

The Cucurbitaceae and Solanaceae illustrated in medieval manuscripts known as the *Tacuinum Sanitatis*

Harry S. Paris^{1,*}, Marie-Christine Daunay² and Jules Janick³

¹Department of Vegetable Crops & Plant Genetics, Agricultural Research Organization, Neve Ya'ar Research Center, PO Box 1021, Ramat Yishay 30-095, Israel, ²INRA, UR1052 Unité de Génétique et d'Amélioration des Fruits et Légumes, F-84140, Montfavet, France and ³Department of Horticulture & Landscape Architecture, Purdue University, 625 Agriculture Mall Drive, West Lafayette, IN 47907-2010, USA

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• **Background and Aims** Beginning in the last two decades of the 14th century, richly illuminated versions of the *Tacuinum Sanitatis*, the Latin translation of an 11th-century Arabic manuscript known as *Taqwim al-Sihha bi al-Ashab al-Sitta*, were produced in northern Italy. These illustrated manuscripts provide a window on late medieval life in that region by containing some 200 full-page illustrations, many of which vividly depict the harvest of vegetables, fruits, flowers, grains, aromatics and medicinal plants. Our objective was to search for and identify the images of taxa of Cucurbitaceae and Solanaceae.

• **Methods** We have located all reported illustrated *Tacuinum Sanitatis* and similar or related manuscripts, searched through printed or electronic reproductions of them, categorized six of them that display full-page illustrations as archetypic, and established the identity of the Cucurbitaceae and Solanaceae appearing in these six manuscripts.

• **Key Results and Conclusions** Of the Cucurbitaceae, *Cucumis sativus* (short-fruited cucumbers), *Cucumis melo* (including round as well as elongate melons), *Citrullus lanatus* (both sweet watermelons and citrons), and *Lagenaria siceraria* (including bottle-shaped as well as long gourds), are illustrated. Of the Solanaceae, *Solanum melongena* (egg-shaped purple aubergines) and *Mandragora* sp. (mandrake) are illustrated. These depictions include some of the earliest known images of cucumber, casaba melon (*Cucumis melo* Inodorous Group) and aubergine, each of which closely resembles an extant cultivar-group or market type. Overall, the botanically most accurate images are in the version of the *Tacuinum* located in the Österreichische Nationalbibliothek, Vienna, cod. ser. n. 2644. Similarities and differences in botanical accuracy among the images of Cucurbitaceae and Solanaceae in the six archetypal *Tacuinum* manuscripts suggest to us that another illustrated *Tacuinum*, now lost, may have antedated and served as a model or inspiration for the six surviving archetypic manuscripts.

Key words: *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Lagenaria siceraria*, *Solanum melongena*, *Mandragora* sp., medieval horticulture, history of horticulture.

INTRODUCTION

The Cucurbitaceae and Solanaceae include some of the more important vegetable crops of the world, with a collective value of billions of dollars annually. These two families include cucumbers, melons, watermelons, squash, pumpkins, aubergines (eggplants), peppers, potatoes and tomatoes, all of which are of worldwide importance, as well as a host of other crops of regional importance and uncultivated taxa of medicinal interest. From descriptions, depictions and artefacts, some dating back several thousands of years, it is known that plants of both families have been appreciated for food and medicine since antiquity (Janick *et al.*, 2007; Daunay *et al.*, 2008; Paris and Janick 2008*a, b*). However, little information has been accessed, collected and analysed with regard to the identity, culture, harvest and use of the Cucurbitaceae and Solanaceae during medieval times.

Our ongoing investigations have focused on obtaining a better understanding of the history of cultivation and use of the Cucurbitaceae and Solanaceae (Paris, 2000, 2001, 2007;

Paris and Janick, 2005, 2008*a, b*; Paris *et al.*, 2006; Janick and Paris 2006*a, b*; Janick *et al.*, 2007; Daunay and Janick, 2007; Daunay *et al.*, 2007, 2008). Among the issues addressed have been the times of arrival of various melon (*Cucumis melo*) types and cucumber (*Cucumis sativus*) in Europe. Specifically, the widely held idea that cucumber was known in Greek and Roman antiquity, based on translations of the Latin *cucumis* as cucumber, has been shown to have no supporting evidence (Janick *et al.*, 2007). Our current objective focuses on the late medieval period, just before the humanistic upheaval of the Renaissance and the European contact with the Americas.

As described below, richly illuminated copies of a Latin manuscript known as the *Tacuinum Sanitatis* were produced in late medieval times. These illustrated *Tacuinum* manuscripts and their emergence into the realm of modern scholarship in the late 19th century have been the subject of some lengthy reviews, including those by Cogliato Arano (1976), Segre Rutz (2002), Bertiz (2003), Hoeniger (2006) and Mane (2006). Over the years, a number of facsimile editions accompanied by scholarly commentary have been issued.

* For correspondence. E-mail hsparis@agri.gov.il

More recently, electronic digitization by the Bibliothèque nationale de France (<http://mandragore.bnf.fr/jsp/rechercheExperte.jsp>), the Bibliothèque municipale de Rouen (France; <http://bibliotheque.rouen.fr/repons/portal/portal>) and the Biblioteca Casanatense (Rome; <http://opac.casanatense.it/SearchmanusMin.htm>) has greatly eased access, facilitating more efficient study and comparison of these documents. Noteworthy is the book by Cogliati Arano (1976), which contains 43 colour and 243 black-and-white reproductions of images, with English translations of the brief accompanying texts, taken from five illustrated *Tacuinum* manuscripts. These reviews and commentaries contain a wealth of historic, artistic and descriptive information and comparative analyses of the different versions of the illustrated *Tacuinum*. However, little critical attention and analysis has been devoted as yet to the images of plants by specialists of particular plant families.

Our interest in the *Tacuinum* focuses on the remarkable full-page illustrations as they relate to horticulture. Among the illustrations are particularly vivid depictions of the harvest of vegetables, fruits, flowers, grains, and aromatic and medicinal plants, which can provide substantial information on insufficiently investigated cultivated plants of the late medieval period. As will be shown, although the botanical details are often missing or erroneous, the depictions are valuable for identifying the crop plants known from late medieval northern Italy. Our specific objective was to identify the taxa of Cucurbitaceae and Solanaceae present in the illustrated versions of the *Tacuinum Sanitatis*.

HISTORICAL CONTEXT

Production of the lavishly illuminated Latin manuscripts known as the *Tacuinum Sanitatis* was begun in northern Italy in the last decades of the 14th century (Cogliati Arano, 1976; Segre Rutz, 2002; Bertiz, 2003; Hoeniger, 2006; Mane, 2006). These were manuals of health derived from the unillustrated *Taqwim al-Sihha bi al-Ashab al-Sitta* (*Rectifying Health by Six Causes*), an 11th-century Arabic manuscript written by the Christian physician and philosopher Abu al-Hasan al-Mukhtar ibn al-Hasan ibn ‘Abdun Ibn Sa’dun ibn Butlan (d. 1063), who was born and educated in Baghdad and whose travels took him to localities that are today in Iraq, Syria, Egypt, Israel and Turkey (Elkhadem, 1990). The *Taqwim* was a synthesis derived from Greek medical science and tradition, and served as a guide for healthy living, tersely summarizing components of health in a tabular form of 15 columns. Some 280 items were considered to be health-related, covering food and drink, climate and bodily activities, all of them to be balanced as a regimen for a healthy lifestyle. Elkhadem listed 16 surviving copies of the *Taqwim*, all but one of which he was able to access and compare. Translation of the *Taqwim* into Latin was commissioned by the Court of Naples and Sicily and completed by 1266. This translation, although not perfect, was considered by Elkhadem to be faithful to the text of Ibn Butlan. The Latin version, which was to become known as the *Tacuinum Sanitatis*, was copied repeatedly and circulated in Europe. Bertiz listed 14 depositories of copies of the *Tacuinum*.

Over 100 years after the first *Tacuinum* was prepared, in the last quarter of the 14th century, the first illuminated copies of it were commissioned of artists by northern Italian nobility (Cogliati Arano, 1976; Segre Rutz, 2002; Hoeniger, 2006). These illustrated *Tacuinum* manuscripts were among the diverse artistic creations that had been commissioned by the wealthy at that time, and most of the illustrations are idealized snapshots of daily life and seasonal activities in the countryside, with nobles engaged in supervision, sport and romance and feudal labourers at their daily toil. The poverty, wars and plagues that occurred in that region during the second half of the 14th century are ignored. The garden was an island of joy, serenity, recreation and amusement. As such, it was thought to lead to a sunny mental disposition, which was considered to be a valuable component of the maintenance and restoration of health (Bertiz, 2003).

The number of items found in the illustrated *Tacuinum* manuscripts of northern Italy is reduced as compared with the 280 items of the *Taqwim*. Unfamiliar items of the Near East were deleted or replaced by foods or subjects familiar to the local, northern Italian audience (Segre Rutz, 2002; Hoeniger, 2006). The text was markedly abridged. Short paragraphs, indeed selected extracts, substitute for the categorized tabulations and they occupy only a small portion of each folio in the illustrated *Tacuinum* manuscripts. Occupying most of the space of each page, above the text, is a large illustration of the subject matter. Each of the illustrated *Tacuinum* manuscripts contains approx. 200 depictions of plants, animals, agricultural practices and people. However, these *Tacuinum* manuscripts are not exact copies of one another. Not only do illustrations of the same item differ among them, there are a number of items that appear in one or more copies that do not appear in others and vice versa (Delisle, 1896). These illustrated manuscripts were, in effect, individualized, expensive coffee-table books directed to meet the demands of their elite commissioners.

Giangualeazzo Visconti (1351–1402), the Count of Milan and owner of a large feudal estate in the Po Valley (Lombardy, northern Italy), is thought to have commissioned the first illustrated versions of the *Tacuinum* from the workshop of the famous artist Giovannino de Grassi (Hoeniger, 2006). Three of the illustrated *Tacuinum* manuscripts, Paris 1673, Vienna 2644 and Rome 4182 (Table 1), are considered to have been produced in Lombardy during the last two decades of the 14th century by various artists employed in Giovannino de Grassi’s workshop (Cogliati Arano, 1976). A fourth *Tacuinum* manuscript, Liège 1041, is thought to have been produced first (Cogliati Arano, 1976) or just after the other three in the neighbouring western Veneto region (Segre Rutz, 2002; Hoeniger, 2006). Two other *Tacuinum* manuscripts are thought to have been produced later, during the mid-15th century. One of these, Paris 9333, is considered to have been copied by a German artist from Vienna 2644 (Bertiz, 2003; Mane, 2006). The other, Rouen 3054/Liechtenstein, is a derivative of Rome 4182 but was separated into two parts in the 19th century, one part of which is now in Rouen (France) and the other in the hands of a private collector (Segre Rutz, 2002; Bertiz, 2003; Bovey, 2005). We categorize these six manuscripts as archetypes. All six consist of full-page depictions showing plants growing *in situ*, in

TABLE 1. Extant Tacuinum Sanitatis and related manuscripts

Text reference	Depository	Catalogue no.	Manuscript type	Date*
Paris 1673	Bibliothèque Nationale de France, Paris	Nouv. Acq. Lat. 1673	Archetype [‡]	1380–1390
Liège 1041	Bibliothèque de l'Université de Liège	Ms. 1041	Archetype	1380–1400
Vienna 2644	Österreichische Nationalbibliothek, Vienna	Cod. Ser. N. 2644	Archetype	1390–1400
Rome 4182	Biblioteca Casanatense, Rome	Ms. 4182	Archetype	1390–1400
Paris 9333	Bibliothèque Nationale de France, Paris	Latin 9333	Archetype	1445–1451
Rouen 3054/Liechtenstein	Bibliothèque municipale, Rouen, and private collection [†]	Ms. 3054 [Leber 1088]	Archetype	1450s
Vienna 2396	Österreichische Nationalbibliothek, Vienna	Ms. 2396 [Eug. Q. 59]	Variant [§]	1476–1500
Rome 459	Biblioteca Casanatense, Rome	Ms. 459	Composite [¶]	c. 1400
Granada C67	Biblioteca del hospital Real, Universidad de Granada	Ms C67 [BHR/Caja A-001]	Composite	1440–1445
Paris 1108	Bibliothèque Nationale de France, Paris	Italien 1108	Composite [#]	1470–1475
Vienna 5264	Österreichische Nationalbibliothek, Vienna	Ms. 5264 [Med. 2]	Composite	1470–1475
Lugano 15	Bibliothèque Internationale de Gastronomie, Lugano	Ms. 15	Composite	1470–1475

* Dates are according to Cogliati Arano (1976), Opsomer-Halleux (1991), Segre Rutz (2002), Bovey (2005), and/or Hoeniger (2006), and/or respective depository catalogues and websites.

[†] The Rouen 3054 and Liechtenstein manuscripts are actually two parts of the same *Tacuinum* manuscript, separated from one another in the 19th century (Bertiz, 2003; Bovey, 2005).

[‡] Archetypes of the *Tacuinum Sanitatis* are considered as displaying plants growing in a garden or field depicted, together with a text extract, on a full page.

[§] This manuscript is considered a variant because it displays market scenes, four per page.

[¶] Composites are herbals that contain some images displaying plants growing in a garden or field; not all accompanying text is derived from Ibn Butlan.

[#] According to Segre Rutz (2002), another manuscript, New York Public Library Spencer Collection ms. 65, is closely related and similar to Paris 1108, Vienna 5264 and Lugano 15.

a field or garden, instead of a single detached plant specimen as according to the herbal tradition (Hoeniger, 2006).

The six extant archetypal *Tacuinum* manuscripts are listed in Table 1 together with their depositories, catalogue numbers and their shortened designations for use herein. As far as is known, the present report is the first to consider and compare all six of these manuscripts, although it is restricted to two plant families. Chronology and year of production of these manuscripts is not entirely certain and is still debated by scholars, and each of the dates is presented as a span of years. According to Segre Rutz (2002) and Hoeniger (2006), it is likely that more *Tacuinum* manuscripts existed in addition to these six, but they have either been lost or destroyed.

Other works listed in Table 1 are related to the six illustrated archetypal *Tacuinum* manuscripts but differ from them in layout and overall content. They will not be considered in depth here for several reasons. Vienna 2396 is a variant from the archetype because the layout consists of four images per page instead of a single large one. Also, the images containing cucurbits depict market scenes, rather than gardens or fields, and although pleasing artistically, they greatly lack botanical detail and accuracy. The other five manuscripts, Rome 459, Granada C67, Paris 1108, Vienna 5264, and Lugano 15, are categorized as composites because they include wild plants as well as garden plants, and many of the images are in the herbal tradition, showing individual plants or plant parts. They include illustrations of a number of genera from the Cucurbitaceae and Solanaceae that do not appear in the archetypal *Tacuinum* manuscripts, including *Bryonia*, *Ecballium*, *Hyoscyamus*, *Momordica*, *Physalis* (alkekenge) and *Solanum* (nightshades). Another composite manuscript exists in the New York Public Library, Spencer Collection ms. 65 (New York 65), but it has only been possible to access a few of the illustrations within it. According to Segre Rutz (2002), New York 65, Paris 1108, Vienna 5264 and Lugano 15 were produced at about the same time, around 1470 or

so, in the workshop managed by Giovanni Cadamosto of Lodi. These four are reportedly quite similar to one another in format, having two illustrations per page of a modest quality.

Bertiz (2003) listed six printed editions of the *Tacuinum* from the 1530s. These are quite different from the illuminated manuscript copies of the *Tacuinum*, instead being more similar to the *Taqwim* by containing Ibn Butlan's elaborate information in tabular form. Moreover, the woodcut images within are quite small, only 2–3 cm in height, and placed at the bottom of the page in a horizontal band.

THE IMAGES

The illustrations of most of the respective subjects are similar to one another in four of the six archetypal illuminated *Tacuinum* manuscripts: Vienna 2644, Rome 4182, Paris 9333 and Rouen 3054/Liechtenstein (Table 1). In all four, the illuminations are brilliantly coloured and focus primarily on the plants in gardens and fields. The artists even made efforts to depict various small weeds as growing in the gardens. In three of these, Vienna 2644, Rome 4182 and Rouen 3054/Liechtenstein, the lower border of the illustrations is depicted as creviced soil. Possibly, the cracks represent a drying out of the soil outside of the plots, which would suggest that the crops were selectively irrigated. Differing markedly from these four manuscripts are the Liège 1041 and Paris 1673 manuscripts, which focus on social interactions and on architecture, the plants having less detail and accuracy. In the Liège manuscript, the plants are highlighted in colour against the otherwise sepia-lined people and buildings, and sometimes are afforded the protection of a courtyard.

Cucurbit vines are normally procumbent, unless trained or allowed to grow on a structure. The procumbency is accurately depicted in Rome 4182, Rouen 3054 and Liège 1041. In contrast, several of the cucurbits are depicted as erect, without the

aid of any support, in Vienna 2644, Paris 9333 and, especially, in Paris 1673. Apparently, this was a pictorial device employed by the illuminators to provide the viewer with a perspective that maximizes the amount of information about the subject (Bertiz, 2003). Moreover, the crops are idealized and, although flowers and young fruits are often absent, the plants are shown as bountifully producing ripe fruits. Often, too, the size of the fruits is exaggerated and, indeed, little attention is paid to the correct proportional and spatial relationships among the plant parts (Hoeniger, 2006).

Four species of Cucurbitaceae and two genera of Solanaceae can be clearly identified in these six archetypal illustrated *Tacuinum* manuscripts (Table 2). Each of the six taxa of Cucurbitaceae and Solanaceae will be considered separately, across the six manuscripts, but not all of the taxa or their variants appear in all of the manuscripts. Overall, Vienna 2644

has the most botanically accurate depictions and hence, for each taxon or variant, the illustrations in this *Tacuinum* will be presented and considered first whilst the depictions in the Paris 1673 *Tacuinum*, which in most cases are the least accurate, will be presented and considered last. The similar illustrations appearing in Vienna 2644, Paris 9333, Rome 4182 and Rouen 3054/Liechtenstein are, whenever possible, presented together in a block for easy comparison, followed by the quite distinct Liège 1041 and Paris 1673 illustrations. As the labels of the illustrations are not always consistent with the plants depicted, they are listed in Table 2 together with the corresponding taxonomic identity of the plants. It was not possible to access a translation of the brief accompanying paleographic Latin writing for all of the illustrations. The translations of texts that are alluded to below can be found in Cogliato Arano (1976) and Opsomer-Halleux (1991).

TABLE 2. *Cucurbitaceae and Solanaceae illustrated in the six archetypal Tacuinum Sanitatis manuscripts*

Taxon, common name	Manuscript	Folio no.	Label
<i>Cucumis sativus</i> , short-fruited cucumber	Vienna 2644	23v	Cucumeres & citruli
	Paris 9333	20v	Cucumeres et citruli
	Liège 1041	20v	Cucumeres et citrolli
<i>Cucumis melo</i> , Chate Group	Rome 4182	40r	Cucumeres et citruli
	Rouen 3054	20v	Cucumeres & citruli
<i>Cucumis melo</i> , Inodorous Group, casaba melon	Paris 1673	38v	Cucumeres & cetruli
<i>Cucumis melo</i> , Flexuosus Group, snake melon	Liège 1041	19v	Langurie
<i>Cucumis melo</i> , Adana Group?	Vienna 2644	22r	Melones indi i palestini
	Paris 9333	19r	Melones indi i palestini
	Rome 4182	36r	Melones insipidi
	Rouen 3054	18v	Melones insipidi
	Liège 1041	19r	Melonus inzibidi
	Paris 1673	37v	Melones isipidi
<i>Citrullus lanatus</i> , watermelon	Vienna 2644	21r	Melones dulces
	Paris 9333	18r	Melones dulces
	Rome 4182	35r	Melones dulces
	Rouen 3054	18r	Melones dulces
	Liège 1041	20r	Mellones dulces
	Paris 1673	37r	Melones dulces
<i>Citrullus lanatus</i> , citron watermelon	Vienna 2644	21v	Melones insipidi
	Paris 9333	18v	Melones insipidi
	Rome 4182	37r	Melones indi i palestini
	Rouen 3054	19r	Melones indi i palestini
	Paris 1673	38r	Melones palestini
	<i>Lagenaria siceraria</i> , calabash, bottle gourd	Vienna 2644	22v
Paris 9333		19v	Cucurbite
Rome 4182		38r	Cucurbite
Rouen 3054		19v	Cucurbite
Liège 1041		18v	Cucurpide
Paris 1673		36v	Cucurbite
<i>Solanum melongena</i> , aubergine, eggplant	Vienna 2644	31v	Melongiana
	Paris 9333	21r	Melongiana
	Rome 4182	41r	Melongiana
	Rouen 3054	21r	Melongiana
	Paris 1673	25v	Melongiane
<i>Mandragora</i> sp., mandrake	Vienna 2644	40r	Fructus mandragore
	Paris 9333	37r	Fructus mandragore
	Rome 4182	73r	Fructus mandragore
	Liechtenstein	13r	Fructus mandragore
	Liège 1041	16v	Fructus mandragore
	Paris 1673	85r	Fructus mandragore

Cucumis sativus L. (cucumber, *Cucurbitaceae*); Fig. 1

Vienna 2644 folio 23v (Fig. 1A) depicts two gowned figures harvesting fruits from viney plants having undivided leaves and small yellow flowers. The fruits are shown as somewhat longer than the length of a hand, short cylindrical, and tuberculate, indicating cucumbers, *Cucumis sativus*. The intense yellow colour of the fruits indicates that they are ripe, the accompanying short paragraph stating that the fruits are best chosen as fully grown but before they turn yellow. The image in Paris 9333 folio 20v (Fig. 1B) is similar, the fruit surfaces appear to be uneven but tubercles are not defined. The image in the Liège 1041 folio 20v (Fig. 1C) depicts two taxa, one of these appears to be cucumber and the other a citron tree, *Citrus medica* L. (Rutaceae). The lower image shows a simplified, prostrate plant with green foliage and short cylindrical, yellow fruits about the length of a hand. Two of these appear to have an uneven surface, consistent with cucumbers, *C. sativus*. The citrus tree is shown bearing large, yellow fruits, also having an uneven surface. The bipartite label, *Cucumeres et citrulli*, suggests that *citrulli* is here interpreted to be citron but in other *Tacuinum* manuscripts, in which the citron appears alone, it is labelled differently.

Cucumis melo L. (melon, *Cucurbitaceae*); Figs 2 and 3

- (1) Rome 4182 folio 40r (Fig. 2A), also labelled *Cucumeres et citrulli* (Table 1), shows viney plants having cordate leaves bearing white flowers. The fruits are short cylindrical, slightly longer than the leaf laminae, green-yellow with orange-yellow stripes that are contiguous over the entire length of the fruit. This striping precludes cucumber, *Cucumis sativus*, but is entirely consistent with chate melon, *C. melo* subsp. *melo* Chate Group (syn. Adzhur Group) (Pitrat *et al.*, 2000) which, like cucumber, is grown for consumption of its immature fruits. The yellow colouration of the fruits indicates that they are mature, well beyond their usefulness as an esculent. Rouen 3054 folio 20v (Fig. 2B) is similar, also erroneously showing white flowers.
- (2) Paris 1673 folio 38v (Fig. 2C), also labelled *Cucumeres & cetruli* (Table 1), depicts a vine bearing alternating leaves with undivided to slightly divided laminae that are acute at the apex. Some of the leaves are coloured green, others brown, perhaps to indicate the adaxial and abaxial leaf surfaces. No flowers are depicted. What is unique about this image, though, is that, when examined carefully, the long oval, pale fruits, larger than the size of a hand, can be seen to be wrinkled, the same as modern casaba melons, *Cucumis melo* subsp. *melo* Inodorous Group.
- (3) Liège 1041 folio 19v (Fig. 2D), labelled *Langurie*, depicts a simplified, prostrate, viney plant bearing acutely cordate laminae and long, narrow, green, striate fruits. The fruits are of considerably greater length than a hand. A kneeling well-dressed woman holds a plate having four long, narrow, green fruits, offering them to two nobly dressed men. The shape and striations of the fruits leave no doubt that this image depicts snake melon, *Cucumis melo* subsp. *melo* Flexuosus Group. The text advises that the best ones are sweet and watery.



FIG. 1. Cucumbers, *Cucumis sativus*, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 23v, (B) Paris 9333 folio 20v, (C) Liège 1041 folio 20v.



FIG. 2. Melons, *Cucumis melo* subsp. *melo*, depicted in the *Tacuinum Sanitatis*: (A, B) Chate melons (Rome 4182 folio 40r, A; Rouen 3054 folio 20v, B); (C) casaba melons (Paris 1673 folio 38v); (D) snake melons (Liège 1041 folio 19v).

(4) Vienna 2644 folio 22r (Fig. 3A) depicts several plants growing in a garden with the label *Melones indi i palestini*. The vines are not dense, have cordate leaf laminae, small yellow flowers, and bear round, entirely yellow fruits slightly larger than a person's head. Two people are among the vines. A lady dressed in a blue gown is picking a fruit and a man in a red tunic with blue tights holds a fruit to his nose, indicating that the fruits are aromatic. The shape, colour and fragrance of the fruits leave no doubt that a type of melon, *Cucumis melo*, is depicted. The scenery in Paris 9333 folio 19r (Fig. 3B) hardly differs except for the clothing, lack of soil cracks, and green colouration of the ground. An entirely different depiction is given the same label, *Melones indi i palestini*, in the Rome 4182 and Rouen 3054 manuscripts (see below), but similar depictions are labelled *Melones insipidi* for Rome 4182 folio 36r (Fig. 3C) and for Rouen 3054 folio 18v (Fig. 3D). Evidently, the images

or the labels got switched. Both of the images lack people but do show plants bearing fruits that are round and yellow, about the same size or larger than the cordate leaf laminae. The flowers, however, are incorrectly depicted as white. The Rouen manuscript depicts the foliage as thinned out, more revealing of the fruits, which are of an intense yellow. Liège 1041 folio 19r (Fig. 3E) carries the label *Melonus inzibidi* for a simplified plant bearing yellow-green, lobed fruits, two characteristics which are consistent with *C. melo*. Paris 1673 folio 37v (Fig. 3F), labelled *Melones isipidi*, shows two women with an individual viney plant having acute, undivided leaf laminae, no flowers, and oval, yellow-green fruits nearly the same size as a person's head. All of these six images appear to represent melons of *C. melo* Adana Group. The text indicates that they are lemon-coloured and that the best ones are large, sweet and watery, indicating that they are used when ripe.



FIG. 3. Melons, *Cucumis melo* subsp. *melo*, possibly adana melons, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 22r; (B) Paris 9333 folio 19r; (C) Rome 4182 folio 36r; (D) Rouen 3054 folio 18v; (E) Liège 1041 folio 19r; (F) Paris 1673 folio 37v.

Citrullus lanatus (Thunb.) Matsum. & Nakai (watermelon, Cucurbitaceae); Figs 4 and 5

- (1) Vienna 2644 folio 21r (Fig. 4A), labelled *Melones dulces*, is a depiction of watermelon plants growing in a field or garden. In the jungle of vines, a man in a grey tunic is shown among the plants, steadying a fruit in one hand and holding a knife in the other, about to cut the fruit from the plant. The fruits leave no doubt as to the intended identity of the crop, as they are long oval, dark and light green-striped, larger than a man's head, and several of them have burst or been sliced open to reveal red flesh. The flowers are correctly depicted as small and yellow but the leaf laminae are not depicted realistically as they are shown as being entire instead of pinnatifid. The depiction of Paris 9333 folio 18r (Fig. 4B) is quite similar, showing a man in grey crouching over a watermelon that he is about to pick, and two burst or sliced watermelons having a red interior. Rome 4182 folio 35r (Fig. 4C) is inaccurate not only for the shape of the leaf laminae, but also for the white colour of the flowers. The size and exterior colouration of the fruits is similar to that shown in Vienna 2644 and Paris 9333. A crouching man dressed in a red tunic is about to cut a fruit from the plant, but none of the fruits show the flesh. Rouen 3054 folio 18r (Fig. 4D) is a simplified version of the picture in the Rome 4182 manuscript, in that the foliage has been thinned out, but is otherwise almost the same. Liège 1041 folio 20r (Fig. 4E) depicts five people in a courtyard and a highly simplified single plant, having but a few undivided leaves, no flowers, and several oval, yellow-green fruits that are striated, differing in size and probably reflective of differing stages of development, the larger, more mature ones about the same size and shape as in the other *Tacuinum* manuscripts. Hence their identity as watermelon is probable, even though not entirely certain, unless this illustration is considered in light of those with the *Melones dulces* label in the other manuscripts. Paris 1673 folio 37r (Fig. 4F) depicts two men with an individual viney plant having entire leaves and no flowers, the green fruits being striated and nearly of the same size and shape as the *Melones dulces* of the other manuscripts. One man appears to be drinking out of an end of one of the fruits. The text advises that the best ones are from Samarqand (modern Uzbekistan).
- (2) Vienna 2644 folio 21v (Fig. 5A) depicts viney plants growing in a field or garden. Two elegantly clothed people stand among dispersed vines. One of them holds a harvested fruit in one hand and a knife in the other, beginning to slice the fruit open. The leaf laminae are shown as entire and the flowers are depicted as small and yellow. The fruits are larger than the heads of the people, round and entirely dark green. Although the leaf laminae are not realistically shaped, being entire rather than pinnatifid, the size and yellow colour of the flowers and the roundness and green colour of the fruits, leave us with but little doubt that a type of watermelon is being illustrated. Given the label *Melones insipidi*, this would appear to be a citron. Present-day citron watermelons are often used to make preserves. They are watery

but usually hard, small and not sweet. The scene in Paris 9333 folio 18v (Fig. 5B) hardly differs except in the women's clothing, the lack of soil cracks, and green ground colour. An entirely different depiction is given the same label, *Melones insipidi*, in the Rome 4182 and Rouen 3054 manuscripts, but depictions similar to those in Vienna 2644 folio 21v (Fig. 5A) and Paris 9333 folio 18v (Fig. 5B) are labelled *Melones indi i palestini* for Rome 4182 folio 37r (Fig. 5C) and Rouen 3054 folio 19r (Fig. 5D). Hence, the illustrations or labels have been switched. The depictions of citron watermelons in the Rome and Rouen manuscripts are without people. The leaf laminae are shown as deeply divided, although not pinnatifid as in real life. However, the flowers are incorrectly depicted as white. The Rouen manuscript (Fig. 5D) depicts the foliage as thinned out, better revealing the fruits. Paris 1673 folio 38r (Fig. 5E), labelled *Melones palestini*, shows an individual viney plant having scarcely divided leaf laminae and no flowers, bearing round to slightly oval, light yellow-green fruits. Here too, the label appears not to be associated with the correct image. Reminiscent of Fig. 5A and B, two persons are depicted, one of them slicing a fruit and the other is tasting a piece but without enthusiasm, as would be expected for an insipid fruit. The Liège 1041 manuscript does not have a corresponding image. The *Taqwim* indicated that the fruits are best used when ripe.

Lagenaria siceraria (Molina) Standl. (calabash or bottle gourd, Cucurbitaceae); Fig. 6

All six of the *Tacuinum Sanitatis* manuscripts contain easily identifiable and fairly accurate depictions of the calabash or bottle gourd. Most of the manuscripts depict the entire leaves and white flowers faithfully, and show variation in the shape of the fruits, with one or more of the fruits being long and narrow and one or more being flask- or bottle-shaped. Two individuals are shown harvesting long, pale, immature fruits in Vienna 2644 folio 22v (Fig. 6A) and Paris 9333 folio 19v (Fig. 6B); in the latter the plants are growing on a trellis. Also, immature fruits, most of them bottle-shaped, are depicted in Rome 4182 folio 38r (Fig. 6C) and Rouen 3054 folio 19v (Fig. 6D), the foliage being thinned out and the plants depicted as growing on a trellis in the latter. In all four depictions, the viney plants have undivided leaves and the appropriate white flowers. Liège 1041 folio 18v (Fig. 6E) depicts two separate plants, their foliage coloured green but the fruits on each are uncoloured. One fruit on each plant is in the process of being harvested, one of the plants shown as having bottle-shaped fruits and the other has long fruits. Paris 1673 folio 36v (Fig. 6F) is perhaps the most horticulturally pleasing image of this species as the plants are depicted as growing on an arbour. Although incorrectly shown as having acute leaf laminae, the plants are otherwise depicted accurately as bearing tendrils and fairly large white flowers. Long fruits dangle from the arbour and are in the process of being harvested by two gown-clad women. The text advises that the gourds are best used when fresh and green.



FIG. 4. Watermelons, *Citrullus lanatus*, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 21r; (B) Paris 9333 folio 18r; (C) Rome 4182 folio 35r; (D) Rouen 3054 folio 18r; (E) Liège 1041 folio 20r; (F) Paris 1673 folio 37r.



FIG. 5. Citron watermelons, *Citrullus lanatus*, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 21v; (B) Paris 9333 folio 18v; (C) Rome 4182 folio 37r; (D) Rouen 3054 folio 19r; (E) Paris 1673 folio 38r.



FIG. 6. Calabash or bottle gourds, *Lagenaria siceraria*, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 22v; (B) Paris 9333 folio 19v; (C) Rome 4182 folio 38r; (D) Rouen 3054 folio 19v; (E) Liège 1041 folio 18v; (F) Paris 1673 folio 36v.

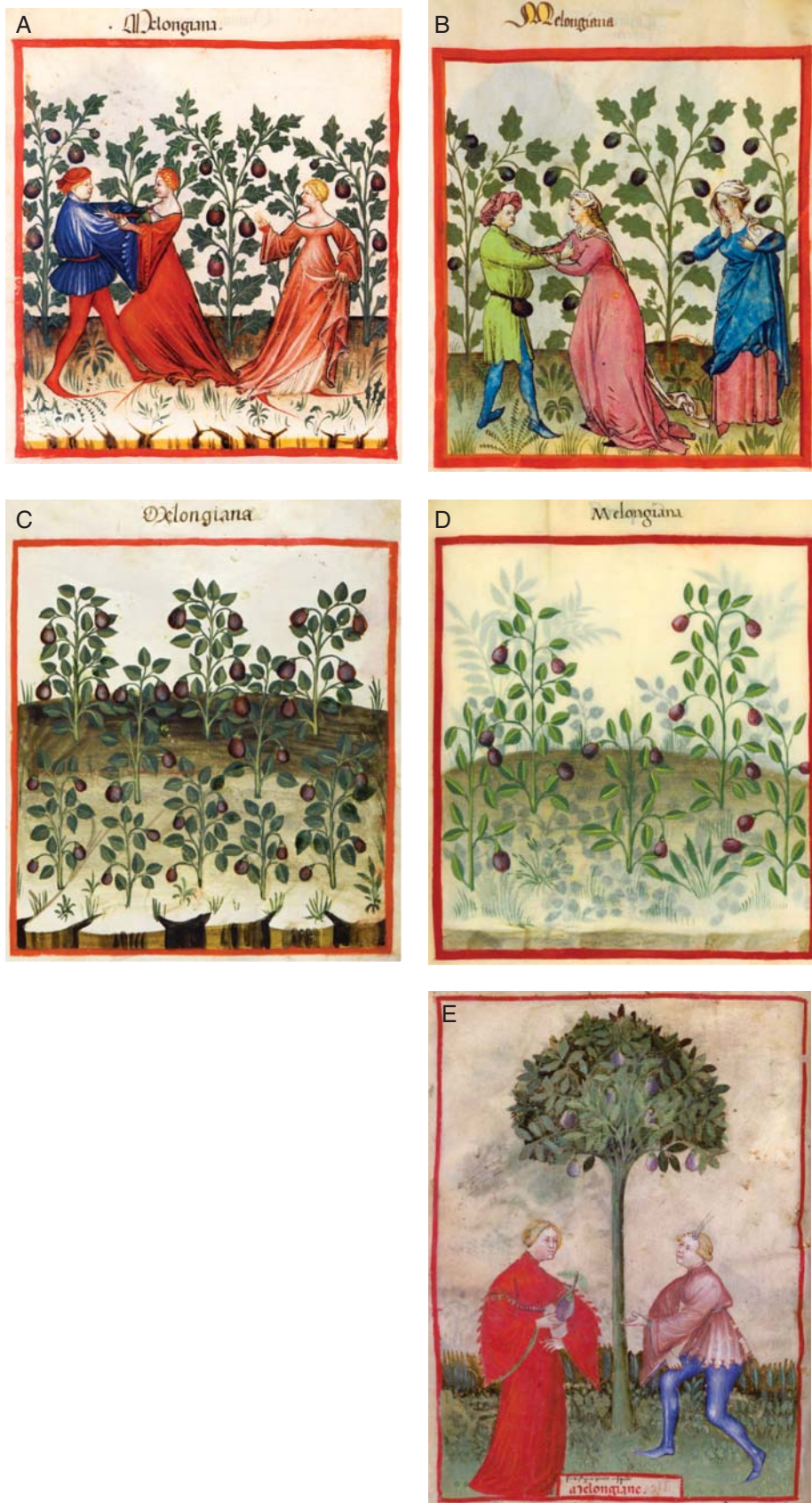


FIG. 7. Aubergine (eggplant), *Solanum melongena*, depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 31v; (B) Paris 9333 folio 21r; (C) Rome 4182 folio 41r; (D) Rouen 3054 folio 21r; (E) Paris 1673 folio 25v.

Solanum melongena L. (aubergine or eggplant, Solanaceae); Fig. 7

Vienna 2644 folio 31v (Fig. 7A) is not only one of the most stunning paintings in all of the *Tacuinum* manuscripts, it is also the most botanically correct in its depiction of aubergine, labelled *Melongiana*. This illustration appears to have been drawn from live plants in a garden, as four plants are depicted as aligned in a row. Moreover, the plants are depicted accurately for leaf shape, fruit and calyx size, shape and colour, and they are loaded with realistic egg-shaped, deep purple, glossy fruits at different stages of growth, the younger, smaller ones correctly depicted as borne near the plant apices. Eggplants have prominent, attractive corollas, usually purple, but, strangely, they are not shown. The plants are taller than the people in the foreground and exhibit only a few apical branches. Adult plants can indeed reach a person's height but are more highly branched, suggesting that either the plants were pruned or, for clarity and aesthetics, basal branches simply were not drawn. The eggplant illustration in Paris 9333 folio 21r (Fig. 7B) is almost identical, but the plants bear fewer leaves and fruits and are less precisely drawn, specifically, no small developing fruits are depicted. Vienna 2644 folio 31v (Fig. 7A) shows a lady admonishing a couple in which the man is fondling his female partner and Paris 9333 folio 21r (Fig. 7B) shows a lady who appears to be stunned by this same activity, seemingly implying that eggplant has aphrodisiacal properties. In Rome 4182 folio 41r (Fig. 7C), there are three rows of aubergines but no people. The egg-shaped fruits are deep purple and borne on unusually long, narrow peduncles; but the leaves are not depicted as undulate, instead they are unrealistically depicted as acutely cordate. In Rouen 3054 folio 21r (Fig. 7D), which is clearly derived from Rome 4182 folio 41r, the drawings are still cruder. In Paris 1673 folio 25v (Fig. 7E), the image shows a lady in a high-necked red gown with wide sleeves offering a light purple aubergine to a young man dressed in a mauve tunic and blue tights. However, the aubergine fruits are shown as borne by a tree! Overall, these illustrations show a successive decrease in botanical accuracy from Vienna 2644 to Paris 1673. The Liège 1041 manuscript does not contain an image of aubergine. The *Taqwim* indicated that the best aubergines were fresh, sweet and medium-sized, the old or raw fruits being bitter or indigestible, respectively.

Mandragora L. spp. (mandrake, Solanaceae); Fig. 8

The depictions of mandrake in Vienna 2644 folio 40r (Fig. 8A), Paris 9333 folio 37r (Fig. 8B), Rome 4182 folio 73r (Fig. 8C) and Liechtenstein folio 13r (Fig. 8D) are quite similar to each other, showing an anthropomorphized mandrake in a field with other wild plants. A starved dog tied to the mandrake has ripped the plant out from the soil in its effort to reach the scraps of food left for it by a male attendant, who in Paris 9333 (Fig. 8B) is shown protecting his ears from the legendary deadly shriek of the mandrake. The image in Vienna 2644 (Fig. 8A) is once again the most detailed. The two different colours of leaves in Vienna 2644 folio 40r and Liechtenstein folio 13r (Fig. 8D) probably indicate adaxial and abaxial leaf surfaces. The rosette of leaves, the leaf

shape and erect position of the fruits are consistent with real botanical features of mandrake, but the clustering and redness of the fruits are not and the anthropomorphization of the plant is, of course, imaginary. Liège 1041 folio 16v (Fig. 8E) shows two women in a courtyard, one of them presenting a human doll-like mandrake root to the other, apparently based on the Biblical account of Leah giving her *duda'im* (mandrakes) to her younger sister Rachel (*Genesis* 30: 14–15). Paris 1673 folio 85r (Fig. 8F) contains a similar theme, the aphrodisiac properties of the mandrake depicted by the male character kneeling in a clearly suggestive posture towards the smiling female. While not anthropomorphized, the depiction of the mandrake here is nonetheless unrealistic, the plant being too tall, the leaves depicted as dentate, and the fruits again depicted in clusters. Only the rosette growth habit and the greenish-yellowish fruit colour are correct. It is clear that none of the *Tacuinum* images of mandrake were drawn from live plants, but were based on ancient illustrated herbals and on the tales associated with this plant since antiquity. The text indicates that large, fragrant fruits were to be preferred.

DISCUSSION

Four species of Cucurbitaceae and two taxa of Solanaceae can be clearly identified from illustrations in the six extant archetypal *Tacuinum Sanitatis* manuscripts. The Cucurbitaceae are *Cucumis melo*, *Citrullus lanatus*, *Lagenaria siceraria* and *Cucumis sativus*. The Solanaceae are *Solanum melongena* and a species of *Mandragora*. Except for the mandrake, they are depicted as well-tended. Moreover, polymorphy is evident in three of the four species of Cucurbitaceae among the *Tacuinum* manuscripts, corresponding to and beyond that already illustrated and described in classical times (Janick *et al.*, 2007).

For *Cucumis melo*, four horticultural types are evident. Long and narrow, young green fruits labelled *Langurie* in Liège 1041 (Fig. 2D) clearly illustrate snake melons, *Cucumis melo* subsp. *melo* Flexuosus Group. This is the only image in the archetypal *Tacuinum* that shows snake melons. The oval, yellow-striped fruits labelled *Cucumeres et citruli* in the Rome 4182 manuscript (Fig. 2A) are clearly mature, ripe fruits of chate melons, *C. melo* subsp. *melo* Chate Group, now a relict crop in Italy (Hammer *et al.*, 1986). Both, snake melons and chate melons are consumed only when immature, similar to cucumbers (Pitrat, 2003). Chate melons appear in wall paintings of ancient Egypt and have been identified as the *qishu'im* of the Hebrew Bible (*Numbers* 11:5) that were remembered from Egypt and longed for by the Children of Israel during their wanderings in the Sinai Desert (Feliqs, 1968). The snake melons were identified as the *cucumis* of Pliny, 1st century CE, and the *qishu'in* of the *Mishna*, the Hebrew-language codex of Jewish law, 2nd century CE (Janick *et al.*, 2007). The third horticultural type of melon found in the *Tacuinum* manuscripts is the round, nearly spherical, yellow, aromatic fruits, labelled *Melones indi i palestini* in the Vienna 2644 manuscript (Fig. 3A). This melon was probably pleasant tasting, but not necessarily sweet like the commonly encountered sweet melons of today. Apparently it was similar to that referred to



FIG. 8. Mandrake, *Mandragora* spp., depicted in the *Tacuinum Sanitatis*: (A) Vienna 2644 folio 40r; (B) Paris 9333 folio 37r; (C) Rome 4182 folio 73r; (D) Liechtenstein folio 13r; (E) Liège 1041 folio 16v; (F) Paris 1673 folio 85r.

as *melo* by Pliny and as *melafefon* in the *Mishna*, possibly *C. melo* subsp. *melo* Adana Group (Pitrat, 2003). Similarly too, the fruits were eaten when mature, but the descriptions lack the enthusiasm with which the truly sweet melons of *C. melo* subsp. *melo* Cantalupensis Group were received when they arrived in Europe near the end of the 15th century (Goldman, 2002). A fourth type of melon is depicted only in the Paris 1673 manuscript. Labelled *Cucumeres et cetruli*, the fruits are depicted as oval, light-coloured and wrinkled (Fig. 2C). The wrinkled rind is diagnostic of casaba melons, *C. melo* subsp. *melo* Inodorous Group; the pale-coloured fruits closely resemble those of the 'Branco' casaba. However, casaba melons with intensely pigmented rinds, yellow, green or variegated, are much preferred today, and are most extensively grown in Spain and Asia Minor. Casaba melons are very sweet when fully mature but, like all other sweet melons, they are bland when immature, beginning to accumulate sucrose only upon approaching physiological maturity (Burger *et al.*, 2006). The label *Cucumeres & cetruli*, instead of *Melones*, can only lead to the conclusion that these melons were thought to be a variant of chate melons or cucumbers, i.e. were used when immature, prior to ripening, and were not recognized as being potentially sweet. Casaba melons require a warm and especially long growing season in order to mature to their remarkable degree of sweetness. Apparently, the potential qualities and cultural requirements of this type of melon were not known to the local populace or even to the commissioner of this manuscript, who presumably was from the internationally connected, well-educated nobility. These qualities were to remain unrecognized even beyond the time of the introduction into Italy of other sweet melons, the cantaloupes and muskmelons (Cantalupensis Group and Reticulatus Group), a century later (Janick *et al.*, 2007).

For *Citrullus lanatus*, large, long oval, light and dark green-striped fruits with red flesh are labelled *Melones dulces* in the Vienna 2644 manuscript (Fig. 4A) whilst spherical, dark green fruits are labelled *Melones insipidi* in the same manuscript (Fig. 5A). Obviously, the *Melones dulces* are quite similar to modern, red-fleshed, sweet watermelons. Watermelons were known in ancient Egypt (Murray, 2000; Janick *et al.*, 2007) and these *avattihim* of Egypt were also yearned for by the Children of Israel in the Sinai Desert (*Numbers* 11:5). Indeed, a long oval, striped fruit appears among ancient Egyptian depictions (Manniche, 1989). Watermelon remains have been recovered from Egypt of classical times (Cox and van der Ween, 2008). However, images of them are less frequent than those of melons, *Cucumis melo* (Andrews, 1958), leading Janick *et al.* (2007) to suggest that watermelons may not have been as widely appreciated because of their crossability with the hard, insipid citron watermelon and with the intensely bitter colocynth, *Citrullus colocynthis* (L.) Schrad., which grow wild east and south of the Mediterranean Sea (Lebeda *et al.*, 2007). The *Melones insipidi* appears to represent cultivated citron watermelons, also known as preserving melons. Citron watermelons are usually small, round, and striped dark and light green, with insipid, hard, pale-coloured flesh. The entirely dark-green cultivar labelled *Melones insipidi* in Vienna 2644 closely resembles the extant 'Red-Seeded Citron' (Goldman, 2002) but a different citron cultivar, with

a light yellow-green rind, is represented in Paris 1673 (Fig. 5E). Sweet watermelons (line 15) and two insipid watermelons (line 16) were listed by Ibn Butlan in one of his tables (Elkhadem, 1990) and it is notable, too, that both sweet and bland cultivars of *C. lanatus* had been distinguished in medieval northern Italy. Today, the citron watermelon is a relict crop in the Mediterranean region (Laggetti and Hammer, 2007), the fruits used for making preserves, the eating of the seeds, or serving as animal fodder. In some other regions it has become a naturalized, troublesome weed (Robinson and Decker-Walters, 1997). Sweet and citron watermelons have been considered as separate subspecies by Jeffrey (2001) and have been shown to be genetically quite distinct from one another (Levi and Thomas, 2005; Dane and Liu, 2007). The citron watermelon harbours considerably more genetic variation than does the sweet watermelon (Levi *et al.*, 2000). The colocynth, too, was mentioned in the *Taqwim* (Elkhadem, 1990). However, it was not included in the illustrated *Tacuinum* manuscripts, probably because it was not an esculent and not commonly grown in northern Italy. The colocynth was valued for medicinal purposes and appears to have been exported from the Middle East to Mediterranean Europe in late medieval times (Amar and Hazot, 2003).

For *Lagenaria siceraria*, two forms are represented, generally bottle-shaped, utilitarian and long, edible, with the vines growing intertwined in the same garden (Fig. 6A–D). The former are grown for use of the mature fruits as vessels or utensils and the latter are grown for consumption of the cooked immature fruits. The difficulty in maintaining container and edible forms apart was alluded to in classical times. Pliny proposed overcoming the problem by selecting seeds from particular regions of the fruit whilst the *Mishna* prohibited the planting of different forms next to one another in the same garden (Janick *et al.* 2007). Indeed, in Liège 1041 (Fig. 6E), two plants, one bearing bottle-shaped gourds and the other long gourds, are depicted as growing separately. In Paris 1673 (Fig. 6F), only long-shaped gourds are illustrated, the plants having been beautifully trained to climb an arbour in order to bear straight, long, hanging fruits. The text indicates that these gourds were to be used for eating when young and green (Cogliato Arano, 1976).

For *Cucumis sativus*, only one horticultural form is depicted and it is most plainly and clearly illustrated in Vienna 2644 (Fig. 1A). The fruits are depicted as yellow, even though the caption calls for use of fully grown fruits that have not yet turned yellow (Cogliato Arano, 1976). They have a short cylindrical shape and the characteristic tubercles, much the same as the cucumbers depicted in the early Renaissance festoons of the Villa Farnesina (Janick and Paris, 2006a) and other 16th century European images. The earliest illustration of cucumber known to us is from folio 42v of the *Manfredus de Monte Imperiali* herbal (Bibliothèque Nationale de France ms. Latin 6823), 1330–1340, which precisely and realistically depicts a cucumber plant bearing fruits of this same cultivar-group, which is referred to as the American Pickling Group (Paris and Maynard, 2008) and which is still widely grown today. Given the uniformity of the various late medieval through late 16th-century depictions of cucumber, *C. sativus* appears to have been a relatively recent arrival in most of Europe. Cucumbers are native to the Indian subcontinent

(de Candolle, 1886). They are thought to have been introduced into Moorish Spain in the medieval period, apparently being referred to by Ibn al-'Awwam (Clément-Mullet, 1864), but it is not clear whether they were introduced to the rest of Europe from there or as a result of the Mongol invasions led by Genghis Khan, which opened a safe overland route to Asia in the 13th century. Albertus Magnus may have described cucumbers in the latter half of that century (Hedrick, 1919).

For *Solanum melongena*, aubergine (eggplant), only egg-shaped fruits are depicted, and as dark purple in the four most closely related *Tacuinum* manuscripts, quite similar to the common modern-day market type of which 'Black Beauty' is an example. In Paris 1673 (Fig. 7E), the fruits are a lighter shade of purple. In all five of the archetypal *Tacuinum* manuscripts in which aubergine is illustrated, the fruits are depicted as immature, consistent with the goal of the *Tacuinum* to recommend the optimal stage for healthy consumption. Egg-shaped, purple aubergines are also found in Rome 459 (folio 163v) and Italien 1108 (folio 49r) (Table 1), and similarly shaped but light purple fruits are depicted in the *Manfredus de Monte Imperiali* herbal (folio 106v), dated 1330–1340, which as far as is known is the earliest occidental aubergine illustration of *S. melongena*. As egg-shaped, but white or pale-coloured fruits are illustrated in Vienna 2396 (folio 6v), Granada C67 (folio 105r) and Vienna 5264 (folio 55v), the range of aubergine fruit colour variation known in late medieval Europe appears to have been similar to that described in 12th-century Moorish Spain by Ibn Al-'Awwam (Clément-Mullet, 1864). Ancient literature from China indicates that purple fruit colour was typical there too but both round and long-fruited eggplants were recorded by the 14th century (Wang et al., 2008). The supposed aphrodisiac property of aubergine, as illustrated by the amorous couple in the foreground of Vienna 2644 folio 31v (Fig. 7A) and Paris 9333 folio 21r (Fig. 7B), is not mentioned in the *Taqwim* (Elkhadem, 1990). We have not found another medieval source suggestive of an aphrodisiac effect of aubergine, nonetheless such an effect is again alluded to in Renaissance herbals (Daunay and Janick, 2007).

For *Mandragore*, the illustrations are labelled *Fructus mandragore* throughout the six archetypal *Tacuinum*. All but one of the images of mandrake are anthropomorphized, recalling the ancient legend of its deadly shriek when pulled out the soil, and using a starving dog for this task (Thompson, 1968; Daunay et al., 2008). This tale, which dates to antiquity, was already depicted as the frontispiece of the earliest surviving illustrated herbal, the *Anicia Juliana Codex*, dated 512 CE. The alleged aphrodisiac properties of the mandrake (Feliks, 1968) are recalled in Liège 1041 (Fig. 8E) and Paris 1673 (Fig. 8F) even though they were not mentioned in the *Taqwim* (Elkhadem, 1990).

Horticulturally important Cucurbitaceae, notably *Cucurbita* L. species, that have been thought on the basis of archaeological, linguistic and historical evidence to have their origins in the Americas (Whitaker, 1947) are indeed absent from the *Tacuinum* manuscripts, the first of which pre-dated the European contact initiated by Columbus by only little over a century. The same holds true for the New World Solanaceae. There are neither images of pumpkins and squash, even though these do appear in European images from the first

two decades of the 16th century (Janick and Paris, 2006a; Paris et al. 2006), nor of tomatoes, potatoes or capsicum peppers, even though these appear in European images of the mid-16th century (Daunay et al., 2008).

As far as is known, this is the first report to consider and compare all six extant archetypal illustrated *Tacuinum Sanitatis* manuscripts, which has been made feasible by the ever-increasing availability of printed and electronic reproductions of these manuscripts. This report also appears to be the first dedicated to a botanical analysis of the depictions in the *Tacuinum*, albeit restricted to the Cucurbitaceae and Solanaceae, plant families with which there is a long-standing interest in their diversity. We believe that this analysis not only sheds light on the identification and use of these taxa in the medieval period but also can help clarify the relationships among these manuscripts.

According to Cogliati Arano (1976), the first illustrated *Tacuinum Sanitatis* manuscripts of the late 14th century must have been conceptualized in accordance with an overall plan that was coordinated by Giovannino dei Grassi. He probably had learned advisors who focused him on and explained to him the details in the text of the unillustrated *Tacuinum* manuscripts, from which a list of subjects to be illustrated was prepared, outlined, and assigned to particular artists employed in his workshop. Whilst late medieval painters typically worked by copying from pre-existing imagery in order to fulfil the specific content of a text (Hoeniger, 2006), we have not yet encountered cucurbit and aubergine images that we believe could have acted as models for those in the *Tacuinum* manuscripts. Nor was it even expected of medieval artists to always illustrate according to the subject matter, and yet in the illustrated *Tacuinum*, the text does indeed conform, in nearly all cases, undoubtedly tracing back to the original purpose of the *Taqwim* as a guide to good health. Moreover, the labels used for the images of Cucurbitaceae and Solanaceae have been conserved across the archetypal *Tacuinum* manuscripts, except for a few spelling variations. The variant orthography occurs mostly in the Liège 1041 manuscript (Table 2), from which Segre Rutz (2002) concluded that this manuscript was not derived from Lombardy, but rather from the neighbouring Veneto region.

Nonetheless, there occurred a major error in assigning two of the cucurbit labels to the correct illustrations (Table 2). Vienna 2644 folio 22r (Fig. 3A) and Paris 9333 folio 19r (Fig. 3B), each labelled *Melones indi i palestini*, depict a person smelling a large, yellow round fruit, consistent with a melon, *Cucumis melo*. The illustrations in Rome 4182 folio 36r (Fig. 3C) and Rouen folio 18v (Fig. 3D), which show similar large, yellow, round fruits, are instead labelled *Melones insipidi*. On the other hand, Vienna 2644 folio 21v (Fig. 5A) and Paris 9333 folio 18v (Fig. 5B), each labelled *Melones insipidi*, depict plants bearing dark-green fruits, consistent with *Citrullus lanatus* as do the illustrations in Rome 4182 folio 37r (Fig. 5C) and Rouen 3054 folio 19r (Fig. 5D) but labelled *Melones indi et palestini*. The Latin text of Vienna 2644 is longer and more descriptive than those of the other manuscripts and it indicates that the *Melones indi i palestini* fruits are yellow (Cogliati Arano, 1976), consistent with *C. melo*. Therefore, the labelling of the illustrations would be correct in the Vienna 2644 and Paris 9333

manuscripts and misplaced in the other two. The drawings of the Paris 1673 folios 37v and 38r (Figs 3F and 5E) have less clarity, but they do seem to have the same reversal of labelling as occurs in Rome 4182 and Rouen 3054; the same appears to occur for the *Melones inzipidi* of the Liège 1041 folio 19r (Fig. 3E). The misplacement of the labels suggests that the artists or the scribes assigned these folios were not familiar with these two cucurbits.

Another anomaly in the labelling concerns the *Cucumeres et citruli* (or with different orthography) and is most obvious in the Liège 1041 manuscript (Fig. 1C), which depicts two different taxa, as might be expected from a bipartite label. The taxa depicted therein are unrelated, cucumber (*Cucumis sativus*) and a citrus fruit, probably citron (*Citrus medica*). The citrus-fruit citron, not to be confused with the cucurbit citron, is depicted as a separate image in the other *Tacuinum* manuscripts. Possibly, mature citrus-fruit citrons and mature cucumbers were confused because they share a similar external appearance by their intense yellow colour, acute stylar end, and uneven, bumpy surface as well as by their similar epithets. On the other hand, only one taxon is depicted with the bipartite label *Cucumeres et citruli* in the other illustrated *Tacuinum* manuscripts, and this taxon is *Cucumis sativus* in Vienna 2644 (Fig. 1A) and Paris 9333 (Fig. 1B) and *Cucumis melo* in Rome 4182 (Fig. 2A), Rouen 3054 (Fig. 2B) and Paris 1673 (Fig. 2C). A plausible explanation for the single representation of *Cucumeres et citruli* is that the *citruli* were similar in appearance to the *cucumeres* and were used in similar fashion. Indeed, the bipartite label is derived from the *Taqwim* in which *al-qitha* and *al-khiyar* are entered together in line 66 of Table 10, indicating that both were to be marinated in vinegar or pickled (Elkhadem, 1990). *Qitha*, an Arabic epithet for chate melon, *Cucumis melo*, is the linguistic equivalent of the Hebrew *qishu*, which was *cucumis* to the Romans (Janick *et al.*, 2007), from which the medieval epithet *cucumeres* appears to have been derived. *Khiyar*, an Arabic epithet that is consistently associated with cucumber, *Cucumis sativus* (Amar, 2000), appears to have a central Asian origin (de Candolle, 1886). The pairing of *qitha* and *khiyar* by Ibn Butlan echoes the early 10th century Iraqi agricultural compendium of Ibn Wahshiyya (Hämeen-Anttila, 2006). In late medieval Europe, the Latin epithet *citruli* and its orthographic variants were associated with *C. sativus* (Sturtevant, 1891; Baumann, 1974). Indeed, Rome 459 (Table 1) has accurate illustrations of individual plants of *C. sativus* (folio 72r), *C. melo* (folio 170v) and *Citrullus lanatus* (folio 82v). These are labelled, respectively, *citroli*, *melones* and *cucumeres*, which correspond with modern Italian *cetriolo*, *melone* and *cocomero* for cucumber, melon and watermelon (Rebora *et al.*, 1967). The abbreviated text (Cogliato Arano, 1976) indicates that the *cucumeres* & *citruli*, collectively, were intended for use when green, prior to turning yellow, i.e. when immature, like snake melons, chate melons and cucumbers are used to the present day. Curiously, even though the *cucumeres* & *citruli* were to be consumed prior to their turning yellow, they are depicted as yellow (Figs 1A–C and 2A and B) in all of the *Tacuinum* manuscripts except Paris 1673, in which they are instead shown as a pale-coloured casaba melon (Fig. 2C).

Hoenerger (2006) wrote that the plants in general, and cucurbits in particular, illustrated in the *Tacuinum* have the same general appearance as those in the *Manfredus* herbal and Rome 459. However, in both of those manuscripts, the cucurbit plants are depicted individually with close-up, painstaking accuracy whilst even in the Vienna 2644 *Tacuinum*, they are depicted from afar, as a group growing in a garden, and hence the detail is not nearly as great. Hoenerger also considered the *Tacuinum* images of cucurbits to have ‘a botanical realism that reflects careful scrutiny’, citing the image of ‘*cucumeres* (cucumbers)’, Paris 1673 fol. 38v (Fig. 2C), as an example. In that folio, the foliage is not depicted with great detail or accuracy and the flowers are absent. On the other hand, the fruits are well-detailed and with great enough accuracy to clearly show that they are not cucumbers, *Cucumis sativus*, but melons, *C. melo*.

Of the six illustrated archetypal *Tacuinum* manuscripts, four are more similar to one another than any of them is to the remaining two. These four, Vienna 2644, Paris 9333, Rome 4182 and Rouen 3054 are brilliantly coloured and generally are more detailed and accurate with regard to the plants than are the other two, Paris 1673 and Liège 1041. Overall, Vienna 2644 has the most detailed and accurate representations of Cucurbitaceae and Solanaceae. Those of Paris 9333 appear to be copies, almost identical, but for some of the finer details. Similarly, the representations in Rouen 3054 appear to be copies of those in Rome 4182. Nonetheless, the Vienna 2644 and Paris 9333 images differ in several important ways from those in Rome 4182 and Rouen 3054. The image of *Cucumeres* & *citruli* depicts *Cucumis sativus* in Vienna 2644 and Paris 9333 but instead shows *C. melo* in Rome 4182 and Rouen 3054. Corolla colour is correctly depicted as yellow for *Cucumis* and *Citrullus* in Vienna 2644 and Paris 9333 and incorrectly depicted as white in Rome 4182 and Rouen 3054. Vienna 2644 and Paris 9333 have the correct labellings for citron watermelons and adana melons whilst a mix-up occurred in the other *Tacuinum* manuscripts. On the other hand, the leaf laminae of the citron (watermelon) are correctly depicted as being divided in the Rome 4182 and Rouen 3054 manuscripts, but incorrectly depicted as entire in Vienna 2644 and Paris 9333. Furthermore, in Rome 4182 and Rouen 3054, the melons and watermelons are correctly depicted as procumbent whilst in Vienna 2644 and Paris 9333 they are depicted as growing erect. For aubergine, lamina shape and peduncle length are more accurate in Vienna 2644 and Paris 9333 than in Rome 4182 and Rouen 3054. As the two late 14th-century manuscripts, Vienna 2644 and Rome 4182 (Table 1), are similar to one another but contain different inaccuracies, it seems to us that they must have been derived from a common, more accurate model. Based on other similarities and differences between Vienna 2644 and Rome 4182, Hoenerger (2006) arrived at the same conclusion. Not only did more *Tacuinum* manuscripts exist, one of them must have predated the Vienna 2644 and Rome 4182 manuscripts. Moreover, the artists who drew this hypothesized model manuscript must have been familiar with the plant material, as it is drawn with a good degree of detail and accuracy in these two manuscripts. Apparently, both the Liège 1041 and Paris 1673 manuscripts were derived separately and, given their lack of

botanical detail and accuracy, were prepared by instructors and artists who were less familiar with the plants.

No consensus of opinion has been reached among scholars concerning the chronological order and relationships of the late 14th-century Vienna 2644, Rome 4182, Paris 1673 and Liège 1041 manuscripts. Various orders and relationships have been suggested, based on artistic and textual considerations, by Cogliati Arano (1976), Witthoft (1978), Segre Rutz (2002), Hoeniger (2006), and references therein. Differences in botanical accuracy among the archetypal illustrated *Tacuinum* manuscripts, however, further suggest the possibility that the lost *Tacuinum* version, the one that served as the common template for Vienna 2644 and Rome 4182, pre-dated all of the known surviving illustrated *Tacuinum* manuscripts. This lost manuscript would also have served as the inspiration for the Paris 1673 and Liège 1041 versions, but for whatever reason was unavailable to serve as a template for them. Based on other evidence, such a sequence has indeed already been offered by Hoeniger (2006, p. 62):

‘A hypothetical reconstruction of the relationships among these manuscripts would run like this: Giangaleazzo had a lavish *Tacuinum sanitatis* created in the first place for his own personal enjoyment and that of his wife, but this version has not survived. Soon afterwards, he commissioned the Paris and Vienna manuscripts as beautiful gifts to be bestowed on family and friends on highly politicized occasions. As the manuscripts came to be admired at courts in northern Italy and in Vienna where Verde Visconti resided, other rich nobles desired their own copies.’

By comparing *Rubus* L. (Rosaceae) images appearing in extant medieval Dioscoridean manuscripts, Hummer and Janick (2007) offered an analogous hypothesis, that is, a lost Dioscoridean manuscript furnished with accurate images must have antedated and served as the template or inspiration for the extant manuscripts.

The horticultural and botanical legacy of the *Tacuinum Sanitatis* is the images of crop plants in their cultural setting of late 14th-century northern Italy. These images do not appear to have been copied from other sources such as herbals, books of hours or calendars, but rather appear to be fresh interpretations, having been drawn from living plants growing in gardens and fields. Therefore, most of the images, at least those of the hypothetical lost *Tacuinum Sanitatis*, must have been based on personal knowledge of the artists or their instructors. The images of cucumbers, casaba melons and aubergines are among the earliest depictions of these plants in Europe, suggesting that they were new introductions and, remarkably, the fruits depicted closely resemble those of extant cultivar-groups or market types. Finally, we suggest that botanical and horticultural accuracy can be used as a tool to derive relationships among the manuscripts.

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