

Article

# Technology of Dyeing beyond Text

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**Abstract:** A major source in the research on Baltic cultural history (Latvia, Estonia), including studies dedicated to the clothing of local inhabitants, are the drawings and descriptions of Johann Christoph Brotze (1742–1823), which date back to the turn of the 18th and 19th centuries. They contain references to dyes and dyeing methods used by local peasants. The information recorded by J. C. Brotze, although fragmentary, is valuable because researchers lack documentary sources about the dyeing methods used in the 18th century in the territory of present-day Latvia. Additional research yields more extensive information about the contents of the descriptions. The current article will describe the experimental method that enabled the establishment of the specific dyeing technique, which, using *Bixa orellana* L., was employed to obtain the particular orange color referred to in the descriptions.

**Keywords:** natural dyes; *Bixa orellana* L.; J. C. Brotze; traditional clothing; Vidzeme region of Latvia

## 1. Introduction

A major source in the research on the Baltic history of culture (Latvia, Estonia), including the studies dedicated to clothing of the local inhabitants, are the drawings and descriptions of Johann Christoph Brotze (1742–1823), which date back to the turn of the 18th and 19th centuries. They contain some references to dyes and dyeing methods used by the local peasants. The information recorded by J. C. Brotze, although fragmentary, is valuable, because researchers lack documentary sources about the past dyeing methods used in the 18th century in the territory of present-day Latvia. Additional research provides more extensive information about the contents of the descriptions. The information found in J. C. Brotze's collection constitutes the basis of the current article; hence, an insight must be provided into the background of J. C. Brotze and the origins of the manuscript he left to posterity. Brotze was born in Görlitz, Saxony. His ancestors came from the territory of contemporary Czech Republic, the religious community of the Moravian Brethren, although Brotze himself did not belong to it. Although his family was impoverished, Johann Christoph Brotze earned a living as a technical draftsman and acquired his education at the Görlitz Gymnasium and at the Universities of Leipzig and Wittenberg [1] (pp. 8–10). In 1768, he moved to Riga, which at that time was a part of the Livonian Governorate of the Russian Empire, and started working as a tutor in the Baltic German family Von Vegesack. However, a year later, he became a teacher at the Riga Imperial Lyceum and worked there as a pedagogue for 46 years, and in 1801 he became the rector of this lyceum [1] (p. 10). At the same time, he learned the Latvian language of the local peasants and was a keen cultural historian and researcher of the Baltic region. Brotze's own testimony that he studied "the language of this land [i.e., Latvian]" [1] (p. 10) is essential, because it affirms that the author could have obtained the information contained in the comments to the drawings directly from the local peasants, thus increasing the historical reliability of this material. Brotze's digitally available biography states: "Brotze belongs to the so-called school of polymaths—Renaissance men of the late humanist movement and considered the collection and processing of historical sources to be his main task. Brotze collected historical materials, drew everything that he considered to be important: people, buildings, coins, coats of arms, city plans, technical innovations, etc., moreover, recorded everything with great precision



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and always added written explanations to the drawings, which sometimes comprised a few lines, but occasionally took up several pages" [2]. J. C. Brotze died in 1823 and was laid to rest in Riga [1] (p. 27).

He left an immense amount of material, which consists of written messages, drawings and redrawings, including coats of arms and plans. The vast heritage includes the collection of cultural-historical drawings and descriptions in 10 volumes, "Sammlung verschiedener Liefländischer Monumente, Prospecte, Münzen, Wappen etc.". The author collected materials for these volumes between 1770 and 1818, both in Riga and during his travels in the Baltic provinces of the then Russian Empire (the territory of present-day Latvia and Estonia) [3].

Among other things, the aforementioned descriptions contain references to natural dyes and mordants that local peasants used to dye their clothes. This information had not attracted the attention of previous generations of researchers. Likewise, it must be noted that Brotze repeatedly depicted yellow/orange aprons as part of peasant clothing, although such apparel is not present in museum holdings.

The purpose of this paper is to collect the evidence left by Brotze concerning the aforesaid aprons and the dye used to obtain their orange color, and to test the reliability of these records against other written sources. To obtain further information about the dyeing technique, dyeing experiments were used to obtain the tangerine-orange color indicated in the description. Practical dyeing experiments, using *Bixa orellana* L., and their results constitute an essential part of the study. They were carried out to ascertain the reliability of Brotze's records, as well as to establish the dyeing technology used. The results of the research yield more substantial knowledge about the circulation of information (the combined use of modern (new) and traditional information) in the social class of peasants, who formed the largest part of society in the Baltics during the researched period.

## 2. Materials and Methods

The research is based on an interdisciplinary approach, combining the research methods of the humanities and natural sciences. Analyzing the information provided by the written sources and illustrations created by contemporaries about peasant clothing in the territory of present-day Latvia in the late 18th and early 19th century, it is possible to obtain new information in the research on the history of traditional clothing. Drawings of clothing from previous centuries, created by eyewitnesses, and the texts explaining these drawings are a particularly valuable source of knowledge in the history of clothing for a period from which relatively few, if any, practical objects survive. Along with information about the history of clothing, these texts contain evidence of using natural dyes for dyeing textiles. Practical dyeing experiments carried out by the author were also used to prepare the article.

### 2.1. Published Written and Iconographic Sources

Very little is known about the history of clothing in Latvia in the 18th century. Since only some pieces of traditional clothing from this period have reached the holdings of the museums (moreover, the dating of these specimens is usually determined quite approximately), the research uses mainly descriptions and drawings, which, unfortunately, provide only fragmentary, mosaic-like evidence of the development of the historical clothing worn by Latvian peasants. An essential source of the article is Johan Christoph Brotze's collection of drawings and their descriptions, "Sammlung verschiedener Liefländischer Monumente, Prospecte, Münzen, Wappen etc.", created at the end of the 18th century and the beginning of the 19th century. The manuscript is stored in the UL Academic Library and is also available electronically [2]. The part of this collection that refers to the territory of Latvia, together with scientific comments, was published in four volumes between 1992 and 2007 [4–7]. The texts explaining the drawings are published in the German language corresponding to the original, accompanied by the translation into Latvian.

To obtain a broader historical picture, as well as to evaluate the degree of reliability of the descriptions of the drawings, the information provided by Brotze was compared with

the testimonies found in other written sources about the cultural and historical evidence, which are of interest on this occasion: yellow women's aprons and a plant used for dyeing with the German name 'Orlean'.

The written sources used in the study, along with the descriptions of J. C. Brotze's drawings, also include the late 18th and early 19th century periodicals in Latvian and German languages. Since the periodicals in the German language in the territory of Latvia appeared earlier than those in the Latvian language, the German press of Riga contains valuable information about the goods imported into the Baltic provinces of the Russian Empire at the end of the 18th and the beginning of the 19th century, and the activities of merchants in Riga. For the current article, the periodicals "Rigische Anzeigen" [8–12], "Rigasche Zeitung" [13–16], "Rigasche Stadtblätter" [17–19], and others [20,21] have been used.

## 2.2. Unpublished Written Sources

The set of written sources created in the 20th century comprises the ethnographic expedition materials of the Monuments Board, stored in the collection of the National History Museum of Latvia (NHML). They consist of questionnaire-type ethnographic object description pages, as well as free-form written information. This article mainly draws upon the information about dyeing with plant-based dyes, which can be found in the section "Dyeing, washing, bleaching" (LNV M ZAE folder 47) [22] and "Female folk dress" (ibid., folder 35) [23]. The materials of the ethnographic expeditions were used to gain a broader insight into the dyeing methods used by the peasants. A study published in Riga in 1935 and dedicated to ancient Latvian dyeing methods was also used for this purpose [24].

## 3. Results

### 3.1. Records Concerning Yellow/Orange Aprons

J. C. Brotze drew yellow aprons and provided written information about them with reference to various places in Vidzeme. Dark yellow or orange-yellow aprons can be observed in a drawing that may have been made around 1794: "Clothing in the manors of Gaujiena and Trapene" (Figure 1). The color of these aprons is noted in the description of the drawing: "Die Weiber tragen alltägl[ich]einen schwarzen Rock, Orangefarbne Schürze, und hellgraues Leibchen mit langen Schößen, deßen Nätthe und Ränder öfters mit bunten Schnüren oder bunter Wolle brodirt sind"—"Women commonly wear a black skirt, an orange apron and a light grey bodice with long sleeves, the seams and edges of which are often embroidered with colored cords or colored woolen threads" [7] (p. 313). Yellow aprons are worn by three of the five female figures depicted (one is shown with her back to the viewer, while the body of another is concealed behind other figures).

Similar aprons are also shown for the peasant women of the Rūjiena area (Figure 2). In the description of this drawing, J. C. Brotze indicated not only the color of the aprons, but also the dye with which it was obtained: "(...) die Röcke färben siemit Birken-Erlenrinde und Vitriol schwarz, und die Schürzen mit Orlean orangefarben; doch tragen sie auch andere"—"They dye their skirt black with birch and alder bark, and vitriol, and their aprons with Orlean orange, but they also wear other ones" [6] (pp. 436–437). Although the author of the drawings refers to the orange color, the coloring in the drawings appears golden yellow. (Discussing this question in more detail would be the topic of another study, which would analyze historical names of colors).

In a very small drawing of a female figure in the foreground of the view of Jeru Manor in 1800, an orange-yellow apron can also be seen (Figure 3). Here, the artist focused on the landscape and did not comment on the outfit of the depicted figure [6] (pp. 432–433).



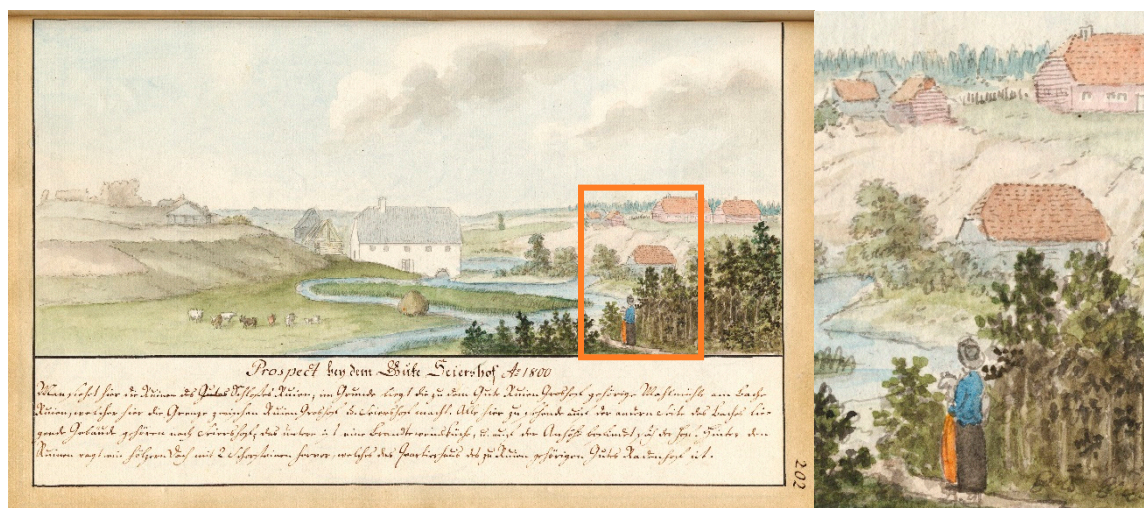


**Figure 1.** Clothing in the manors of Gaujiena and Trapene, [2] bm06005a ([https://www.acadlib.lu.lv/broce/lielbildes/sejums\\_nr6/bm06005am.htm](https://www.acadlib.lu.lv/broce/lielbildes/sejums_nr6/bm06005am.htm) (accessed on 4 March 2024)).



**Figure 2.** The peasants of the Rujiena area, [2] bm08008a ([https://www.acadlib.lu.lv/broce/lielbildes/sejums\\_nr8/bm08008am.htm](https://www.acadlib.lu.lv/broce/lielbildes/sejums_nr8/bm08008am.htm) (accessed on 4 March 2024)).





**Figure 3.** View of Jeru manor, [2] bm08202a ([https://www.acadlib.lu.lv/broce/lielbildes/sejums\\_nr8/bm08202am.htm](https://www.acadlib.lu.lv/broce/lielbildes/sejums_nr8/bm08202am.htm) (accessed on 4 March 2024)).

These drawings by J. C. Brotze and their descriptions convey that at the end of the 18th century, in various parts of Vidzeme, Latvian peasant women wore yellow aprons of a rather intense color in addition to aprons of other colors. The article will explore and ascertain the dyestuff used to obtain the orange color, which has not been noted in other sources (regarding the territory of Latvia) until now.

### 3.2. Orlean

The evidence left by J. C. Brotze about clothing in late 18th century, in addition to drawing attention to the color of the aprons, which has not been noted in other publications, also indicates the dyestuff used for its production: orlean, or in English—annatto, which is obtained from the seeds of the shrub *Bixa orellana* L. [25,26]. It is also used as a dye for violins and other stringed instruments [27]. However, it is much more widely used as a food coloring (E 160b) and flavoring [28,29] (Annatto, Bixin, Norbixin (E 160b) is authorized as a food additive in the European Union (EU) in accordance with Annex II to Regulation (EC) No. 1333/2008 on food additives, and specific purity criteria have been defined in the Commission Regulation (EU) No. 231/2012). It is still occasionally used for textile dyeing, as evidenced by some dyers' blog posts on the internet, such as Franklin's post on 3 October 2015 [30].

In the 1930s the ethnographer Ādolfs Karnups translated the text written by J. C. Brotze in German, “die Röcke färben sie mit Birken-Erlenrinde und Vitriol schwarz, und die Schürzen mit Orlean orangefarben” [6] (pp. 436–437), slightly differently from the contemporary version: “They dye their skirts black with birch and alder bark, and vitriol, and their aprons—in orange of Orléans” [31]. Here, the word ‘Orlean’ is interpreted as signifying a place name (Orléans—a city in France). Unfortunately, Ā. Karnups had not additionally considered the content of this quote and provided no further comments.

Seeking a more accurate translation of the word ‘orlean’, the 18th-century Riga German press yielded a confirmation that it was used at that time to denote a dye, not a place name. The word ‘orlean’ emerges from 1785 to 1846 in merchants’ advertisements together with other textile dyeing substances (German: Farben) [8–21]. The term ‘Farben’ as a designation of a substance which is a part of a specific group was used at that time only for substances used for dyeing textiles. If annatto was initially specified as belonging to dyes (Farben), then in the second half of the 19th century, it emerges in association with foreign spices, which indicates its use in cooking.

The customs list of imported goods of the Russian Empire dating back to the 1830s and 1840s show that orlean (annatto) was a medium-cost product. Its import duty was half that of the very widely used indigo, which was required to obtain the dark blue color.

Comparatively much more expensive was cochineal, which was used to produce a bright red or pink color. However, the common madder or dyer's madder (*Rubia tinctorum* L.), another source of the red color, was half the price of annatto. Thus, for example, in 1831, an import duty of 1 ruble had to be paid for one pound of annatto, 2 rubles for indigo, 10 rubles for cochineal, and only 50 kopecks for dyer's madder [14].

The lists of imported goods from the beginning of the 19th century also reveal the quantities of dyestuff brought into the region: in 1809, 14,189 ½ pounds of annatto, 4642 pounds of cochineal, and 50,630 ¾ pounds of indigo were imported [17]. However, two years later, in 1811, the amount of annatto imported had almost doubled: 29,403 pounds of this dye were imported. Comparatively, 57,596 ½ pounds of indigo and 5666 ½ pounds of turmeric were also imported that year, also referred to by the descriptive term 'Farben'—dyes [19] (see Table 1).

**Table 1.** The quantity of imported dyestuff in the port of Riga in 1809–1811 \*.

Year	Dyestuff/Farben	Amount (Pounds)	Sources
1809	Cochenille	4642	Specification der im 1809 ten Jahre in Riga eingeführten Waaren. <i>Rigasche Stadtblätter</i> , 1810, 9, p. 3. [17]
	Indigo	50,630 ¾	
	Orlean	14,189 ½	
1810	Cochenille	7456 ½	Specification der im 1810 ten Jahre in Riga eingeführten Waaren. <i>Rigasche Stadtblätter</i> , 1811, 1, p. 8. [18]
	Indigo	11,569 ½	
	Orlean	3105	
	Kurkumma	25,061 ½	
1811	Indigo	57,596 ½	Specification der im 1811 ten Jahre in Riga eingeführten Waaren. <i>Rigasche Stadtblätter</i> , 1812, 4, p. 2. [19]
	Orlean	29,403	
	Kurkumma	5666 ½	

\* The terms denoting dyestuff have been provided in the original transcription of the source document.

The publications found in the press indicate that at the time when J. C. Brotze made the drawings, annatto ('Orlean') was a textile dyestuff well-known in German society, also known by the author of the drawings himself. However, this does not mean that this particular dyestuff was used by the peasants of Vidzeme. Nevertheless, such a possibility cannot be precluded.

### 3.3. Dyeing Experiments

The analyzed written sources indicate that in the late 18th and early 19th century, the peasants of the Vidzeme (Livonia) province of the Russian Empire had the opportunity to purchase and use the imported foreign dye *Bixa orellana* L. for dyeing their clothing. Meanwhile, these written sources do not provide indication as to the applied dyeing method. Although the information on dyeing with *B. orellana* can already be found in the scientific literature [25,26,32], practical dyeing experiments based on local ethnographic material about other plants were carried out to establish which dyeing technique best matched the color tones in the drawings.

#### 3.3.1. Dyeing Experiment I

In the dyeing experiment, dried, crushed seeds of *Bixa orellana* L. were used (Figure 4). The ratio of initial dyestuff (plant) to fiber weight was 1:1.

The ground seeds were soaked in cold water for 12 h. Then, the liquid was slowly heated to boiling point and boiled for 1 h. Then, the dyestuff was strained to separate plant particles, and cooled. The resulting liquid was orange-brown in color (Figure 5).



**Figure 4.** Whole and ground seeds of *Bixa orellana* L. Photo: A. Karlson.











**Figure 5.** Dye solution from *Bixa orellana* L. Photo: A. Karlson.

Both plant (flax and cotton) and animal fiber (wool yarn) were dyed in seed annatto dye solution to test how different materials reacted with this dye.

Linen and cotton threads pre-treated in two different ways were used: (1) boiled without mordant, and (2) mordanted by using alum (8 g  $\text{KAl}(\text{SO}_4)_2$ /100 g fiber). The wool yarn used in the experiment was of two types—unmordanted, and mordanted with alum and cream of tartar (8 g  $\text{KAl}(\text{SO}_4)_2$  + 7 g  $\text{KC}_4\text{H}_5\text{O}_6$ /100 g fiber). The materials prepared for coloring were immersed in the cooled (25–30 °C) dye liquid for several (~3) hours. After that, heating of the dye liquid was started. The solution was heated to 90 degrees, and heating continued at this temperature for 1.5 h. Different materials colored markedly differently (Table 2, the first column of color samples).



**Table 2.** Tones of colors obtained by dyeing with *Bixa orellana* L.

	Dyed in Plain Water with Heating	Modified with Alkaline Solution (Lye)
Wool without mordant		
Wool mordanted with alum		
Linen mordanted with alum		
Cotton mordanted with alum		

Since none of the obtained color tones corresponded to the designation ‘orange’, based on the accumulated dyeing experience, it was decided to try to change the color shade by after-treatment of the fiber with lye—an alkaline solution obtained from wood ash. The dyed, but still wet, samples were rinsed in a warm alkaline solution (55 °C) of pH 10–12. As a result, the color of plant fiber changed from a cream tone to an orangish color, while the color of wool fiber changed from distinctly yellow to a golden yellow-brown color (Table 2, the second column of color samples).

It was found that orlean/annatto dyestuff binds to the fiber without the mediation of the mordant, which corresponds to the information found in the scientific literature [25,28] (p. 193). Respectively, the unmordanted yarn dyed as well or even more intensely than the mordanted one. Furthermore, the unmordanted yarn reacted more actively to the after-treatment of the fiber in an alkaline solution—the obtained color tone was brighter for linen and cotton, as well as wool.

Although initially the dyestuff solution was prepared in a ratio of 1:1 (plants: material to be dyed), during the dyeing process, it became evident that the dyestuff saturation in the liquid was high, and it was possible to dye a larger amount of fiber in it. As a result, two times as much fiber was dyed, with the obtained color tone maintaining a similar intensity. This means that the amount of orlean/annatto required is only half the weight of the fiber to be dyed, which is a relatively small amount.

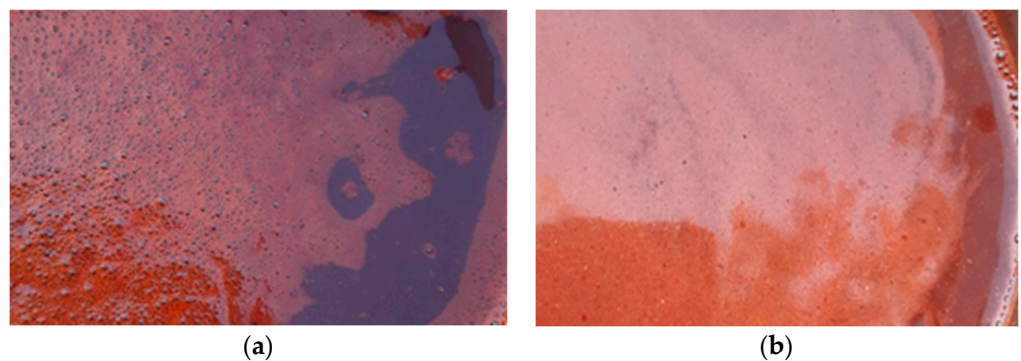
In order to ascertain whether the Latvian peasants were familiar with the method of dyeing with the use of alkaline solution (lye), corresponding recipes were sought in the ethnographic material.

Both the materials collected by the Monuments Board and stored in NHML [33] and the book of Martha Bieleinstein [24] describe dyeing techniques, when plants (*Agrimonia eupatoria* L., *Alnus glutinosa* (L.) Gaertn., *Calluna vulgaris* (L.) Hull, *Juniperus communis* L., *Ledum palustre* L., *Potentilla erecta* (L.) Raeusch., *Prunus avium* L., etc.) are doused with a strong (pH not specified) lye solution and heated in it, thus obtaining a dyestuff solution [24] (pp. 137–139).

In previous dyeing experiments, the author of the article had already used these notes to test them in practice. As a result, it was found that an essential part of the process was left out of the record: the plants mentioned by Martha Bielenstein [24] (pp. 137–139) should not only be heated in the alkaline solution, but also soaked in it beforehand. Depending on the type of plant used to obtain dyestuff, the soaking process can take several days or even a week. This length of time is determined by how quickly the alkaline liquid becomes pH neutral in interaction with the substances present in the plants. This is necessary in order to ensure that the animal fiber (wool yarn) is not damaged during the subsequent dyeing process, which involves heating.

### 3.3.2. Dyeing Experiment II

In order to test the results of the dyeing technique recorded in the ethnographic materials with the imported plant *Bixa orellana* L., a second dyeing experiment was carried out. Only fabrics of plant fiber (linen and cotton) were dyed in it. The ratio of the dyestuff to the weight of the fiber was 2:3 (to ascertain that the obtained color tone would be sufficiently bright). Two parallel dyeing experiments were carried out: (1) by soaking the plant material (seeds of *B. orellana*) producing the dyestuff in water; and (2) by soaking the plant material producing the dyestuff in an alkaline (pH 12) solution. Ground *B. orellana* seeds were soaked for about 3.5 days (87 h), then slowly heated and boiled for 1.5 h. Already during the soaking process, the color of the liquid differed: the alkaline solution was significantly darker (Figure 6). After heating, the color difference was even more pronounced (Figure 7).

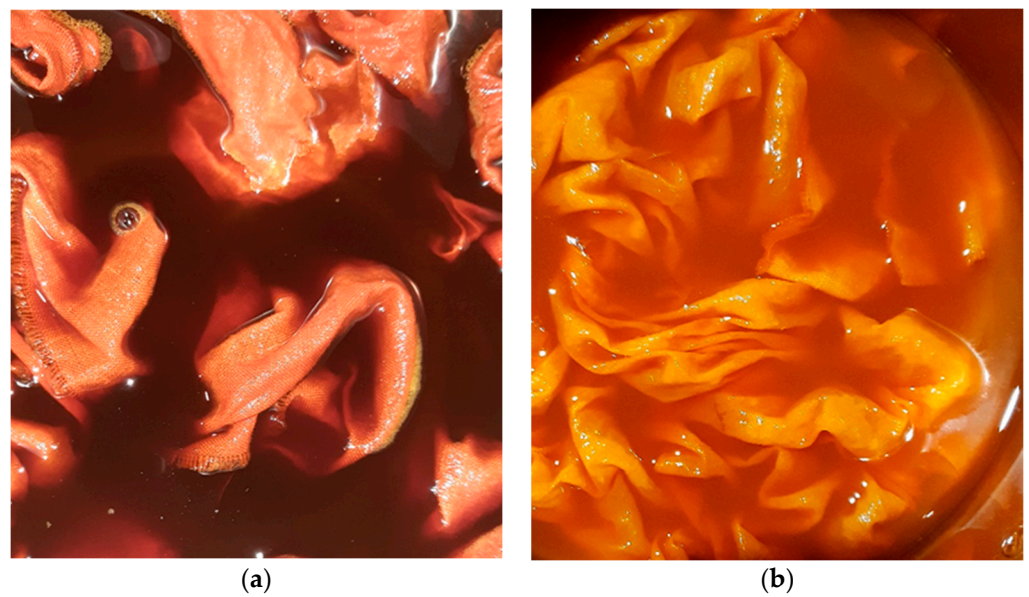


**Figure 6.** The color of the liquid in which ground *Bixa orellana* L. seeds are soaked: (a) in an alkaline solution; (b) in water.

Before dyeing, pieces of linen and cotton fabric were boiled in a liquid with added detergent (1 tablespoon per 6 L of water) to ensure that the fiber was as clean as possible. The clean and wet fabrics were then soaked in the cooled dyestuff solution (Figure 8), and after several hours, the heating was started. As before, the liquid was gradually heated to a boiling temperature, and then the material to be dyed was heated at the boiling temperature for about 1 h. Then, it was left to cool in the dyestuff solution and rinsed (Figure 9). As a result, much brighter and more saturated color tones were obtained than in the first experiment (Figure 10).



**Figure 7.** Dyestuff solutions obtained from *Bixa orellana* L.: (1) on the left—from the plant soaked in lye (alkaline solution); (2) on the right—from the plant soaked in water.



**Figure 8.** Fabrics prepared for dyeing are soaked in a boiled and strained dyestuff solution: (a) liquid prepared with alkali; (b) the liquid prepared in water.





**Figure 9.** Pieces of fabric dyed with *Bixa orellana* L. during the rinsing process.



**Figure 10.** Fabric samples dyed with *Bixa orellana* L. From the left: (1) linen fabric and (2) cotton fabric dyed in a liquid obtained by soaking the plants producing the dyestuff in water. Next: (3) linen fabric and (4) cotton fabric dyed in a liquid obtained by soaking the plants producing the dyestuff in an alkaline solution.

The color obtained with alkali (as the fabric dried, the fiber became about half as light—as is usually the case with textiles of plant origin) is sufficiently specific to be described exactly as the tangerine-orange color mentioned by J. C. Brotze.

Based on in-depth studies of written sources about the tradition of using the plants to produce dyestuff in Latvia [34] and the author's more than 15 years of practical experience in dyeing with nature-derived substances, it can be said that there are no other known plants that would have been used in the territory of Latvia, with which fibers of plant origin could be dyed in this color. This could confirm the hypothesis that orlean/annatto has not only been known as a dyestuff to J. C. Brotze, but could also have been used by Vidzeme peasants to obtain a tangerine-orange colored apron. Moreover, as proved by means of the practical experiment, when dyeing a small piece of clothing, such as an apron, or the amount of yarn required for it, a relatively small amount of plant producing the dyestuff is required. However, it is precisely the fact that money has been paid for this dyestuff that bestows upon a garment dyed in this color the meaning of particular luxury.

#### 4. Conclusions

From the findings presented in this paper, we can conclude that Johann Christoph Brotze mentioned a real dye used for dyeing peasant aprons worn as festive attire. The plant *Bixa orellana* L. indicated as dyestuff was available in the Vidzeme governorate of the Russian Empire, and peasants could buy it because only a small amount of dye was needed for dyeing. Practical experiments further demonstrated that alkali was utilized in the dyeing process in the 18th century. It is highly probable that the plant used as the source of dye was soaked in alkali before dyeing, thereby obtaining a brighter orange color. Moreover, the tone of the linen fabric dyed in the experiments corresponds to the one seen in Brotze's drawings. Additionally, a technology not mentioned in the written source has been uncovered, as illustrated in Figure 11.



**Figure 11.** Reconstruction of clothing according to J.C.Brotze's drawing, apron dyed with *Bixa orellana* L. using the dyeing method described in the article with the use of alkali. Photo: M. Karlsons.

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**Data Availability Statement:** The data used in the article are not confidential or restricted.



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