# Flowers of *Aloe vera* from Medieval manuscripts to Renaissance printed books[1]

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**/ Abstract**

*Aloe vera* is a popular herbal product and its extracts are part of a multi-million-dollar (US) industry. Aloes have been used as a remedy worldwide for centuries. To elucidate the accumulation of knowledge from the Greco-Roman period to the Renaissance, we have sought the earliest surviving illustrations and preserved herbarium specimens of flowering *Aloe*. This search for illustrations of *Aloe vera* in Medieval manuscripts and early printed books up to 1590 shows that most of these sources depict and describe only vegetative material. The first illustration we identified of an unambiguously flowering *Aloe vera* is from an Arabic manuscript dated to the 12th century. The first printed illustration of a flowering plant appeared in 1562 and is based on paintings executed no later than around 1560. The earliest records of flowering *Aloe vera* are provided by Italian herbarium specimens from the period 1539–1554, but *Aloe* was successfully cultivated in Italy (Venice) as early as around 1445–1448, and in Germany (Nürnberg) in 1542.

*L'*Aloe vera *è un prodotto erboristico popolare e i suoi estratti fanno parte di un'industria multimilionaria. Le aloe sono state usate come rimedio in tutto il mondo per secoli. Per esaminare come la conoscenza dell'aloe si sia evoluta dal periodo greco-romano fino al Rinascimento, abbiamo cercato le più antiche illustrazioni esistenti e gli esemplari di* Aloe *in fiore conservati in erbari. Questa ricerca di illustrazioni di* Aloe vera *nei manoscritti medievali e nei libri stampati fino al 1590 mostra che la maggior parte di queste fonti rappresenta e descrive solo materiale vegetativo. La prima illustrazione che abbiamo identificato di un'*Aloe vera *chiaramente in fiore proviene da un manoscritto arabo datato al XII secolo. La prima illustrazione stampata di una pianta in fiore è apparsa nel 1562 ed è basata su dipinti eseguiti non oltre il 1560 circa. Le prime testimonianze di* Aloe vera *in fiore sono fornite da esemplari di erbario italiani del periodo 1539–1554, ma l'*Aloe *era già coltivata con successo in Italia (Venezia) intorno al 1445–1448 e in Germania (Norimberga) nel 1542.*

**/ Keywords**

*Aloe; Illustration; Medieval manuscripts.*

## 1. Introduction

*Aloe vera* (Linné) Burmann fil. (Asphodelaceae) is a popular plant in the contemporary health industry[2] that has been ascribed an impressive array of therapeutic uses throughout the world.[3] From a botanical perspective the genus *Aloe* encompasses 614 species in the most recent taxonomic treatment.[4] *Aloe* species are perennial plants with typically thick, succulent ("fleshy") leaves arranged in a rosette, with inflorescences originating from near the rosette centre. Flowers are diurnal, usually tubular, and often pendent, varying from white and green to yellow, orange, red and purplish. Fruits are three-parted erect capsules with usually dark brown to black flattened seeds. Growth form varies from sessile, little or unbranched rosettes to trees with branched crowns. Many species are popular in horticulture as garden plants in frost-free areas and are grown indoors by succulent plant enthusiasts. Apart from *A. vera*, several other species have been used for a variety of purposes, at least locally.[5] However, a small number of species are toxic due to the presence of hemlock alkaloids.[6]

There are two components of *A. vera* that are of pharmaceutical interest, the "exudate" and the "gel". The exudate is used as laxative/purgative, as already described in the 1st century CE by the Greek pharmacologist Pedanius Dioscorides of Anazarbus: "It loosens the bowel and cleanses the stomach".[7] The compounds responsible for this effect are anthrone-C-glycosides, esp. barbaloin,[8] and this laxative principle was first discovered and experimentally confirmed to be active in 1851/1852. At that time, *Aloe* preparations were part of several national pharmacopeias, and were also widely advocated as "digestive tonic".[9] The "gel", which possibly enhances wound healing, was also described by Dioscorides as "suitable for gluing together wounds".[10]

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[2] Olwen M. Grace, Ronnell R. Klopper, Gideon F. Smith, Neill R. Crouch, Estrela Figueiredo, Nina Rønsted, and Abraham E. van Wyk, "Documented utility and biocultural value of *Aloe* L. (Asphodelaceae): A review", *Economic Botany* 63 (2009): 167–178.

[3] See especially Julia F. Morton, "Folk uses and commercial exploitation of *Aloe* leaf pulp", *Economic Botany* 15 (1961): 311–319.

[4] Len E. Newton, "*Aloe* (Asphodelaceae)", in *Illustrated Handbook of Succulent Plants: Monocotyledons*, ed. Urs Eggli and Reto Nyffeler (Cham: Springer Nature, 2020²): 485–696.

[5] Len E. Newton, "Aloes in habitat", in *Aloes. The genus* Aloe, ed. T. Reynolds (Boca Raton: CRC Press, 2004), 3–14; Charlotte S. Bjorå, Emily Wabuyele, Olwen M. Grace, Inger Nordal and Len E. Newton, "The uses of Kenyan Aloes: An analysis of implications for names, distribution and conservation", *Journal of Ethnobiology and Ethnomedicine* 11, no. 82 (2015): 1–16; also, Newton, "*Aloe* (Asphodelaceae)", 485–696.

[6] Tom Reynolds, "*Aloe* chemistry", in *Aloes. The genus* Aloe, ed. Tom Reynolds (Boca Raton: CRC Press, 2004), 39–74; Newton, "*Aloe*", 489–490.

[7] Dioscorides, *De materia medica* III, 22. All translations of Dioscorides are according to Lily Y. Beck, *Pedanius Dioscorides of Anazarbus. De Materia Medica* (Hildesheim/Zürich/New York: Olms-Weidmann, 2017³): 187.

[8] Tom Reynolds, "*Aloe* chemistry", in *Aloes. The genus* Aloe, ed. Tom Reynolds (Boca Raton: CRC Press, 2004), 39–74; Newton, "*Aloe*", 489–490.

[9] John S. Haller, "A drug for all seasons. Medical and pharmacological history of Aloe", *Bulletin of the New York Academy of Medicine* 66 no. 6 (1990): 650–651.

[10] Dioscorides, *De materia medica* III, 22: 187.

Further undocumented claims as a general health stimulant can today be found in many places.[11] The gel's main components are various polysaccharides,[12] and the purported effect of the leaf pulp to treat skin ailments may simply be the result of supplying water to the injured tissue.[13]

Although *Aloe* has been cultivated and used medicinally since antiquity, precise botanical identification of it in ancient sources remains elusive. Several molecular phylogenetic studies have attempted to circumscribe *Aloe* taxonomically with controversy. Some authors consider several early branching clades to represent separate genera.[14] Despite these studies, the phylogenetic relationships within *Aloe* are still incompletely known, so a break-up is therefore premature.[15] *Aloe vera* of modern trade belongs to a clade that predominantly embraces species from the Arabian Peninsula and the Horn of Africa. *A. perryi* Baker, also with a long tradition of pharmaceutical usage, is superficially similar and is also part of this clade, but not closely related to *A. vera*. Grace argues that species with very thick and "juicy" leaves are predominantly selected.[16] *Aloe vera* is currently unknown from the wild. The closely similar *Aloe officinalis* is reported from Saudi Arabia and Yemen, where it occurs at low altitudes.[17] The chief differences between *A. officinalis* and the commonly cultivated *A. vera* is that the flowers of *A. officinalis* are commonly orange to red, and rarely yellow, whereas those of *A. vera* are mostly yellow. *Aloe vera* is probably best treated as a cultivar, resulting from perhaps

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[11] In contrast to the general claims that abound in the Internet, studies presenting well-founded evidence for therapeutic effects of *Aloe vera* products are scarce. Reviews, such as Suseela Lanka, "A review on *Aloe vera* – the wonder medicinal plant", *Journal of Drug Delivery & Therapeutics* 8 (2018): 94–99, show that most of these claims are based on in-vitro-studies, while e.g. Xiaoqing Guo and Nan Mei, "*Aloe vera*: A review of toxicity and adverse clinical effects", *Journal of Environmental Science and Health*, C 34, no. 2 (2016): 77–96, stress that toxic effects must also be considered. It is clear, however, that *Aloe* species have a long history of utilization in their countries of natural occurrence, as testified by Godwin Anywar, Patience Tugume, and Esezah K. Kakudidi, "A review of *Aloe* species used in traditional medicine in East Africa", *South African Journal of Botany* 147 (2021): 1027–1041. A more detailed review of modern *Aloe* use and pharmaceutical claims is outside the scope of this paper.

[12] Reynolds, "*Aloe* chemistry"; Louise I. Ahl, Christopher J. Barnes, Henriette L. Pedersen, Bodil Jørgensen, William G. T. Willats, Olwen M. Grace, and Nina H. Rønsted, "Exploring the composition of plant cell wall polysaccharides in succulent aloes", *Plants People Planet* (2023): 335–353.

[13] Morton, "Folk uses", 316.

[14] Olwen M. Grace, Ronell R. Klopper, Gideon F. Smith, Neil Crouch, Estrela Figueiredo, Nina Rønsted, and Abraham E. van Wyk, "A revised generic classification for Aloe (Xanthorrhoeaceae subfam. Asphodeloideae)", *Phytotaxa* 76 (2013): 7–14; Barnabas H. Daru, John C. Manning, James S. Boatwright, Olivier Maurin, Norman MacLean, Hanno Schaefer, Maria Kuzmina, and Michelle van der Bank, "Molecular and morphological analysis of subfamily alooideae (Asphodelaceae) and the inclusion of Chortolirion in Aloe", *Taxon* 62 (2013): 62–76; John C. Manning, James S. Boatwright and Barnabas H. Daru, "Aloe and goodbye: a new evolutionary classification of the Alooids", *Alsterworthia International* 14, no. 2 (2014): 7–15; Olwen M. Grace, Sven Buerki, Matthew R.E. Symonds, Felix Forste, Abraham E. van Wyk, Gideon F. Smith, Ronell R. Klopper, Charlotte S. Bjorå, Sophie Neale, Sebsebe Demissew, Monique S.J. Simmonds, and Nina Rønsted, "Evolutionary history and leaf succulence as explanations for medicinal use in aloes and the global popularity of Aloe vera", *BMC Evolutionary Biology* 15 (2015): 29.

[15] Newton, "*Aloe*", 487.

[16] Grace et al., "Evolutionary history", 6–7.

[17] Tom McCoy, *The Aloes of Arabia* (Temecula: McCoy Publishing, 2019).

over 2000 years of selection and cultivation.[18] For this reason, the present contribution uses *Aloe* as a generic term to refer to the Aloes which were traditionally used in medicine.

The historical identification of *Aloe vera* in source material and determination of the extent of its cultivation and early circulation through trade consequently remains unclear. The present study clarifies the historical circulation and cultivation of *Aloe* in the wider Mediterranean region from Greco-Roman times to the 16th century through its illustrations in manuscripts, early modern printed books, and early herbarium specimens. Illustrations of plants are common-place today in different types of botanical publications – from taxonomical treatises to regional floras, lexica, and gardening literature. While pictures are common tools in botanical study today, there is some controversy as to when they became important in the history of science. Illustrations were far less common historically due to the difficulty and expense of producing them. Print and photography have increased the availability of illustrations to broader audiences today. Yet as early as the 6th century CE, the Roman scholar Cassiodorus advised monks at the Vivarium monastery in Calabria to study Dioscorides' *De materia medica* partly on account of its illustrations.[19] Early illustrations sometimes complemented descriptions in the text, and sometimes replaced them. And while earlier researchers have typically assumed that illustrations in early manuscript herbals were simply copied from earlier sources,[20] there is now growing evidence for a critical tradition of updating, improving, and replacing earlier illustrations.[21] Diachronic study of the representation of plant morphology (and not stylistic changes) can reveal shifts and improvements in botanical knowledge over time.

## 2. *Aloe vera* history

The name *Aloe* enters Latin usage via the Greek *aloē* (ἀλόη),[22] which may have been borrowed from the Hebrew *ahal* (typically plural as אֲהָלוֹת or אֲהָלִים in Biblical sources) via Phoenician.[23] The original source of the word may ultimately go back to a word for aloeswood in a South Dravidian language that has parallels in modern Tamil and Malayalam (*akil*), Kannada (*agil*)

[18] Newton, "*Aloe*", 675–676.

[19] Cassiodorus, *Institutiones*, 31.2.

[20] Minta Collins, *Medieval herbals. The illustrative traditions* (Toronto/London: The British Library/University of Toronto Press, 2000), 148–154; Jean A. Givens, *Observation and Image-Making in Gothic Art* (Cambridge: Cambridge University Press, 2005), 144–145.

[21] Andrew Griebeler, *Botanical Icons: Critical Practices of Illustration in the Premodern Mediterranean* (Chicago: University of Chicago Press, 2024); Andrew Griebeler, "Botanical Illustration and Byzantine Visual Inquiry in the Morgan Dioscorides", *The Art Bulletin* 105, no. 1 (2022): 93–116.

[22] Jacques André, *Les noms des plantes dans la Rome antique* (Paris: Les Belles Lettres, 1985).

[23] John. A. C. Greppin, "The various Aloës in ancient times", *Indo-European Studies* 16, no. 1–2 (1988): 33–36. Hebrew designates *Aloe* as *ilava* (אֵילְוָוא) in the Talmud (Gittin 69b). Biblical references to *ahalim* and *ahalot* likely refer to aloeswood.

and Tulu (*agilu*).[24] Aloeswood, also called agarwood, refers to the heartwood of several trees in the genera *Aquilaria* and *Gyrinops* (Thymelaeaceae) that has become resinous and aromatic as a result of fungal invasion and stress. The Dravidian term may have entered Hebrew either directly through trade or through another language.[25] The association between *Aloe* and aloeswood may have arisen in Greek as a result of a commercial association between the two similarly resinous products of *Aloe* and aloeswood that circulated in ancient markets. It is worth noting, however, that confusion can be avoided in Greek when aloeswood is designated by the term *agalochon* (ἀγάλοχον).[26] The suspected derivation from an Arabic *alloeh*, seen in the literature without Arabic letters, appears spurious, though there is a rare Arabic term *ālūwwa* (ألوّة) or *ūlūwwa* (وألوّة) which refers to aloeswood.[27] *Aloe* is typically called *ṣabir* or *ṣabr* (صبر) in Arabic.[28] *Ṣabr* echoes other names of *Aloe* in other Semitic languages, such as *sabhrâ* in Syriac and *ṣiburu* in Assyrian.[29] Another Arabic synonym for *Aloe*, *alwa* or *aluwī* (ألوى), is presumably derived from the Greek name of the plant.[30]

Knowledge about the pharmaceutical properties of aloes allegedly goes back to ancient times (e.g., Assyria).[31] In the 1st century CE, *Aloe* was dealt with by Dioscorides in *Peri hylēs iatrikēs* (*De materia medica* III, 22) and by Pliny the Elder in *Naturalis historia* XXVII, 14, both summarizing existing knowledge of that time, and possibly drawing on common sources.[32] *Aloe* was then new to Greco-Roman pharmacology and likely became first available during the 1st century BCE.[33]

Dioscorides described its inflorescence ("like the flowering stem of asphodel"), flower ("white", which is at variance with the plants identified as *A. vera* today) and fruit ("resembling that of an asphodel").[34] The exact identification of Dioscorides' *Aloe* as to species is

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[24] Ibid., 34. Greppin cites the dictionary by Thomas Burrow and Murray Barnson Emeneau, *A Dravidian Etymological Dictionary* (Oxford: Oxford University Press, 1984), 1984.4, no. 13.

[25] Greppin, "The Various Aloës", 34.

[26] Ibid.

[27] Ibid., 38. Abū Ḥanīfa ad-Dīnawarī (ninth c.), *Kitāb al-nabāt,* sec. 40, in Bernhard Lewin (ed.), *The Book of Plants: Part of the Alphabetical Section* (Wiesbaden: Harrassowitz, 1953), 39 [٣٩].

[28] Armenag K. Bedevian, *Polyglottic Dictionary of Plant Names* (Cairo: Argus and Papazian, 1936), n. 227 (s.v. *Aloe vera*).

[29] Reginald Campbell Thompson, *A Dictionary of Assyrian Botany* (London: The British Academy, 1949), 129–130.

[30] Albert Dietrich, *Die Dioskurides-Erklärung des Ibn al-Baiṭār. Ein Beitrag zur arabischen Pflanzensynonymik des Mittelalters* (Göttingen: Vandenhoeck & Ruprecht, 1991), 159.

[31] E.g. Campbell Thompson, *A Dictionary of Assyrian Botany*, 129–130.

[32] Dioscorides, *De materia medica* III, 22. All translations of Dioscorides are according to Lily Y. Beck, *Pedanius Dioscorides of Anazarbus. De Materia Medica* (Hildesheim/Zürich/New York: Olms-Weidmann, 2017[3]): 187.

[33] John Scarborough, "Roman pharmacy and the eastern drug trade: Some problems as illustrated by the example of Aloe", *Pharmacy in History* 24, no. 4 (1982): 141; John S. Haller, "A drug for all seasons. Medical and pharmacological history of *Aloe*", *Bulletin of the New York Academy of Medicine* 66, no. 7 (1990): 654.

[34] Dioscorides, *De materia medica* III, 22.

somewhat uncertain and open to debate.[35] Arguably, the plant in question is *Aloe perryi* from the island of Socotra,[36] and an origin from Socotra for the imported solidified leaf extract obtained from this species appears possible. However, the cultivated and illustrated material is likely what is known today as *A. vera*, which is much more tolerant of cool winter temperatures in the eastern Mediterranean, while *A. perryi* is unlikely to have been successfully cultivated there as it needs warmer temperatures. It is thus likely that Dioscorides' information (and texts based on it) embraced both of these two species. It cannot be ruled out that other similar species from the Arabian Peninsula and the Horn of Africa were involved as well. Indeed, there are several superficially similar species native to the Arabian Peninsula and the Socotran archipelago, including some with white or at least whitish flowers.[37] In addition, cultivated or naturalized plants identified as *A. vera* probably involve two different taxa, i.e. (1) richly offsetting plants with usually simple inflorescences and flowers similar to *A. officinalis* Forsskål, and (2) the commercially grown, less proliferous plants with often branched inflorescences from the *A. rubroviolacea* Schweinfurth complex.[38]

*Aloe* appears to have been a readily available commodity in Greco-Roman Egypt, as mentions of it occur in twenty different Greek papyri from the region.[39] It was likely imported through trade stations from the "East" and from the south of the Arabian Peninsula and the Horn of Africa.[40] *Aloē* appears alongside frankincense as a trade good exported from the ancient port of Cana in Yemen in the *Periplus of the Erythraean Sea*.[41]

Due to its medicinal importance, and the wish to have its fresh leaves available for immediate use, *A. vera* may have been locally cultivated in frost-free climates from early times, perhaps as far back as ancient Sumer.[42] This claim has been difficult to verify, though.[43] We have not identified documentation of the use, sourcing, or cultivation of *Aloe* from As-

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[35] Maximilian Haars, *Die allgemeinen Wirkungspotenziale der einfachen Arzneimittel bei Galen*, Quellen und Studien zur Geschichte der Pharmazie, Band 116 (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 2018), 164–165.

[36] Scarborough, "Roman pharmacy", 138.

[37] McCoy, "Aloes of Arabia", 103, 352, and 390.

[38] Ibid., 267.

[39] Dimitris Roumpekas, "Aloe in the Greek papyri of Greco-Roman and Late Antique Egypt", *Arctos* 54 (2020): 213–225.

[40] Ibid., 215.

[41] George W. B. Huntingford, *The Periplus of the Erythraean Sea, by an Unknown Author* (London: Hakluyt Society, 1980 [1976]), 36.

[42] Newton, *Illustrated Handbook of Succulent Plants*, 485–696, cites Nuria Chinchilla, Ceferino Carrera, Alexandra G. Durán, Mariola Macías, Ascensión Torres and Francisco A. Macías, "*Aloe barbadensis*: How a miraculous plant becomes reality", *Phytochemistry Review* 12 (2013): 581–602.

[43] T. Pank Arbøll, personal communication. Entries for *Aloe* are to be found in several Assyrian Dictionaries. Campbell Thompson, *A dictionary of Assyrian botany*, 129–130, as *ṣibaru*; Wolfram von Soden, *Akkadisches Handwörterbuch* (Wiesbaden: Otto Harrassowitz, 1959), 1097, as *ṣiba/uru*; Ignace J. Gelb, Benno Landsberger and A. Leo Oppenheim, *The Assyrian dictionary of the Oriental Institute of the University of Chicago* (Chicago: The Oriental Institute/Glückstadt: J. J. Augustin Verlagsbuchhandlung, 1962), 154–155, as *ṣibaru*.

syrian to Greco-Roman times, so we regard claims of early use and cultivation with caution. Many centuries later, Pliny the Elder reported that *Aloe* grew in India and in Asia (*Naturalis Historia* XVII, 14), and Dioscorides added "Arabia" and "along certain coastal areas, and on islands, as for instance on Andros" (*De materia medica* III, 22) in the Cyclades. "India" at that time could refer to the "East" in general, as well as Ethiopia and surrounding regions, due in part to the circulation of Asian and African trade goods through the Red Sea.[44] Pliny further reported that the plant was grown in conical jars as was also the case for another succulent plant that he called *aeizoon*, which is usually identified as a species of the genus *Sempervivum* ("Houseleek", Crassulaceae).[45] Dioscorides specifically noted that *Aloe* "extracted juice is exported" from India, but that the plant also grew elsewhere, including on the Greek island of Andros, adding that the plants cultivated there were "not good for extracting juice."[46] Beyond these references, it is unclear from surviving texts how extensively *Aloe* was cultivated in antiquity and the Middle Ages. Arabic dispensatories make regular reference to a cultivated aloe and an aloe imported from Succotra, *ṣabir usqūṭarī* (صبر اسقوطري). ʿAbdallāh ibn Ṣāliḥ, a commentator on Dioscorides working in Marrakesh in late 12th century, mentions three different kinds of *Aloe*: a cultivated variety, a wild Spanish variety similar to, but smaller than the cultivated variety, and a third variety from ʿIdwa, the coast of northern Morocco.[47] In the 13th century CE, the Andalusi botanist Ibn al-Bayṭār reported that *Aloe* was frequently planted in houses.[48] Byzantine texts generally distinguish between *Aloe* and other *Aloe* products, such as "hepatic *Aloe*" (ἀλόη ἡπατική, *aloē hepatikē*), so-called on account of its liver-like colour, and "yellow *Aloe*" (ἀλόη ξανθή, *aloē xanthē*).[49] Similar distinctions among *Aloe* products appear in late medieval Italian trade documents.[50] *Aloe vera* rapidly spread throughout the world with early colonists, as witnessed inter alia by its synonym *Aloe barbadensis* Miller, described in 1768 on the basis of cultivated material from Barbados (hence its species name, testifying its introduction to the West Indies),[51] or *Aloe indica* Royle, a red-flowering variant, introduced to South Asia.[52] From 1761 onwards, the so-called "Cape *Aloe*" produced chiefly from *Aloe ferox* Miller in South Afri-

[44] Scarborough, "Roman pharmacy", 135, and 137.

[45] Pliny the Elder, *Naturalis historia* XXVI, 5.16.

[46] Dioscorides, *De materia medica* III, 22.

[47] Albert Dietrich, *Dioscorides Triumphans, Dioscurides triumphans: ein anonymer arabischer Kommentar (Ende 12. Jahrh. n. Chr.) zur Materia medica, arabischer Text nebst kommentierter deutscher Übersetzung* (Göttingen: Vandenhoeck & Ruprecht 1988), vol. 2, 368.

[48] Albert Dietrich, *Die Dioskurides-Erklärung des Ibn al-Baiṭār. Ein Beitrag zur arabischen Pflanzensynonymik des Mittelalters* (Göttingen: Vandenhoeck & Ruprecht, 1991), 159.

[49] Erich Trapp, *Lexikon zur byzantinischen Gräzität* (Vienna: Austrian Academy of the Sciences, 1994), s.v. ἡπατικός. For examples of texts, see *Geoponica* VI, 6; Nicholas of Myrepsus, *Dynameron* I, 26.

[50] See, e.g., Franco Borlandi (ed.), *El libro di mercatantie et usanze de' paesi* (Torino: S. Lattes & c., 1936), 160–165; Allen Evans (ed.), *Francesco Balducci Pegolotti, La pratica della mercatura* (Cambridge: The Mediaeval Academy of America, 1936), 375.

[51] Morton, "Folk uses", 313.

[52] Newton, "*Aloe*", 676.

ca was introduced into the trade.[53] *Aloe ferox* was also erroneously identified as *A. succotrina* Weston, which despite its species epithet is not at all connected to Socotra,[54] and was also confused with *A. perryi*.[55] The name *A. succotrina* continues to be used in error for *Aloe* of the trade well into recent times.[56] Today, *A. vera* forms a multi-million-dollar health industry, and it is cultivated in large plantations in tropical and subtropical climates throughout the world: e.g., Canary Islands, Africa (e.g., Kenya, Uganda), USA (California, Texas), and the Caribbean (Barbados, Curaçao), etc.[57]

## 3. Material and Methods

In this study, we use illustrations from medieval manuscripts, early modern printed books and manuscripts, and dried specimens in early herbaria (until 1590) to elucidate the knowledge about *Aloe vera* in the Middle East, and Mediterranean and Central Europe, including its introduction into European cultivation. These historical sources provide the basis for a more informed understanding of the history and expansion of knowledge attached to a species. We searched for illustrations of *Aloe* in several ways, concentrating on items that are available in digitized form. For manuscripts, we determined textual sources that were illustrated and included references to *Aloe*, such as Dioscorides' *De materia medica* in Greek, its Latin and Arabic translations, and the *Tractatus de herbis*. The starting point is the Vienna Dioscorides from the early 6th century[58] and the rich secondary literature on this unique manuscript, from which we further traced information on other manuscripts. For Greek and Arabic manuscripts, a handlist prepared by Marie Cronier formed the base, while for Renaissance botanical books, the catalogue of Frank Anderson[59] and a handlist prepared by Urs Eggli during the past 20 years was primarily used. Timelines of manuscripts and books discussed in the text are given in Figure 8. Details, holdings, and notes on accessibility of all studied resources are found in Table 1. The search of manuscripts should be considered non-exhaustive due to the number of undigitized and uncatalogued manuscripts and printed books. Bias in the preservation of manuscripts should also be noted: no illustrated Arabic manuscripts survive before the 11th century CE, even though Arabic books had been illustrated earlier, as is known from a few surviving fragments.[60] Similarly, many more illustrated Latin and Greek manuscripts

[53] Walter H. Hodge, "The drug aloes of commerce, with special reference to the Cape species", *Economic Botany* 7 (1953): 110; Haller, "A drug for all seasons", 649.

[54] Isaac B. Balfour, "Botany of Socotra", *Transactions of the Royal Society of Edinburgh* 31 (1888): 291.

[55] Hodge, "The drug aloes", 107.

[56] For example, by Chinchilla et al., "*Aloe barbadensis*", 581–602.

[57] Haller, "A drug for all seasons"; Ray Upton, Pavel Axentiev and Diana Swisher, "*Aloe vera* Leaf, *Aloe vera* Leaf Juice, *Aloe vera* Inner Leaf Juice, *Aloe vera* (L.) Burm. F. Standards of Identity, Analysis and Quality Control", *American Herbal Pharmacopoeia*, 2012.

[58] MS Vienna Österreichische Nationalbibliothek, Cod. Med. Gr. 1.

[59] Frank J. Anderson, *An illustrated history of the herbals* (New York: Columbia University Press, 1977).

[60] See Eva Hoffman, "The Beginnings of the Illustrated Arabic Book: An Intersection between Art and Scholarship", *Muqarnas* 17 (2000): 39.

survive from the 13th century and later than do before then. The earliest surviving manuscript copy of a picture, or a text rarely coincides with the first historical instance of it. We used the accuracy of a picture as a rough proxy for the image-makers' observational practice and familiarity with the plant. We assessed accuracy of depiction solely on the basis of morphological features present in the illustration of a plant. We disregarded stylistic features of a depiction such as the presence or absence of modelling, the rigidity or flatness of the plant depicted, the boldness of outlines, and so forth. Accuracy, together with evidence for change within the manuscript tradition, were used to assess the relative novelty of a feature within a manuscript illustration. We also looked for dried specimens of *Aloe* contained in the earliest surviving herbaria which were compiled during the 16th century.[61] We were able to search the contents of seventeen surviving herbaria,[62] which are either available online or whose botanical contents have been published (Table 2 for details for herbaria with *Aloe* material).

[61] For an overview of 16th century herbaria see Gerard Thijsse, "Tusschen pampier geleyt: Ontstaan, verspreiding en gebruik van de vroegste herbaria", in *De groene middeleeuwen. Duizend jaar gebruik van planten (600–1600)*, ed. Linda Ijpelaar and Claudine A. Chavannes-Mazelwen (Eindhoven: Lecturis BV, 2016), 64–93; Riccardo M. Baldini, Giovanni Cristofolini and Carlos Aedo, "The extant herbaria from the sixteenth century: A synopsis", *Webbia* 77, no. 1 (2022): 23–33.

[62] On Mendoza: personal communication by Carlos Aedo. On the Anonimo Toscano, see Emilio Chiovenda, "Un antichissimo Erbario anonimo del Museo Botanico di Firenze", *Annali di Botanica* 17 (1927): 119–139; Giovanni Cristofolini and Chiara Nepi, "La paternità del cosiddetto 'Erbario Merini' conservato presso il Museo di Storia Naturale dell'Università di Firenze: una questione aperta", *Notiziario della Società Botanica Italiana* 5 (2021): 55–59. On Petrollini, see Otto Penzig, *Illustrazione degli Erbarii di Gherardo Cibo* (Milano: Hoepli, 1905); Anastasia Stefanaki et al., "Breaking the silence of the 500-year-old smiling garden of everlasting flowers: The En Tibi book herbarium", *PLoS ONE* (2019): 14:e0217779. On Imperato, see Annamaria Ciarallo, "L'erbario di Ferrante Imperato", *Museologia Scientifica* 3 (1986): 187–204. On Aldrovandi see Adriano Soldano, "La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi", *Atti dell'Istituto Veneto di Scienze, Lettere ed Arti, Classe de Scienze fisiche, Matematiche e Naturali* (2000–2005). On Platter, see https://www.burgerbib.ch/de/bestaende/privatarchive/einzelstuecke/platter-herbarium (accessed 22 April 2024). On Ratzenberger, see Hermann F. Kessler, *Das älteste und erste Herbarium Deutschlands, im Jahre 1592 von Dr Caspar Ratzenberger angelegt: gegenwärtig noch im Königlichen Museum zu Cassel befindlich* (Kassel: Freyschmidt, 1870). On Girault, personal communication by Cécile Aupic. On the so-called "En Tibi" herbarium see Anastasia Stefanaki et al., "The En Tibi herbarium, a 16th century Italian treasure", *Botanical Journal of the Linnean Society* 187 (2018): 397–427. On Rauwolf see Anastasia Stefanaki et al., "The early book herbaria of Leonhard Rauwolf (S. France and N. Italy, 1560–1563): new light on a plant collection from the 'golden age of botany'", *Rendiconti Lincei. Scienze Fisiche e Naturali* 32 (2021): 449–461; Abdolbaset Ghorbani et al., "Botanical and floristic composition of the historical herbarium of Leonhard Rauwolf collected in the Near East (1573–1575)", *Taxon* 67 (2018): 565–580; on Cesalpino see Theodor Caruel, *Illustratio in hortum siccum Andreae Caesalpini* (Florentiae: Le Monnier, 1858); on Cade see https://www.nationaalherbarium.nl/Cade/ (accessed 22 April 2024). On the Ducale Estense herbarium see Jules Camus and Otto Penzig, *Illustrazione del ducale Erbario Estense conservato nel R. Archivio di Stato in Modena* (Modena: G.T. Vincenzi e nipoti, 1885). On Harder see Franz Speta and Franz Grims, "Hieronymus Harder und sein 'Linzer' Herbarium aus dem Jahre 1599", *Kataloge des Oberösterreichischen Landesmuseums* 105 (1980): 307–330; http://daten.digitale-sammlungen.de/~db/0001/bsb00011834/images/ (accessed 22 April 2024). On Bauhin's herbarium: personal communication by Jurriaan de Vos. On Bauhin at Bologna, see Antonio Baldacci, "Un erbario Bolognese del secolo XVII", *Memorie della Reale Academia delle Scienze dell'Istituto di Bologna, Classe di Scienze Fisiche* 6 (1907): 147–159. On Aldrovandi's school: personal communication by Giovanni Cristofolini.

Tab. 1. List of Manuscripts, paintings, and Renaissance books with illustrations of *Aloe*, in ascending chronological order.

| Timeline ID / Fig. | Manuscript / Book / Painting shortname | Time period | Language | Holding Institution | Shelf Mark | Aloe illustration | URL |
|---|---|---|---|---|---|---|---|
| *Timeline years in brackets: Only place holder in the timeline, illustration left out for copyright / permission issues* | | | | | | | |
| **MANUSCRIPTS** | | | | | | | |
| 512 / Fig. 1 | Vienna Dioscorides | 512 c. | Greek | Österreichische Nationalbibliothek, Vienna | Cod. Med. Gr. 1 | fol. 15r | http://data.onb.ac.at/rec/baa9623785 |
| | Naples Dioscorides | late 6. to early 7. cent. | Greek | Biblioteca Nazionale, Naples | Ex Vind. Gr. 1 / Suppl. Graec. 28 | ABSENT (page lost) | not digitally available |
| 800-899 / Fig. 4a | BNF Gr. 2179 | early 9. cent. | Greek | Bibliothèque Nationale de France, Paris | Gr. 2179 | fol. 16r | http://gallica.bnf.fr/ark:/12148/btv1b525002505 |
| 900-999 / Fig. 4b | Munich Clm 337 | 10. cent. | Latin | Bayerische StaatsBibliothek, Munich | BSB Clm 337 | fol. 78 r (p. 198, scan p. 157) | https://opacplus.bsb-muenchen.de/title/BV021827917 |
| 950-1025 | Athos Omega 75 | 950-1025 | Greek | Mone Megistes Lauras, Athos (Monastery of the Great Laura, Mount Athos, Greec) | Omega 75 | fol. 18r | not digitally available |
| | Leiden Codex Or 289 | 1083 | Arabic | Bibliotheek der Rijksuniversiteit (University Library), Leiden | Or. 289 | ABSENT (page lost) | https://digitalcollections.universiteitleiden.nl/view/item/1578266/pages |
| 1150-1175 / Fig. 3a | BNF Ar. 4947 | middle to 3. quarter 12. cent. | Arabic | Bibliothèque Nationale de France, Paris | Ar. 4947 | fol. 50v | https://gallica.bnf.fr/ark:/12148/btv1b84229648 |
| | Copy of ms. at the Shrine of Imam Riza, Mashad: Royal Palace of Gulistan, Tehran | second half 12. cent. / copied 1629 | Arabic | Original ms. (not accessible) Shrine of Imam Riza, Mashad / copy: former Royal Palace of Gulistan, Tehran | | Copy fol. 171v | not digitally accessible |
| 1150-1199 | Copy of ms. at the Shrine of Imam Riza, Mashad: Spencer Pers. Ms. 39 | second half 12. cent. / copied 1889-1890 | Arabic | Original ms. (not accessible) Shrine of Imam Riza, Mashad / copy: New York Public Library | Copy: Pers. Ms. 39 | Copy: fol. 129v | https://digitalcollections.nypl.org/items/5e66b3e8-cbf7-d471-e040-e00a180654d7 |
| | Aya Sofiya 3704 | 13. cent. | Arabic | Suleymaniye Library (Süleymaniye Kütüphanesi), Istanbul | 3704 | fol. 71v | not digitally available |

| Timeline ID / Fig. | Manuscript / Book / Painting shortname | Time period | Language | Holding Institution | Shelf Mark | Aloe illustration | URL |
|---|---|---|---|---|---|---|---|
| (1200-1250) | Aya Sofiya 3702 | 13. cent. | Arabic | Suleymaniye Library (Süleymaniye Kütüphanesi), Istanbul | 3702 | fol. 11v | not digitally available |
| (1229) | Ahmet III 2127 | 1229 | Arabic | Topkapi Palace Library (Topkapi Sarayi Müzesi Kütüphanesi), Istanbul | Ahmet III 2127 | fol. 124r | not digitally available |
| 1239-1240 | Bodleian Arab D 138 | 1239-1240 | Arabic | Bodleian Library, Oxford | Arab. D. 138 | fol. 15v | https://digital.bodleian.ox.ac.uk/objects/4f104fd5-16b5-4cd6-99b3-9a8f8868d7ff/surfaces/f8d9c7dc-1c82-4af6-bee8-ae526710b865/ |
| 1244-1245 / Fig. 3c | Bologna 2954 | 1244-1245 | Arabic | Biblioteca Universitaria, Bologna | Cod. Arab. 2954 | fol. 128r | https://historica.unibo.it/explore?bitstream_id=363984&handle=20.500.14008/78130&provider=iiif-image&viewer=mirador |
| (1275-1299) | A 95 sup | 1275-1299 | Greek | Biblioteca Ambrosiana, Milano | A 95 sup. | fol. 19v | https://digitallibrary.unicatt.it/veneranda/0b02da8280089dc9 |
| 1280-1350 / Fig. 3d | Egerton 747 | 1280 -1350 | Latin | British Library, London | Ms. Egerton 747 | fol. 1r | https://commons.wikimedia.org/wiki/File:BL_Egerton_747,_f.001r.jpg |
| 1301-1350 | BNF Latin 6823 | 1301-1350 | Latin | Bibliothèque Nationale de France, Paris | Lat. 6823 | fol. 4r | https://gallica.bnf.fr/ark:/12148/btv1b6000517p |
| (1325-1375) | Marc Gr. XI-21 | 1325-1375 | Greek | Biblioteca Marciana, Venice | Gr. XI,21 (=453) | fol. 95v | not digitally available |
| (1334) | BL Oriental 3366 | 1334 | Arabic | British Library, London | Or. 3366 | fol. 17v | https://www.qdl.qa/en/archive/81055/vdc_100023512696.0x00002e |
| | Morgan 873, Codex Salernitanus | 1350-1375 | Latin | The Morgan Library and Museum, New York | Ms. M 873 | fol. 1r | http://ica.themorgan.org/manuscript/page/1/159345 |
| | BNF Grec 2183 | 1350-1450 | Greek | Bibliothèque Nationale de France, Paris | Grec 2183 | fol. 69v | https://gallica.bnf.fr/ark:/12148/btv1b10521259v |
| (1395-1399) | Casanatense 459 | 1395-1399 | Latin | Biblioteca Casanatense, Roma | Ms. 459 | fol. 12v | https://www.loc.gov/resource/gdcwdl.wdl_11560/?sp=25 |
| 1401-1499 | Arsenal 2888, Platearius | | Latin | Bibliothèquede l'Arsenal, Paris | Arsenal 2888 | fol. 1v | https://gallica.bnf.fr/ark:/12148/btv1b550098035 |
| (1440-1453) | Banks Dioscorides | | Greek | Natural History Museum, London | Banks Dio | fol. 5r | not digitally available |
| (1440-1453) | Bologna 3632 | | Greek | Biblioteca Universitaria, Bologna | BUB Ms 3632 | fol. 393r | not digitally available |

| Timeline ID / Fig. | Manuscript / Book / Painting shortname | Time period | Language | Holding Institution | Shelf Mark | Aloe illustration | URL |
|---|---|---|---|---|---|---|---|
| 1445-1448 / Fig. 2a | Codice Benedetto Rinio / Herb. Roccabonella | | Latin | Biblioteca Nazionale Marciana, Venice | Lat. VI 59.2548 | fol. 349 | Search - Internet Culturale |
| | Chigi Dioscorides | | Greek | Biblioteca Apostolica Vaticana | Chigi F VII 159 | fol. 14r | https://digi.vatlib.it/view/MSS_Chig.F.VII.159 |
| | Cambridge Ee 5.7 | middle 15. cent. | Greek | Cambridge University Library | Ms. Ee 5.7 | fol. 4r | not digitally available |
| 1475-1525 / Fig. 3b | Vienna Codex 2277 | very end 15. / very early 16. cent. | Latin | Österreichische Nationalbibliothek, Vienna | Codex 2277 Icones Plantarum | fol. 2r | https://digital.onb.ac.at/RepViewer/viewer.faces?doc=DTL_6307876 |
| 1450-1475 | BNF Grec 2180 | 1450-1475 | Greek | Bibliothèque Nationale, Paris | Grec 2180 | fol. 26r | https://gallica.bnf.fr/ark:/12148/btv1b52509195s/f1.image |
| (1450-1499) | Salamanca Cod 2659 | 1450-1499 | Greek | Biblioteca Histórica de la Universidad de Salamanca | 2659 | fol. 85v | https://gredos.usal.es/bitstream/handle/10366/55565/BG~Ms.2659.pdf?sequence=31&isAllowed=y |
| (1543-1566) | Codex Fuchs | 1543-1566 | German/ latin | Österreichische Nationalbibliothek, Vienna | Cod. 11117-11125 | 1(1): 271, 273 | not digitally available, see Baumann & al. 2001: 225 |
| 1546-1584 / Fig. 2d | Cibo Albums | 1564-1584 | Italian | British Library, London | Add. MS 22332 + 22333 | fol. 144r | not digitally available |
| 1550 c. | BSB Cod. Icon. 34 | 1550 c. | Latin | Bayerische StaatsBibliothek, Munich | Hss. Cod. Icon. 34 | image 173 | https://www.digitale-sammlungen.de/de/view/bsb00015124?page=,1 |
| 1553 | Codex Oellinger | 1553 | illustrations only | Universitätsbibliothek Erlangen-Nürnberg | H62 / MS 2362 | fol. 54-55 | http://digital.bib-bvb.de/view/bvb_mets/viewer.0.6.5.jsp?folder_id=0&dvs=1720025734984~804&pid=16914195&locale=it&usePid1=true&usePid2=true |
| 1553-1565 / Fig. 2b | Michiel, Cinque libri | 1545-1575 | Italian | Biblioteca Nazionale Marciana, Venice | It. 11, 26-30 (=4860-4864) | fol. 120r | not digitally available |
| 1561-1565 / Fig. 2c | Gessner, Historia Plantarum | 1545-1565 | illustrations only | Universitätsbibliothek Erlangen-Nürnberg | H62 / MS 2386, 1-2 | fol. 426v, fol. 417v | https://gateway-bayern.de/BV039778087 |
| BOOKS | | | | | | | |
| 1485 / Fig. 5a | Schöffer, Gart der Gesundheit | 1475 | German | Technische Universtität Braunschweig | | unnumbered folio, "picture 87" | https://doi.org/10.24355/dbbs.084-201104291048-0 |
| 1486 | Arbolayre | 1486(-1488?) | French | Bibliothèque Sainte-Geneviève, Besançon | FOL S 104 (BIS) INV 155 RES | fol. 24v | https://archive.org/details/FOLS104_BIS_INV155RES |
| | Herbarius | 1492 | Dutch | Staatsbibliothek zu Berlin / Preussischer Kulturbesitz | | fol. 26v | http://digital.staatsbibliothek-berlin.de/werkansicht?PPN=PPN78942780X&PHYSID=PHYS_0030&DMDID=&view=overview-toc |
| 1499 / Fig. 5b | Prüss, Ortus Sanitatis | 1499 | Latin | Boston Public Library | | scan page 29 | https://archive.org/details/ortussanitatis00prss/page/n29/mode/1up |

| Timeline ID / Fig. | Manuscript / Book / Painting shortname | Time period | Language | Holding Institution | Shelf Mark | Aloe illustration | URL |
|---|---|---|---|---|---|---|---|
| 1506 | Macer Floridus | 1506 | Latin | Bayerische Staatsbibliothek | Res/4 Diss. 2804#/Beibd. 3 | unnumbered folio, "scan 135" | https://mdz-nbn-resolving.de/urn:nbn:de:bvb:12-bsb10888800-8 |
| 1515 | Gart der Gesundheit | 1515 | German | Staatsbibliothek zu Berlin / Preussischer Kulturbesitz | | fol. 18r | https://digital.staatsbibliothek-berlin.de/ |
| 1527 | Anonymus, Kreuterbuch | 1527 | German | Bayerische Staatsbibliothek | BSB VD16 W4360 | fol. 18r | https://www.digitale-sammlungen.de/de/view/bsb00029498?page=75 |
| 1542 / Fig. 5d | Fuchs, Historia Stirpium | 1542 | Latin | Thüringer Universitäts- und Landesbibliothek Jena | 2 Bot.II.1.1 | p. 138 | https://collections.thulb.uni-jena.de/rsc/viewer/HisBest_derivate_00004258/BE_1058_0000_00.tif?logicalDiv=log_HisBest_derivate_00004258 |
| | Fuchs, New Kreüterbuch | 1543 | German | Byerische Staatsbibliothek | Rar. 2037 | Fig. LXXV | https://opacplus.bsb-muenchen.de/title/BV008594739 |
| | Mattioli, Pedacio Dioscoride ... Libri Cinque | 1544 | Italian | McGill University Library | | p. 224, without illustration | https://archive.org/details/McGillLibrary-osl_di_pedacio_dioscoride_anazarbeo_folioWZ240d594dm1544-20467/page/224/mode/2up |
| 1546a | Bock, Kreüter Buch | 1546 | German | Missouri Botanical Garden Peter H. Raven Library | | fol. CCCLI v | https://www.biodiversitylibrary.org/item/33579#page/736/mode/1up |
| 1546b / Fig. 5c | Rösslin, Kreutterbuch | 1546 | German | Bayerische Staatsbibliothek | Res/2 Phyt. 243 wb | fol. 74r | https://bildsuche.digitale-sammlungen.de/index.html?c=viewer&bandnummer=bsb00031708&pimage=00001&v=100&nav=&l=fr |
| 1554 | Mattioli, Commentarii in libros sex | 1554 | Latin | Universitäts- und Landesbibliothek Düsseldorf | | p. 327 | http://digital.ub.uni-duesseldorf.de/ihd/content/titleinfo/4308691 |
| 1555 | Laguna, Materia Médica | 1555 | Spanish | Biblioteca Nacional de España | | p. 279 | http://bdh.bne.es/bnesearch/detalle/bdh0000037225 |
| | Cordus, Annotationes ... Dioscoridis | 1561 | Latin | ETH-Bibliothek Zürich | Rar 9149 / VD 16 C 5109 | fol. 211v | https://www.e-rara.ch/zut/content/titleinfo/3542818 |
| 1562a / Fig. 6a | Marini, Mesue medici opera | 1562 | Latin | Universidad de Granada, Biblioteca Universitaria | BHR/A-016-152 | fol. 46v | https://granatensis.ugr.es/permalink/34CBUA_UGR/1p2iirq/alma991009067759704990 |
| 1562b / Fig. 6b | Mattioli, Herbarz | 1562 | Czech | Library Antonin Svehla / Ceska digitálni knihovna | | fol. 196r | https://cdk.lib.cas.cz/view/uuid:e99476da-8cc0-48a2-98b4-50a1c4037325?page=uuid:e5188de5-e302-11e6-88ad-001999480be2 |
| | Mattioli, New Kreuterbuch | 1563 | German | Bayerische Staatsbibliothek, München | 2 Phyt. 195 | fol. 275r | https://www.digitale-sammlungen.de/de/view/bsb10149845?page=628 |

| Timeline ID / Fig. | Manuscript / Book / Painting shortname | Time period | Language | Holding Institution | Shelf Mark | Aloe illustration | URL |
|---|---|---|---|---|---|---|---|
| | Mattioli, Commentarii Dioscoridis | 1565 | Latin | Staats- und Stadtbibliothek Augsburg | | pp. 683-684 | https://opacplus.bsb-muenchen.de/title/BV009120319 |
| | Garcia de Orta, Aromatum | 1567 | Latin | Bayerische Staatsbibliothek | Res(M.med. 484 | p. 14, without illustration | https://www.digitale-sammlungen.de/en/view/bsb10186529?page=14 |
| 1585 | Durante, Herbario Nuovo | 1585 | Italian | Österreichische Nationalbibliothek, Vienna | BE.4.J.33 | p. 17 | http://digital.onb.ac.at/OnbViewer/viewer.faces?doc=ABO_%2BZ182657609 |
| 1586 | Camerer, Kreutterbuch | 1586 | German | Staatliche Bibliothek Regensburg | VD16 ZV 15556 | fol. 230v | https://www.digitale-sammlungen.de/de/view/bsb11057664?page=482 |

Tab. 2. Renaissance book herbaria with details on the presence of *Aloe* specimens, listed in ascending chronological order of their start of making.

| Herbarium/ herbarium maker | Period | Origin of Material | Deposited at | Aloe specimens: Presence & Name | Volume | Date of Specimen | Digital images |
|---|---|---|---|---|---|---|---|
| Mendoza herbarium | 1539-1554 | Italy (Venice?, Rome?) | Real Biblioteca del Monasterio de San Lorenzo de El Escorial, Spain | Aloe epatica; Epatica | Vol. 1 | 1539-1554 | pending |
| Francesco Petrollini (formerly known as "Cibo", and "Rome Herbarium" / Fig. 7a) | c. 1550-1553 | Bologna, Italy | Biblioteca Angelica, Rome | Aloe | Vol. 2, fol. 34r | c. 1550-1553 | on request |
| Ulisse Aldrovandi | c. 1551-1586 | Bologna, Italy | Herbarium BOLO, Orto Botanico & Herbario, Università di Bologna | Aloè | Vol. 1, fol. 34.3 | 1551 | https://botanica.sma.unibo.it/aldrovandi/Explore |
| | | | | Aloe Matth. Cum flore. Aloë terrestris | Vol. 3, fol. 21 | 1552 | https://botanica.sma.unibo.it/aldrovandi/Explore |
| Felix Platter | c. 1552-1614 | Basel, Switzerland | Burgerbibliothek Bern | no specimen present but 5 sheets with illustrations from printed books | | | https://www.burgerbib.ch/de/bestaende/privatarchive/einzelstuecke/platter-herbarium/recherche |
| Caspar Ratzenberger / Fig. 7b | 1556-1592 | Kassel, Germany, and elsewhere | Naturkundemuseum Ottoneum, Kassel | Aloes, Sempervivum marinum, Sedum (Sertum), amarum Columellae | Vol. 3, fol. 401 | (1556-)1592 | on request |

## 4. Results

### Aloe *in medieval manuscripts*

To our knowledge, the earliest surviving illustration of *Aloe*, showing a plant with a young developing inflorescence (Fig. 1), is in the Vienna Dioscorides.[63] This is a late antique Greek manuscript compiled in the early 6th century CE. Commonly, the date of 512 is given for the codex, but this has been questioned,[64] and it is argued that the manuscript was probably completed before 512.[65]

The illustration in the Vienna Dioscorides was copied from a now lost model dating back to the 4th or 5th century, of which the Naples Dioscorides[66] is also a descendant. However, it has often been pointed out that some of the illustrations in the Vienna Dioscorides are much more realistic than those in its Neapolitan version. Although it has long been thought that these more realistic illustrations would demonstrate that the Vienna Dioscorides was more faithful to its model, recent research seems to suggest that the painters of the Vienna Dioscorides may have improved some of the pictures. These more accurate depictions in the Vienna manuscript, including that of *Aloe*, may have been based on direct observation or familiarity with plants available in the region around Constantinople[67] where the manuscript was produced.

This illustration of *Aloe* from the Vienna Dioscorides was reproduced in later Greek manuscripts[68] including the 15th century Chigi Dioscorides[69] and the Banks Dioscorides.[70] The illustration in the Chigi Dioscorides was itself copied into a Latin manuscript now in Vienna,[71] while the image in the Banks Dioscorides was copied into another manuscript now in

[63] MS Vienna Österreichische Nationalbibliothek, Cod. Med. Gr. 1, f. 15r. A flowering *Aloe* purportedly carved on an Egyptian stele from the New Kingdom (1550–712 BCE) (George Thomson, "Aloe vera and the identity of the plant carvings in Rosslyn Chapel, Scotland", *Bradleya* 39 (2021): 265–270) is likely inauthentic. It appears to have been digitally superimposed on a photograph of a relief of Ramesses II as a child that is now in the Louvre Museum.

[64] Müller, "Ein vermeintlich fester Anker".

[65] Ernst Gamillscheg, "Das Geschenk für Juliana Anicia. Überlegungen zu Struktur und Entstehung des Wiener Dioskurides", in *Byzantina Mediterranea: Festschrift für Johannes Koder zum 65. Geburtstag*, ed. Klaus Belke, Ewald Kislinger, Andreas Külzer, Maria A. Stassinopoulou (Wien-Köln-Weimar: Böhlau Verlag, 2007), 187–195.

[66] MS Napoli Biblioteca Nazionale, Ex. Vind. Gr. 1 / Suppl. Graec. 28; the folio with the chapter dealing with *Aloe* has been lost.

[67] Leslie Brubaker, "The Vienna Dioscorides and Anicia Juliana", in *Byzantine Garden Culture*, ed. Antony R. Littlewood et al. (Washington: Dumbarton Oaks, 2002), 189–214.

[68] Francesca Marchetti, "La trasmissione delle illustrazioni del Dioscoride di Vienna negli anni intorno alla caduta di Costantinopoli", *Jahrbuch der Österreichischen Byzantinistik* 66 (2016): 168.

[69] MS Vaticano Biblioteca Apostolica Vaticana, Chigi F VII 159, 2nd quarter of the 15th century, f. 14r.

[70] MS London Natural History Museum, Banks Dio, mid-15th century, probably 1440s to at most 1453, f. 5r.

[71] MS Vienna Österreichische Nationalbibliothek, Cod. 2277, very end of the 15th or very beginning of the 16th century, f. 2r.


Fig. 1. MS Vienna Österreichische Nationalbibliothek, Codex Med. Gr. 1, from c. 512, f. 15r, the earliest known illustration in a medical manuscript, showing an adult plant with a budding inflorescence (Source: Österreichische Nationalbibliothek. Permissions obtained for all images).

Cambridge.[72] A strikingly similar illustration is found in a collection of illustrations made by the painter-naturalist Gherardo Cibo sometime between 1564 and 1584 (Fig. 2d).[73]

The illustration of *Aloe* in the Vienna Dioscorides and most of its subsequent copies depict the plant at a single moment in its yearly cycle with a developing inflorescence. The decision not to show the flower could reflect contemporary understandings of what constituted important knowledge about the plant, including the perceived ideal time to harvest it. Ancient and medieval botanical authorities did not have a full understanding of pollination and did not appreciate the utility of characters of the flowers for identification and classification. Flowers were not always available for identification. Ancient and medieval authorities instead tended to think of them as merely ornamental features that at most announced the fruiting of the plant.[74]

An interesting shift in the history of the copying of this image appears in an illustration in the late 15th century codex containing copies of images from the Chigi codex now in Vienna (Fig. 3b).[75] It is a faithful reproduction of the illustrations of the 6th century Vienna Dioscorides, but the inflorescence is drawn much longer with seemingly aborted buds in the apical portion, and faint ink drawings of flowers in the lower part, left uncoloured as if only tentative, and only roughly correct. Likely, these could have been added later by someone who had seen a living flowering plant. Updating and correcting of illustrations occurs elsewhere in this manuscript, as seen, e.g. in the addition of a branch in the illustration of *Cistus* (f. 36r). Such updating commonly occurs in botanical manuscripts that were actually in use.[76] The addition of the flowers here also hints at a shift in the contemporaries' expectations of what information a botanical illustration should convey. In this case, flowers were now considered an important part of the plant's appearance, worthy of inclusion, and perhaps even necessary to ensure the "completeness" of a picture.

The next surviving illustration appears in a manuscript now in Paris produced in the Levant in the late 8th or early 9th century (Fig. 4a).[77] Here the *Aloe* appears as a highly simplified sterile plant with simply rendered leaves, an apparent midvein, and a margin devoid of prickles. Brown exudate flows from its side to the ground – a notable depiction showing not only

[72] MS Cambridge Cambridge University Library, Ee. 5.7, mid-15th century, f. 4r.

[73] MS London British Library, Add. 22332, the so-called Cibo Albums, f. 144r.

[74] Gavin Hardy and Laurence Totelin, *Ancient botany* (London: Routledge, 2016), 107.

[75] MS Vienna Österreichische Nationalbibliothek, Cod. 2277, f. 2r.

[76] Andrew Griebeler, *Botanical Icons: Critical Practices of Illustration in the Premodern Mediterranean* (Chicago: University of Chicago Press, 2024), see examples 148–154, 219–220.

[77] MS Paris Bibliothèque Nationale de France, Gr. 2179, f. 16r. For details see Marie Cronier, "Transcrire l'arabe en grec. À propos des annotations du Parisinus gr. 2179 (Dioscoride)", in *Manuscripta Graeca et Orientalia. Mélanges monastiques et patristiques en l'honneur de Paul Géhin*, ed. André Binggeli et al. (Leuven: Peeters, 2016), 247–265.

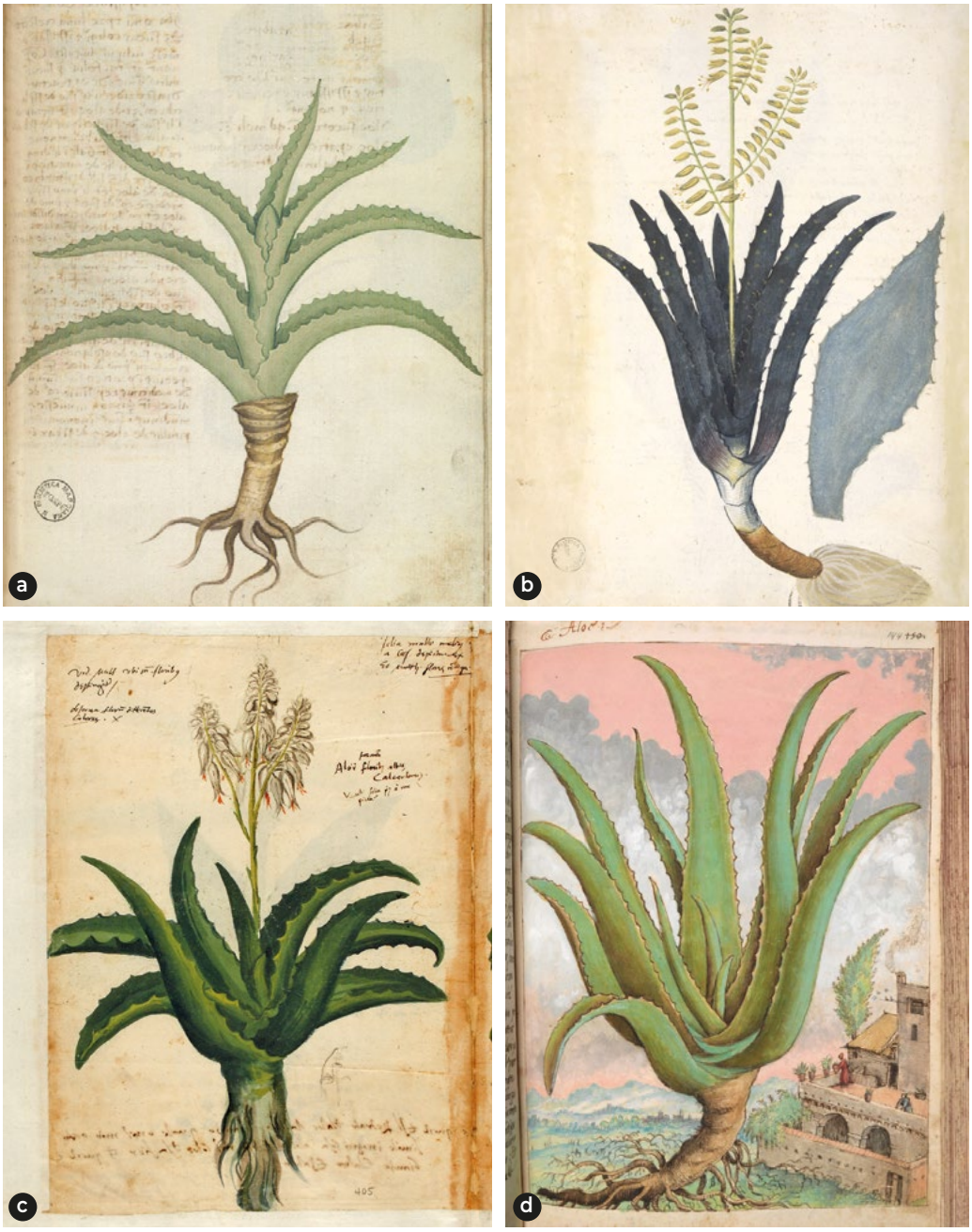


Fig. 2. (a) Herbarium Roccabonella, period 1445–1448, f. 349 (Source: Biblioteca Nazionale Marciana, Venice, permission obtained for re-print). (b) Michiel, *Cinque Libri*, period 1553–1565, f. 120r (Source: Biblioteca Nazionale Marciana, Venice, permission obtained for re-print). (c) Anonymous painter, c. 1560–1461, painting sent by Calzolari to Gessner, now part of Gessner, *Historia Plantarum*, vol. 2, f. 426v (Source: Universitätsbibliothek Erlangen-Nürnberg, Public Domain Mark 1.0). (d) Herbal manuscript of Gherardo Cibo, period 1564–1584, Add MS 22332, f. 144r (Source: British Library London, permission obtained for re-print).


Fig. 3. (a) MS Paris Bibliothèque Nationale de France, Arab. 4947 (period 1150–1175), f. 50v, the earliest illustration clearly showing an inflorescence with open flowers (Source: Bibliothèque Nationale, Paris, Public Domain, non-commercial use permitted). (b) MS Vienna Österreichische Nationalbibliothek, Codex 2277 (period 1450–1499), f. 2r, a faithful copy of the "Vienna 512" model [Fig. 1] but the inflorescence has been modified and includes buds and flowers (Source: Österreichische Nationalbibliothek. Permission obtained for re-print). (c) MS Bologna Biblioteca Universitaria, Cod. Arab. 2954 (c. 1244), f. 128r (Source: Biblioteca Università Bologna, CC BY NC ND 4.0). (d) MS London British Library, Egerton 747 (period 1280–1350), f. 1r, with the highly stylized illustration typical for the *Tractatus* tradition (Source: British Library, London. Permission obtained for re-print).

the plant but also the plant part used.[78] The artist may not have ever seen an actual plant but provided a stylized drawing of a generalized leaf.[79] Given the emphasis on the *Aloe* exudate, the maker of the illustration may have primarily known *Aloe* through *Aloe* products, as encountered in marketplaces.

The first illustration clearly showing a naturalistic flowering plant is in an Arabic manuscript also now in Paris (BNF Ar. 4947) (Fig. 3a),[80] dated to the middle or third quarter of the 12th century. As in many Arabic manuscripts, the illustration follows the chapter it illustrates, rather than preceding it, as is the case in most Greek and Latin manuscripts. Though many of the illustrations in this Arabic manuscript can be traced all the way back to the illustrations of the Old Paris Dioscorides (BNF Gr. 2179),[81] this illustration of *Aloe* cannot.

This Paris Arabic manuscript was, according to Mahmoud Sadek, perhaps copied in the Diyar Bakr region (northern Syria; today Diyarbakir, south-eastern Turkey) for the Artūqid sovereign, Fakhr al-Dīn.[82] This illustrated manuscript contains an Arabic translation of Dioscorides, purportedly based on a (now lost) Syriac translation of Dioscorides, by the famous Baghdadi translator Ḥunayn ibn Isḥāq, who died in 873. George Saliba and Linda Komaroff have, however, more recently questioned this reconstruction of the manuscript's history.[83] In the second half of the 12th century, this same, now-lost Syriac translation gave rise to a new Arabic translation, made for a rival of the previous patron: this second translation is now preserved in a manuscript in Mashhad (Iran) at the Shrine of Imam Riza. Presented on several occasions in exhibitions of Islamic art in Europe during the 20th century,[84] it is now inaccessible to researchers. However, its illustrations can be reconstructed thanks to its many descendants. Its most faithful copy was made in 1889–1890 for the Shah of Iran and is now preserved in New York.[85] The image of the *Aloe* in this manuscript is extremely similar to that in the Arabic manuscript in Paris (BNF Ar. 4947).[86]

Another copy of the Mashhad manuscript is now in Tehran, in the library of the former royal palace of Gulistan: it was copied in 1629 for the personal physician of the Safavid

[78] Griebeler, *Botanical Icons*, 94.

[79] Ibid.

[80] MS Paris Bibliothèque Nationale de France, Ar. 4947, f. 50v.

[81] Edmond Bonnet, "Étude sur les figures de plantes et d'animaux peintes dans une version arabe manuscrite de la *Matière médicale* de Dioscoride conservée à la BN de Paris", *Janus* 14 (1909): 294–303.

[82] Mahmoud M. Sadek, *The Arabic Materia Medica of Dioscorides* (Quebec: Éditions du Sphinx, 1983), 10–11.

[83] George Saliba and Linda Komaroff, "Illustrated Books May Be Hazardous to Your Health", *Ars Orientalis* 35 (2008): 6–65.

[84] Florence E. Day, "Mesopotamian manuscripts of Dioscorides", *Metropolitan Museum of Art Bulletin* 8, no. 9 (1950): 274.

[85] MS New York, New York Public Library, Spencer Pers. Ms. 39 (which contains the text in Arabic, despite its shelf mark), f. 129r.

[86] See footnote 74.

Fig. 4. (a) MS Paris Bibliothèque Nationale de France, Grec 2179, period 800–899, f. 16r, notable for the depiction of sap drops flowing from the leaves (Source: Bibliothèque Nationale, Paris, Public Domain, non-commercial use permitted). (b) MS Munich Bayerische Staatsbibliothek, Clm 337, period 900–999, f. 78r (scan page 157), the earliest manuscript illustration showing Aloe (the plant in the right-hand column) with an inflorescence and flowers (Source: Bayerische Staatsbibliothek München. Permissions obtained for all images).

ruler:[87] The illustration of the *Aloe* (f. 171v) is also very similar to that of the New York and Paris Arabic Dioscorides manuscripts. The Mashhad manuscript also served as a model for several Persian translations.[88] Considering all evidence based on these related depictions, we can infer that a similar image, with an inflorescence, must have been found on their common model – perhaps the now lost illustrated Syriac manuscript, which may date from the 9th century, the time of the Syriac translation of Dioscorides, or perhaps before.

Generally speaking, Arabic manuscripts of Dioscorides have depictions of *Aloe* that show it with an inflorescence.[89] The only exceptions are two manuscripts which, overall, have very

[87] Hūšang A'lam, "The Arabic Translation of Dioscorides' *De materia medica* by Mihran b. Mansur in comparison with the older translation by Stephanos and Hunayn b. Ishaq", in *Proceedings of the Arabic and Islamic Sections of the 35th* International Congress of Asian and North African Studies (ICANAS), part 1, ed. K. Dévényi and T. Iványi, *The Arabist* 19–20 (1998): 123–130.

[88] For example MS Philadelphia University of Pennsylvania, Laurence J. Schoenberg Collection 278, dated 1595, f. 96, which is, once again, an illustration similar to those previously mentioned.

[89] Additional examples are MS Istanbul Topkapi Palace, Ahmet III 2127, dated 1229, f. 124r, or MS London British Library, Oriental 3366, dated 1334, f. 17v.

schematic and simplified illustrations and seem to be at the end of a long copying process.[90] These two images are likely derived from an ancestor with red inflorescences, as seen for example in the figure of the *Aloe* in a 13th century Arabic manuscript of Dioscorides now in Bologna (Cod. Arab. 2954).[91] It bears a colophon dated 642 (1245) and was probably made in Baghdad. This illustration contains a slightly different depiction of *Aloe* with more elongated and recurved leaves and smaller flowers. There consequently appear to be at least two distinct major branches of *Aloe* depictions in most Arabic Dioscorides. Yet these branches may ultimately go back to the same tradition of *Aloe* depictions. While the illustration in the Bologna manuscript (Cod. Arab. 2954) is different, it appears to be a stylistic reworking of the same flowering *Aloe* that has its earliest surviving example in the Paris manuscript (Paris BNF Ar. 4947). From this we can deduce that the images in the Arabic manuscripts of Dioscorides can all be traced, through more or less faithful copying processes to the same ancestor.

Of the manuscripts preserving a Latin translation of Dioscorides, only one has illustrations.[92] This manuscript is dated to the first half of the 10th century and was probably produced in Southern Italy. It transmits a translation made at an uncertain date, perhaps already in the 6th century.[93] Its image of the *Aloe* (Fig. 4b) is simplistic and, taken out of context, would be difficult to identify with this plant. Nevertheless, a roughly similar illustration is found in a Greek manuscript produced in Constantinople in the late 11th century[94] (though its images may be a slightly later addition), and a comparison with the illustrations of the Arabic manuscripts suggests that they could all go back to a similar illustrated Greek copy, dating from late antiquity (a more precise dating is impossible). This may have been a manuscript of the complete version of Dioscorides, close to the original form, and independent from the abridged and re-elaborated form of the Vienna Dioscorides.

In this respect, it is noteworthy that the image in the Latin manuscript includes, as in almost all Arabic manuscripts, an inflorescence: this could suggest that an inflorescence was present in the image of *Aloe* in a Greek manuscript of Dioscorides produced in the last centuries of antiquity. This image with an inflorescence belongs to a different illustrative tradition than the one attested in the Vienna Dioscorides (see above). The various manuscripts of Dioscorides thus testify to three illustrative traditions for the *Aloe* plant in the last centuries of antiquity: one accurate and naturalistic with a young developing inflorescence (in the Vienna

[90] MS Oxford Bodleian Library, Arab D 138, dated 1239–1240, f. 15v, and MS Istanbul Süleymaniye Library, Ayasofiya 3702, first half of the 13th century, f. 11v.

[91] MS Bologna Biblioteca Universitaria, Cod. Arab. 2954, dated 1244–1245, f. 127v. See Orazgozel Machaeva, *Catalogo dei manoscritti islamici conservati nella Biblioteca Universitaria di Bologna* (Bologna: Persiani, 2017), vol. 1, 206–210.

[92] MS München Bayerische Staatsbibliothek, Clm 337, f. 78r.

[93] Collins, *Medieval herbals*, 148–154.

[94] MS Mount Athos Monastery of the Great Laura, Omega 75, f. 18r.

Dioscorides, Fig. 1), the other very schematic and without inflorescence (in the BNF Gr. 2179, Fig. 4a) or with sketchy inflorescence (in Munich Clm 337, Fig. 4b), and the last (in the BNF Arab. 4947, Fig. 3a) with an inflorescence with fully developed flowers. The last circulated widely (in Greek, Latin and Arabic) and underwent numerous alterations, several times with the disappearance of the inflorescence (e.g., in some Arabic manuscripts).

With the exception of the illustrated Latin Dioscorides now in Munich (Fig. 4b),[95] illustrations of *Aloe* do not reappear in extant Latin manuscripts until the advent of the illustrated *Tractatus de herbis* in the 13th century.[96] The earliest surviving version of this tradition is the manuscript Egerton 747, *Tractatus de herbis* (Fig. 3d),[97] which has been dated to between 1280 and 1350. Many of the illustrations in the *Tractatus* manuscripts are said to have been based on direct observation of plants.[98] The *Aloe* illustrated in all *Tractatus* manuscripts consulted, however, is a simplified and stylized sterile plant with rigid, flattened leaves. The illustration conveys an approximation of the prickly margins of the *Aloe*'s leaves and its general habit, but not much else. The *Tractatus* and the *Circa Instans*, on which it is based, contain many plants that had been absent in earlier Latin herbals such as the *Herbarius* of Pseudo-Apuleius Platonicus, such as bananas, nutmeg, and coconuts. The inclusion of *Aloe* here may similarly reflect the expansion of the trade in plants and *materia medica* in the late medieval Mediterranean. The *Tractatus* illustrations were subsequently copied many times and adapted for reworkings of the text (e.g., the mid-14th century herbal of Manfredus of Monte Imperiale).[99] The *Tractatus* illustrations also circulated in atlases without any accompanying descriptive texts.[100]

Taking all evidence together, the illustrations discussed so far can be grouped into four distinct categories, plus some outliers:

- The Vienna Dioscorides[101] (Fig. 1) and all the faithfully similar illustrations up to and including BNF Grec 2180,[102] Cod. A.95 Sup,[103] Marc Gr.XI-21[104] or the Banks Codex,[105] all with a young developing inflorescence.

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[95] MS Munich Bayerische Staatsbibliothek, Clm 337, f. 78r.

[96] See Collins, *Medieval herbals*, 239–298 and Iolanda Ventura, *Ps. Bartholomaeus Mini de Senis, Tractatus de Herbis (MS London, BL, Egerton 747)* (Firenze: Sismel, 2009), for the relationship of the numerous extant versions of the *Tractatus* and its translations – the French translation known as "Livre des simples médecines" was particularly popular and is represented by at least 25 extant manuscripts.

[97] MS London British Library, Ms. Egerton 747, f. 1r.

[98] Collins, *Medieval herbals*, 148–154.

[99] For example in MS Paris Bibliothèque Nationale de France, Lat. 6823, f. 4r.

[100] For example, MS New York The Morgan Library and Museum, Ms. M 873, f. 1r.

[101] MS Vienna Österreichische Nationalbibliothek, Cod. Med. Gr. 1, f. 15r.

[102] MS Paris Bibliothèque Nationale de France, Grec 2180, f. 26r.

[103] MS Milan Biblioteca Ambrosiana, A.95 Sup., f. 19v.

[104] MS Venice Biblioteca Nazionale Marciana, Gr. XI, 21 (= 453), f. 95v

[105] MS London Natural History Museum, Banks Dio, f. 5r.

- The "Arabic" tradition featuring leaves with a distinctive prickly margin, and an erect inflorescence with porrect flowers, or a nodding developing inflorescence.
- The *Tractatus* tradition with the highly stylized sterile plant, starting with Ms. Egerton 747.[106]
- The "outliers" with "one-of-a-kind" illustrations:
  - BNF Grec 2179[107]
  - Munich Clm 337[108]
  - BNF Grec 2183[109] – this is distinctive, since it has two figures, one similar to BNF Grec 2179, the second similar to the Arabian tradition.

### Aloe *in printed books and Renaissance manuscripts*

The earliest illustration to mention dates from the period 1445–1448 and forms part of the famous Roccabonella Herbarium (Fig. 2a).[110] The illustrations of this manuscript are outstanding for the 15th century, being naturalistic and of high quality. *Aloe vera* appears as a slightly elongated sterile plant. The disposition of the leaves, the toothed leaf margins, and especially the remains of dead leaves below the rosette leave little doubt that the artist had access to a cultivated living plant – and the somewhat etiolated growth is typical for plants cultivated under conditions of low light that are to be expected for a plant grown in Venice at that time, especially when grown indoors in winter to protect it from low temperatures. This illustration is thus the earliest indication that *Aloe* was successfully cultivated in Italy as early as the middle of the 15th century.

The first printed book with an illustration of a flowering *Aloe vera* is the "Gart der Gesundheit", published in 1485 (Fig. 5a).[111] The illustration shows a completely spurious inflorescence and flower shape, but the description of the plant includes details of the leaves (round and broader than in onions, and with a strong odour and bitterness) and mentions that it grows in India, Persia, Arabia and Greece, but no information on the flowers is given – one wonders on what sources the woodcut could have been based. That the flowers are painted white in the coloured copy reproduced here (Fig. 5a) may be purely coincidental or based on the original information in Dioscorides.

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[106] MS London British Library, Ms. Egerton 747, f. 1r.

[107] MS Paris Bibliothèque Nationale de France, Grec 2179, f. 16r.

[108] MS Munich Bayerische Staatsbibliothek, Clm 337, f. 78r.

[109] MS Paris Bibliothèque Nationale de France, Grec 2183, f. 69v.

[110] MS Venice Biblioteca Nazionale Marciana, It. 11, 26–30 (=4860–4864), f. 349. This Codex is also referred to as "Codice Benedetto Rinio". For details see Simonetta Pelusi, "'Quel libro... che vale un tesoro'. La circolazione dei manoscritti slavi a Venezia dalle biblioteche religiose alla Pubblica Libreria", in *Venecija i slovenske književnosti*, ed. D. Ajdačić and P. Lazarević Di Dakomo (Beograd: Zbornik Radova, 2011), 128–133.

[111] Peter Schöffer, *Gart der Gesundheit* (Mainz, Peter Schöffer, 1485). Aloe is on an unnumbered folio of Scan 87 of copy at Technische Universität Braunschweig, at https://doi.org/10.24355/dbbs.084-201104291048-0 (accessed 14 November 2021).

The same or similar illustrations appear in many later popular herbal encyclopaedias (e.g., Fig. 5b),[112] including versions in other languages than German or Latin,[113] up to at least 1527. While there is usually a fair description of the plant, no descriptions of inflorescence or flowers have been located, and the illustrations of these plant parts are completely spurious. Likely, inflorescences and flowers were added to achieve "completeness" in the encyclopaedic compilations.

The first modern and botanically accurate illustration of *Aloe vera* was published by Leonhart Fuchs in the Latin version of his herbal published 1542 (Fig. 5d).[114] This is a completely new illustration of a sterile plant, likely based on the observation of an actual living plant. The accompanying text explicitly notes that *Aloe* was cultivated in Germany but had not yet ever flowered in German gardens. According to the unillustrated Dioscorides translation and commentary by Mattioli from 1544,[115] *Aloe vera* was at that time widespread in cultivation in Italy, to be seen in almost all cities, and grown on windowsills or in loggias.

Fuchs's illustration was copied innumerable times in later works,[116] and sometimes it is appearing as mirror image.[117] A very different illustration, also of a sterile plant, but more reminiscent of an American *Agave* than an African *Aloe*, was published by Eucharius Rösslin in 1546 (Fig. 5c),[118] who specifically mentions that it puts forth a scape with white flowers.

Unpublished illustrations of sterile plants are present in several codices.[119] A particularly nice example is the illustration in the "Cibo Albums" (Fig. 2d), where the sterile plant is shown in front of a background of a monastery with nuns that attend plants cultivated in

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[112] Johann Prüss, *Ortus Sanitatus* (Strassburg: Johann Prüss), 1499.

[113] For example, Peter Mettlinger (ed.), *Arbolayre* (Besançon: Peter Mettlinger, c. 1486–1488), f. 24v.

[114] Leonhart Fuchs, *De Historia Stirpium Commentarii Insignes [...]* (Basel: Officina Isingriniana, 1543), 138. The same woodcut is also published in the German version: Leonhart Fuchs, *New Kreütterbuch, in welchem nit allein die gantz histori, das ist namen, gestalt, statt vnd zeit der wachsung, natur, krafft vnd würckung, des meysten theyls der Kreüter so in Teütschen vnnd andern Landen wachsen, mit dem besten vleiß beschrieben, sonder auch aller derselben wurtzel, stengel, bletter, blumen, samen, frücht, vnd in summa die gantze gestalt, allso artlich vnd kunstlich abgebildet vnd contrafayt ist, das deßgleichen vormals nie gesehen, noch an tag kom[m]en* (Basel: Michael Isingrin, 1543), fig. LXXV.

[115] Pietro A. Mattioli, *Di Pedacio Dioscoride Anazarbeo Libri cinque della historia, & materia medicinale [...]* (Venetia: Nicolo de Bascarini, 1544). Aloe was not illustrated in this volume.

[116] For instance Hieronymus Bock, *Kreüuter Buch, darin Underscheid, Würckung und Namen der Kreüuter so in Deutschen Landen wachsen [...]* (Strasburg: Wendel Rihel, 1546), f. CCCLIv. This book also has a more detailed section on cultivation practices employed by the Nürnberg apothecary Georg Öllinger (see below for details).

[117] For instance, Conrad Gessner (ed.), *Valerii Cordi Simesusii annotations in Pedacii Dioscoridis Anazarbei de medica material libros V [...]* (Strasburg: Josias Rihelius, 1561), f. 211v.

[118] Eucharius Rösslin, *Kreuterbuch*, f. 74r.

[119] MS Munich Bayerische Staatsbibliothek, Cod. Icon. 34, image 173 (this codex is a collection of just illustrations, probably made in Italy around 1550); MS Erlangen-Nürnberg Universitätbibliothek, MS 2362, ff. 54–55 (the so-called "Codex Öllinger", assembled by the Nürnberg apothecary Georg Öllinger); MS London British Library, Add. MS 22332 + 22333, f. 144r (the so-called "Cibo Albums").


Fig. 5. (a) Schöffer, *Gart der Gesundheit*, 1485, unnumbered folio (Source: Technische Universität Braunschweig, CC BY NC 4.0). (b) Prüss, Ortus Sanitatis, 1499, p. 30 (Source: Boston Public Library, Public Domain Mark 1.0.). (c) Rösslin, Kreutterbuch, 1546, f. 74r (Source: Bayerische Staatsbibliothek München, CC BY NC SA 4.0). (d) Fuchs, *Historia Stirpium*, 1542, p. 138 (Source: Thüringer Universitäts- und Landesbibliothek Jena, CC BY NC SA 4.0).

pots. These illustrations are a clear indication that *Aloe vera* was in cultivation at that time, both in Germany and Italy.

The earliest printed illustrations of flowering *Aloe vera* appeared more or less concurrently in two books published in 1562, and are closely connected to unpublished drawings from the same period:

- Two paintings exist in the collection of illustrations assembled by Conrad Gessner (1516–1565):[120] Gessner received the two nearly identical paintings from the Italian apothecary Francesco Calzolari (Franciscus Calceolarius, 1522–1609) in Verona,[121] one showing yellow flowers, the other white flowers (Fig. 2a). Nothing is known about the artist that produced these illustrations. The same collection of illustrations also includes Gessner's own meticulous study of young living sterile specimen of *Aloe*, whose cultivation he describes in 1561.[122] The date when Gessner received these paintings is not known, but evidence points to early 1561: in the book just cited, he describes that *Aloe* produces yellow flowers, and that it flowered in Venice in the garden of the Italian physician and nobleman Maphaeus (Maffeo [de] Maffei; his renowned private botanical garden was also mentioned by Mattioli)[123] – this is the first mention in print of the correct flower colour (described as white ever since Dioscorides). Since Gessner edited a manuscript left by Valerius Cordus and published it as main part of the 1561 book, where he used a copy of Fuchs's original wood cut illustration, we argue that if Gessner would have had received the paintings of the flowering *Aloe* in time, he would almost certainly have used them to produce a new illustration for the Cordus text.
- A painting (possibly produced by the painter Domenico dalle Grece) of a flowering *Aloe vera* is also present in the *Cinque Libri* of the Venezian noblemen Pietro Antonio Michiel (1510–1576) (Fig. 2b).[124] It is undated but cannot be earlier than 1553, when Michiel started to compose his collection of illustrations.[125] The comprehensive annotations[126]

[120] MS Erlangen-Nürnberg Universitätsbibliothek, H62 / MS 2386[1], 2386[2], ff. 426v, 417v. This "Historia Plantarum" was assembled by the Zürich polyhistor Conrad Gessner and consists of his own drawings and drawings received from his network.

[121] Heinrich Zoller and Martin Steinmann, *Conradi Gessneri Historia Plantarum. Gesamtausgabe 1* (Dietikon: Urs Graf-Verlag, 1987); Heinrich Zoller and Martin Steinmann, *Conradi Gessneri Historia Plantarum. Gesamtausgabe 2* (Dietikon: Urs Graf-Verlag, 1991).

[122] Conrad Gessner, "Horti Germaniae", in *Valerii Cordi Simesusii Annotationes in Pedacii Dioscoridis Anazarbei de Medica Materia [...]*, ed. Conrad Gessner (Strasburg: Josias Rihelius, 1561), 245v.

[123] Alessandra Quaranta, *Medici-physici trentini nella seconda metà del Cinquecento* (Trento: Università degli Studi di Trento, Dipartimento di Lettere e Filosofia, 2019), 151–152; Michael Stolberg, *Learned physicians and everyday medical practice in the Renaissance* (Berlin/Boston: Walter de Gruyter Oldenbourg, 2021), 70.

[124] MS Venice Biblioteca Nazionale Marciana, It. 11, 26–30 (=4860–4864), f. 120r.

[125] Alessandro Minelli, *Dizionario Biografico degli Italiani*, 74 (2010), available at https://www.treccani.it/enciclopedia/pietro-antonio-michiel_(Dizionario-Biografico)/ (accessed 15 March 2023).

[126] For a commented transcription see Ettore De Toni, *Pietro Antonio Michiel. I cinque libri di piante: Codice Marciano. Trascrizione e commento* (Venezia: Reale Istituto Veneto di Science, Lettere ed Arti, 1940), 177–178.

include a detailed description of its growth, how it can be propagated by offsets, and that it flowered in May, and this strongly suggests that Michiel cultivated a plant that eventually flowered in his garden.

- A printed illustration of a flowering *Aloe vera* appears in the translation of the medical works of Mesue, edited by the Italian physician Andrea Marini (1523–1566 [1570?]), published 1562 (Fig. 6a).[127] Marini added a long comment that his illustration is based on a picture that he received from the Venezian nobleman "P. Antonius Michaelius" (Pietro Antonio Michiel), who cultivated it in his garden, and adds that flowering Aloes had not been seen previously. The small-scale woodcut is almost identical with Michiel's painting (Fig. 2b) cited above but appears as mirror image.
- Another printed illustration showing a flowering *Aloe vera* was independently first published 1562 in the Czech translation of the commentary of Dioscorides' *De materia medica* by the Italian physician and botanist Pietro Andrea Mattioli (1501–1578) (Fig. 6b).[128] Mattioli's Dioscorides commentary was first published in an unillustrated Italian version in 1544,[129] and in revised, augmented and richly illustrated form in Latin in 1554;[130] its illustration of *Aloe* was likely based on that published by Fuchs in 1542. The book was highly successful and appeared in numerous later editions and languages.[131] The 1562 Czech edition was the first that used the famous and artistically elaborate large-format woodcuts – most of them based on the same material as the small-scale woodcuts of the 1554 edition, but some (including the flowering *Aloe*) completely new. The same illustration was also used in the German edition of 1563[132] and the Latin edition of 1565,[133] in both cases alongside the large-format version of the "original" sterile plant.

None of these paintings is dated, but considering the time needed to typeset the books where they appeared and to produce the woodcuts,[134] they were likely produced around 1560.

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[127] Andrea Marini, *Mesuae opera quae extant omnia: ex duplici translatione, altera quidem antiqua, altera vero nova, [...] adiectae sunt etiam nunc recens Andreae Marini annotationes in simplicia cum imaginibus desideratis* (Venezia: Valgrisius, 1561), f. 46v.

[128] Pietro A. Mattioli, *Herbarz ginak Bylinář welmi vžitečný a Figůrami [...]* (Praha: Girzijka Melantrych z Awentyn, 1562), f. 196r.

[129] Cf. note 115.

[130] Pietro A. Mattioli, *Commentarii in libros sex Pedacii Dioscoridis Anazarbei, de medica materia [...]* (Venezia: Vincentius Valgrisius, 1554), 327.

[131] For details see Anderson, *Illustrated History*, 163–172 and Renate Pfeuffer, "Vom köstlichen Schatz der Kräuter. Das deutsche Kräuterbuch des Pietro Andrea Mattioli von 1563 und seine Illustrationen", *Berichte des Naturwissenschaftlichen Vereins Schwaben* 118 (2014): 3–24.

[132] Pietro A. Mattioli, *New Kreüterbuch: mit den allerschönsten und artlichsten Figuren aller Gewechss [...]* (Praha: Melantrich von Aventin und Valgriss, 1563), f. 275r/v.

[133] Pietro A. Mattioli, *Commentarii in sex libros Pedacii Dioscoridis Anazarbei* De medica materia *[...]* (Venezia: Valgrisius, 1565), 683–684.

[134] For details see Pfeuffer, "Vom köstlichen Schatz": 3, and 18. Mattioli was looking for expert woodcut artists at least as early as late 1559.


Fig. 6. (a) Marini, *Mesuae medici opera*, 1562, f. 46v (Source: Universidad de Granada, Biblioteca Universitaria, CC NY NC ND). (b) Mattioli, *Herbarz*, 1562, f. 196 (Source: Library of Antonin Svehla / Ceska digitálník knihovna, permission obtained for re-print).

No connection to flowering Aloes documented in the form of herbarium specimens (see below) from 1551 onwards has been traced.

A comparison of the paintings and the printed illustrations shows an overall similar plant. The illustration published by Marini in 1562 (Fig. 6a) is near-identical to the Michiel painting (Fig. 2b), and Marini specifically writes that he received the illustration from Michiel. The illustration published by Mattioli in the same year (Fig. 6b) is more reminiscent of the paintings (Fig. 2c) Conrad Gessner received from Francesco Calzolari, with some artistic licence though in the disposition of the leaves and the representation of the trunk and roots, which seem to have been borrowed from the 1542 Fuchs illustration (Fig. 5d). In comparison with the Michiel painting, the Gessner/Calzolari paintings are less stylized (except the roots) and livelier. Michiel's painting, on the other hand, appears "flat" and stylized (and especially so in the printed version in Marini 1562), but it shows the junction of the leaves with the stem more correctly, and also suggests white spots on the leaves, typical for *Aloe vera* and similar species. While Michiel's

painting shows an inflorescence with three side branches, the published version has only two side branches, congruent with the Gessner/Calzolari paintings and the Mattioli woodcuts.

A further painting of a flowering *Aloe* that should be shortly mentioned exists in the collection of materials assembled by Leonhart Fuchs for an expanded and updated version of his successful 1542/1543 books.[135] Baumann et al. state that the painting is based on Mattioli's 1563 book, but this is only partly correct. Fuchs's painting appears to be a concoction of elements from both Michiel's woodcut (overall inflorescence architecture and position of upper porrect flowers and buds), the cited woodcut of Mattioli (position and shape of lower flowers, gracefully arching side branches, plus the leaves from Fuchs's original 1542 woodcut).

### Aloe *in Renaissance Herbaria*

Not many 16th century herbarium specimens of *Aloe* have survived (Table 2). The earliest known specimens are found in the herbaria of Diego Hurtado de Mendoza, Ulisse Aldrovandi and Francesco Petrollini, all originating from Italy. The specimen in the Mendoza herbarium may be the oldest but an exact dating is not available. Mendoza was ambassador of the Spanish emperor Charles V in Venice and Rome between 1539 and 1554.[136] During this period, he bought numerous books and manuscripts, among them probably also the four volumes of his herbarium. The *Aloe* specimen is contained in the first herbarium volume and consists of an inflorescence with bracts, but without flowers, and four leaf fragments.[137] The accompanying handwritten text reads "Aloe epatica," a name used already in medieval texts and in many Renaissance sources to describe a certain type of *Aloe* resin that has the colour of liver.[138] In Vol. 1 of Aldrovandi's herbarium dated 1551, f. 34 consists of a specimen with a leaf fragment, while in Vol. 3, f. 21, dated 1552, there is a specimen consisting of an entire leaf, several leaf fragments, and an unbranched inflorescence (or the main part of a branched inflorescence).[139] The latter specimen was identified as *Aloe arborescens* by Soldano (but this can hardly be correct as *A. arborescens* Miller is a South African species, and the material is compatible with *A. vera*). In Petrollini's herbarium, a specimen consisting of leaf fragments and part of an inflorescence is present

[135] Fuchs, *De Historia*; Fuchs, *New Kreütterbuch*; Brigitte Baumann, Helmut Baumann and Susanne Baumann-Schleihauf, *Die Kräuterbuch-Handschrift des Leonhart Fuchs* (Stuttgart: Ulme, 2002), 225.

[136] Elisa Andretta and José Pardo-Tomás, "Books, plants, herbaria: Diego Hurtado de Mendoza and his circle in Italy (1539–1554)", *History of Science* 58 (2019): 4.

[137] Carlos Aedo, personal communication.

[138] The name *Aloe epatica* already appears in MS London British Library, Ms. Egerton 747 (f. 1r), or in a list of drugs from 1424 from Ferrara, see Friedrich August Flückiger, "Italienische Beiträge zur Geschichte der Pharmacie und Botanik", *Archiv der Pharmacie* 225 (1887): 674.

[139] Adriano Soldano, "La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi I e II", *Atti dell'Istituto Veneto di Scienze, Lettere ed Arti. Classe di Scienze fisiche, Matematiche e Naturali* 158 (2000): 19; Adriano Soldano, "La provenienza delle raccolte dell'erbario di Ulisse Aldrovandi, Volumi III e IV", *Atti dell'Istituto Veneto di Scienze, Lettere ed Arti. Classe di Scienze fisiche, Matematiche e Naturali* 159 (2001): 14.

(Fig. 7a). Also known as Erbario Cibo or Erbario B,[140] Petrollini's herbarium was recently dated 1550–1553[141] and so parts of it slightly precede Aldrovandi's herbarium in age. No evidence, however, has survived about the dating of Petrollini's *Aloe* specimen itself, which is included in Vol. 3, f. 34r (Fig. 7a). Another specimen of *Aloe* (identified as *Aloe perfoliata,* also hardly correct, as *A. perfoliata* Linné is also a South African species), survives in the herbarium of Caspar Ratzenberger from Kassel, Germany (Fig. 7b).[142] This herbarium is dated 1592, but Ratzenberger started his collection already in 1556 and enriched it in subsequent years during his travels in Italy and France.[143] The specimen is notable since Ratzenberger added two samples of dried *Aloe* juice, and a substantial note (in Latin, likely copied and abridged from Garcia de Orta[144] or a later printing of this work), informing inter alia about the corrupted name "succotrina" in use for *Aloe* imported from Socotra.

## 5. Conclusions

The detailed, though non-exhaustive, analyses of Medieval and early Renaissance manuscripts as well as printed books of the 15th and 16th centuries, combined with dried specimens in several herbaria have enabled us to elucidate the timeline along which *Aloe vera* came into cultivation in the Mediterranean and then Central European regions.

*Aloe vera* was at least locally in cultivation in parts of Greece at the time of Dioscorides in the first century CE, as the Vienna Dioscorides mentions that it was cultivated on the Greek island of Andros. The illustrations in the Vienna Dioscorides from the early 6th century CE are likely copies of earlier illustrations, presumably from the 1st or 2nd century CE,[145] which were likely based on observations of living plants.

Illustrations of *Aloe vera* without inflorescences and flowers appear in many Medieval Greek and Latin manuscripts, while Arabic manuscripts from this period generally show flowering plants (Fig. 8). The illustrations are of highly variable quality insofar as a diagnostic

[140] For details of its history see Anastasia Stefanaki, Henk Porck, Ilaria M. Grimaldi, Nikolaus Thurn, Valentina Pugliano, Adriaan Kardinaal et al., "Breaking the silence of the 500-year-old smiling garden of everlasting flowers: The En Tibi book herbarium", *PLoS ONE* 14, no. 6 (2019).

[141] Baldini et al., "Extant Herbaria".

[142] Hermann F. Kessler, *Das älteste und erste Herbarium Deutschlands, im Jahre 1592 von Dr. Caspar Ratzenberger angelegt: gegenwärtig noch im Königlichen Museum zu Cassel befindlich* (Kassel: Freyschmidt, 1870).

[143] Ulrich Schaffrath, "Läuse, Muscheln und Tabak – Das Herbar Ratzenberger", *Philippia* 15, no. 3 (1991): 191–214.

[144] Garcia de Orta, *Aromatum et simplicium aliquot medicamentorum apud Indos nascentium historia [...]* (Antwerp: Plantin, 1567).

[145] Marie Cronier, "L'Herbier alphabétique grec de Dioscoride: quelques remarques sur sa genèse et ses sources textuelles", in *Fito-zooterapia antigua y altomedieval: textos y doctrinas*, ed. Arsenio Ferraces Rodríguez (Coruña: Universidade da Coruña, Servizo de Publicacións, 2009), 33–59; Joshua J. Thomas, "The Illustrated Dioskourides Codices and the Transmission of Images during Antiquity", *Journal of Roman Studies* 109 (2019): 241–273.


Fig. 7. (a) Herbarium Petrollini (period 1550–1553), vol. 1, f. 34r. (Source: Biblioteca Angelica, Roma, permission obtained for re-print). (b) *Herbarium* Ratzenberger (period 1556–1592), vol. 3, f. 401 (Source: Naturkundemuseum Ottoneum, Kassel, permission obtained for re-print).

representation is concerned. One explanation for the growing deterioration of diagnostic representation is that the artists responsible for the illustrations did not have personal knowledge of the plant, and no living plant was available to serve as a model. It is commonly accepted that in such cases, the illustration is composed according to the details available in the description and other associated materials, or that illustrations in part or as a whole were copied from other written sources. The illustration of *Aloe vera* with grossly inaccurate leaves in the Greek manuscript BNF Gr. 2179 (Fig. 4a) from the early 9th century is an example.

The earliest illustrations of a flowering *Aloe* are to be found in the Munich Clm 337 manuscript from the 10th century (Fig. 4b), and in the Arabic manuscript BNF Ar. 4947 from the 12th century (Fig. 3a). While the illustration in Clm 337 bears hardly any resemblance to *Aloe vera*, the somewhat stylized illustration of the latter clearly indicates the general architecture of both the plant and inflorescence, including yellow flowers. The major deviation from living material is the flower position, which is illustrated as porrect but is semi-pendent to pendent in vivo (compare with Gessner's painting from around 1560 (Fig. 2c). This deviation from the expected position of the flower could be due to stylistic concerns or the artist's attempt to

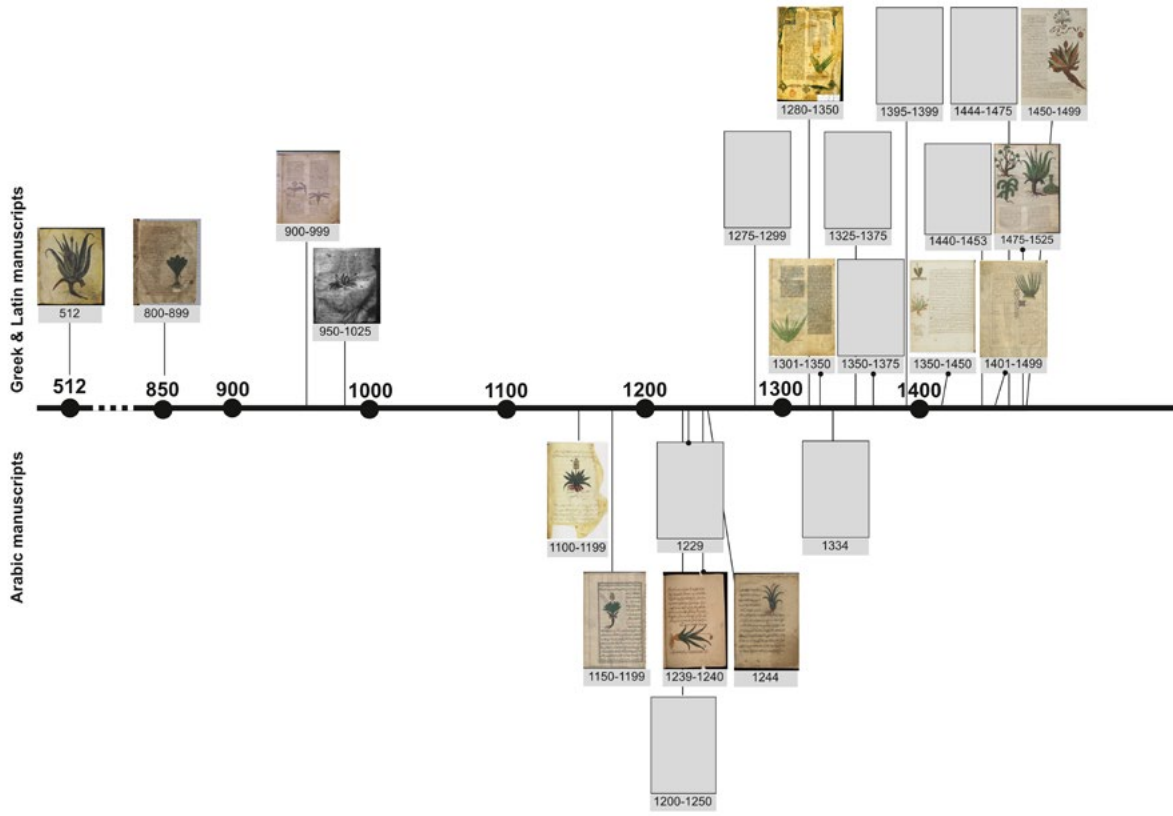
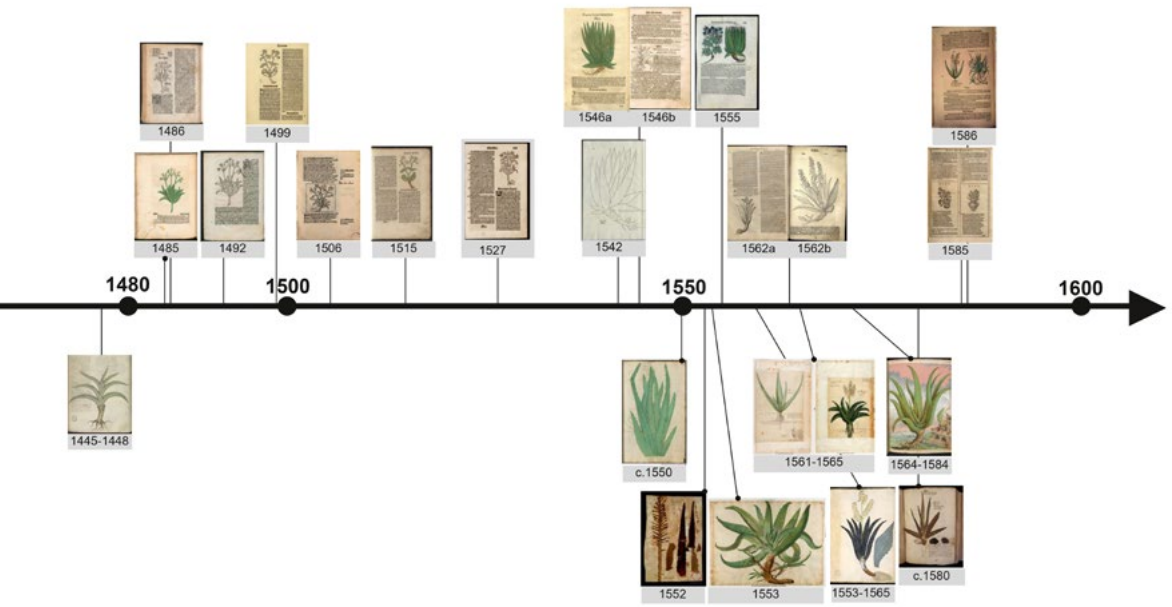



Fig. 8. Timelines showing the chronological sequence of manuscripts and printed books from 500–1600 discussed in the text. The boxes at the bottom of each figure give the approximate time or time span for the item, grey boxes refer to items which are neither open access nor in the public domain. Details of all publications, exact folio or page numbers, library holdings and shelf marks, and digital availability, are to be found in Table 1.

impose further visual clarity by flattening out the flowers. The yellow flower colour is a good indication that the yellow-flowered selection of *Aloe vera* was already in existence in the 12th century in the Arabic world, and around 1560 in Italy.

Evidently, *Aloe vera* was cultivated in Italy in the period 1445–1448; cultivation in Central Europe, north of the Alps, dates back to at least 1542, when Fuchs described that it is locally planted, though it never flowered. Further evidence for local cultivation of *Aloe* in Germany comes from the illustration in the Codex Oellinger, painted no later than 1553, and possibly from Ratzenberger's specimen, although it is not known if this plant was grown in Germany or if perhaps Ratzenberger collected it for example in Italy during his travels. It is also in Italy and around this time that the earliest known herbarium specimens have been pressed, which are now found in the herbaria of Mendoza, Aldrovandi and Petrollini, dating to the period 1539 to 1554.




The earliest known Renaissance illustrations (Fig. 2c), made by an unknown artist, of flowering *Aloe vera* were given to Conrad Gessner by the Italian apothecary Francesco Calzolari, at an unknown date, but most likely not earlier than spring 1561, since Gessner would have used them in his 1561 book if the illustrations were in his possession when the manuscript was finished. More or less simultaneously, Pietro Antonio Michiel produced a painting based on a plant flowering in his garden in Venice (Fig. 2b). Available evidence suggests that *Aloe vera* was successfully cultivated and flowered in the gardens of the Venetian noblemen Maffeo Maffei and, respectively, Pietro Antonio Michiel.[146]

Illustrations of *Aloe* in early printed books up to 1527 invariably depicted flowering plants, but with inaccurate representations of inflorescence and flowers. The first accurate illustrations of flowering *Aloe* in printed books appeared more or less simultaneously in 1562 in Marini's commentaries on texts of Mesue (Fig. 6a), and in 1562 in Mattioli's Czech revision of his earlier commentaries on Dioscorides (Fig. 6b). All these painted and printed illustration of the inflorescence and flowers are closely parallel to each other, and hypothetically, they ultimately all go back to a common source.

[146] De Toni, *Pietro Antonio Michiel*, 177.