained with young fustic, *tanè* and tawny (*lionati*).²⁰ Francesco apparently chose to cater to this target market and specialise in green dyeing; of 721 records of dyeings of wool broadcloth that mention the colour produced, more than 85% were various shades of green.

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