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Rendiconti Lincei. Scienze Fisiche e Naturali

ISSN 2037-4631
Volume 31
Number 4

Rend. Fis. Acc. Lincei (2020)
31:1117-1126
DOI 10.1007/s12210-020-00959-x

Rendiconti Lincei. Scienze Fisiche e Naturali (2020) 31:1117–1126
https://doi.org/10.1007/s12210-020-00959-x

RESEARCH PAPER

Tobacco in the Erbario Estense and other Renaissance evidence of the Columbian taxon in Italy

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Received: 3 August 2020 / Accepted: 18 September 2020 / Published online: 27 September 2020

Abstract

The *Erbario Estense*, preserved in the Archivio Segreto Estense (Modena State Archives, Italy), is one of the very few sixteenth century herbaria still existing today. Among its *exsiccata* are a dozen species coming from the Americas, one of which is tobacco. The author of the specimen calls the plant *Tabacho, ouer Herba Regina*; Camus and Penzig, in the late nineteenth century, identify it as *Nicotiana tabacum* and affirm that it could be the most ancient direct proof of the presence of this plant in Italy. Today, attribution of the specimen to the above-mentioned species is certain and, according to the studies carried out for the present research, only three other sixteenth century *exsiccata* of *N. tabacum* still exist, all of them preserved in the Erbario Aldrovandi in Bologna. Therefore, the specimen of the Erbario Estense is extremely precious from a historical and scientific viewpoint. Tobacco was certainly known by the simplists who were working at that epoch in the lively scientific and medical environment of Ferrara, even if, according to documentary sources, real pharmacological use of the plant seems to have taken place only in successive phases.

Keywords Este duchy · Ferrara · Ancient herbaria · *Nicotiana tabacum* · Ethnobotany

1 Introduction

Italian herbaria dating from the sixteenth century are the oldest known in Europe today (Moggi 2012). The Erbario Estense is one of the least famous, because for about 250 years, it was preserved in the Archivio Segreto Estense and was discovered only in the late nineteenth century (Foucard 1882). The only study available of the entire collection was published 3 years later (Camus and Penzig 1885). In recent times, some further contributions appeared, focusing on specific aspects of this herbarium such as medicinal or cosmetic plants and their uses at the Este court in Ferrara (Vicentini and Mares 2008; Vertuani et al. 2014; Cremonini et al. 2016; Vicentini et al. 2014, 2018). The Erbario Estense consists of a papery codex of 146 sheets (32 × 22 cm) numbered on the *recto*, to which 182 *exsiccata* are glued, accompanied by a progressive number (apart from a few cases) and the common name of the plant (Camus and Penzig 1885). On top of the first page is written *Ducale Erbario Estense del secolo XVI.° sul fine*. The herbarium, by an unknown author, was put together in Ferrara in 1570–1598 (the year in which the Este court was transferred to Modena). Part of the collection was probably prepared after 1585, but the fact that three specimens are glued on more ancient paper that had been cut out and glued on the numbered sheets suggests that a previous herbarium could exist (or a first nucleus of the future herbarium, that may be doubtfully dated at before 1560), from which at least these three *exsiccata* were taken and added to the current Erbario Estense (Camus and Penzig 1885). In this herbarium, the presence of some exotic species of recent introduction to Europe is particularly relevant: we cite, for example, *Solanum lycopersicum* L., *Mirabilis jalapa* L., *Ipomoea quamoclit* L., *Tropaeolum minus* L., *Momordica balsamina* L. (Camus and Penzig 1885). One of the most interesting species is *Nicotiana tabacum* L. (c. 45r., n. 58: *Tabacho, ouer Herba Regina*). At a European

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level, the sample is one of the very first *exsiccata* of this species known today, and is a clear proof of the prosperity and richness of the Este Duchy. In fact, thanks to its enlightened rule, during the fifteenth and sixteenth centuries, Ferrara benefited from a wide network of cultural and commercial exchanges, with notable movement even in medical and botanical fields, where the advent of new plants from recently discovery lands was not infrequent (Vicentini and Mares 2008; Vicentini et al. 2018).

Nicotiana tabacum (Solanaceae) is an annual or perennial robust, erect, herbaceous or lianose plant, 0.8–3 m high, with a stem branching only in the top part. The leaves are large (10–50 cm), oblong-lanceolate and acuminate; the lower ones are ovate, semiamplexicaul with winged petiole. The flowers are 3–5 cm long, trumpet-shaped, white-pinkish, rose, reddish or yellowish, with pedicels 4–5 cm long and a calyx 1–2 cm long, and are organised in inflorescences generally consisting of panicled racemes. Fruits are capsules 1.5–2 cm long. All parts are sticky, covered with short glandular hairs whose exudate is yellow and nicotine-rich (Akehurst 1968; Cocucci and Hunziker 2005; Kishore 2014; Orozco et al. 2016; Pignatti et al. 2017–2019; Verloove 2020). The species is native to South America, especially around the border between NW Argentina and SE Bolivia (Cocucci and Hunziker 2005) or to Gran Chaco, Pampas and the lowlands of Patagonia (Rudgley 2005). *N. tabacum* is an allotetraploid species ($2n=48$) which does not exist in the wild state, but results from natural hybridization of *N. sylvestris* Speg. × *N. otophora* Griseb. or *N. sylvestris* Speg. × *N. tomentosiformis* Goodsp. in the zones where the parent species ranges are superimposed (Cocucci and Hunziker 2005; Christenhusz et al. 2017). The uses of the plant and its effects on man, mostly due to nicotine, are well known. Many varieties are now cultivated for commercial purposes (primarily for smoking, but also for pharmaceutical uses) in many parts of the world. Other congeneric species are maintained as ornamental plants or are spontaneous weeds (Kishore 2014; Christenhusz et al. 2017).

Between the fifteenth and sixteenth centuries, thanks to geographical explorations and conquests of non-European continents, in particular the Americas, a large number of exotic plants were brought to Europe (Peccenini 1994). These were first exchanged among the royal courts as precious novelties (Paoli 2019) and, especially from the 1540s onwards, became the object of deep investigations by scholars (e.g. Cristofolini 1992; Signorini 1996). In this regard, Mattioli's knowledge (1568) of some plants (e.g. maize, sweet pepper, common bean, etc.) which had just arrived in Italy is very interesting (Mariotti 1997).

The Spanish and Portuguese had a monopoly of transoceanic trade, but only clergymen could move freely to discover the rarest and most valuable products of the New World and bring them to Rome. In this cultural and political context, Lisbon became the most important centre for the cultivation of numerous exotic plants, which later spread to the rest of Europe (Paoli 2019): many of them were subsequently included in the European pharmacopoeias, at that time still based on the works by Galenus, Dioscorides and Pliny the Elder (Signorini 1996; Bruni 1998). The first of these plants came from Brazil and were maintained only in the King's gardens and in the gardens of monasteries. A plant that was spread with extraordinary rapidity was *Nicotiana tabacum*, already long used for ritual purposes by the American indigenous populations: it seems that, since his first voyage to America, Columbus brought a roll of dried tobacco leaves to Spain (Marini Bettolo 1992). In the early 1500s, tobacco was brought to Spain from the Caribbean by the monk Ramón Pane, then to Portugal, then to France in the mid-sixteenth century by the Franciscan friar André Thevet, then from Lisbon to the French court in Paris by Jean Nicot de Villemain, French ambassador to Portugal in the 1560–1561, who had already experimented its medicinal virtues for skin diseases and migraine (Mann 2011; Pignatti et al. 2017–2019; Paoli 2019). On account of its properties and uses, *Nicotiana tabacum* was almost certainly the first American plant to spread with immediate success, not only in Europe, but also in Asia and Africa, becoming «*the leading edge of the Columbian Exchange*» (Mann 2011).

In Italy, *N. tabacum* presumably arrived in 1560. In this regard, there are two contrasting traditions (see also Merat and de Lens 1837: 431): according to the current one (e.g. Durante 1585; Donzelli 1675; Lemery 1721), in 1560 cardinal Prospero di Santa Croce sent the Pope some seeds from Lisbon, with instructions on how to cultivate them (the popular Italian name *erba di Santa Croce*, which was used in past centuries to designate tobacco, is derived from him). According to Paoli (2019), however, *N. tabacum* was brought to Tuscany by Alfonso Tornabuoni, ambassador to the Medici family in Paris in the 1559–1560 period, who received the seeds directly from Jean Nicot de Villemain (another Italian popular name of tobacco plant, *erba torna buona*, is derived from him). Anyway, the introduction of the plant in Italy was probably due to more than one single person (Paoli 2019). Its cultivation began practically immediately (around 1560) in the upper Tiber valley, between Tuscany and Umbria, thanks to Niccolò Tornabuoni, and subsequently spread to various parts of Italy (Paoli 2019). According to Saccardo (1909), however, the cultivation in the Tiber valley started in 1570, but a proper explanation of this discrepancy has never been found so far.

At present, Italy is the first producer of tobacco in the European Union. Today the plant is grown mainly in four regions (Veneto, Tuscany, Umbria and Campania; see Mipaaf 2020), whereas in past decades, it was extensively cultivated throughout the national territory (Pignatti et al. 2017–2019). *N. tabacum* is also present as a casual alien

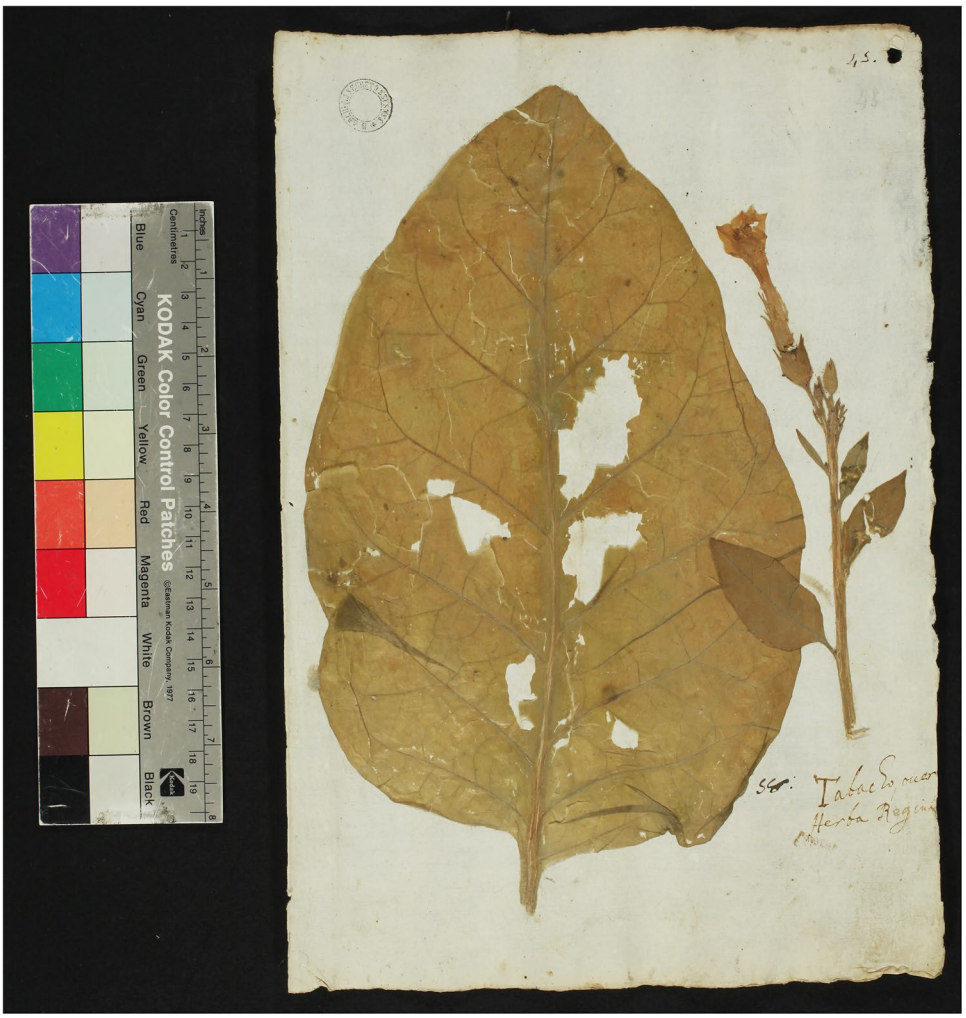

Fig. 1 The specimen of *Nicotiana tabacum* L. preserved in Erbario Estense, c. 45r., n. 58. On the sheet *Tabacho, ouer Herba Regina* (= tobacco, or Queen's Herb) is written

in Piedmont, Trentino-Alto Adige, Umbria, Latium, Campania, Sicily and Sardinia (Portale della Flora d'Italia 2020).

The presence of the *exsiccatum* of *N. tabacum* in the Erbario Estense provided the basis for the research here presented, focusing on the very first phases of the introduction of this species to Italy. To give some further information about its arrival and spreading, we searched for the earliest traces of the species in Italy, checking all the Italian herbaria dating from the sixteenth century and the principal textual sources of medical-pharmaceutical subject (this combined approach allows much more credible results to be obtained rather than a simple analysis of written documents or herbarium specimens, as already demonstrated in previous studies: see for example Pulvirenti et al. 2015; Costa et al. 2016; Bosi et al. 2017; Vicentini et al. 2018). Then, the treatise was centred on the ethnobotanical uses of *N. tabacum*, principally during the Renaissance and, in particular, at the Este court in Ferrara.

2 Materials and methods

First of all, we re-identified the *exsiccatum* of tobacco of the Erbario Estense according to the key published by Cocucci and Hunziker (2005), to verify the identification provided by Camus and Penzig (1885). The sample consists of one leaf and a terminal branch with inflorescence (one flower is developed, two others are simple buds) and is quite well preserved (Fig. 1). Given its overall good state of preservation and the presence of both leaves and a flowered branch (that is infrequent for a herbarium specimen of the sixteenth century: see for example Costa et al. 2016, 2018), it was not necessary to compare it to other more recent samples.

The presence of this specimen in the Erbario Estense suggested we search all the other *exsiccata* of this plant in remaining Italian herbaria dating from the sixteenth century known today: Erbario Aldrovandi, preserved in Bologna (BOLO), Erbario Cesalpino and Erbario Merini,

preserved in Florence (FI), Erbario Ex Cibo, preserved in Biblioteca Angelica in Rome, Erbario En Tibi, preserved in Leiden but of Italian origin (see Stefanaki et al. 2019). The research was performed through the names by which *N. tabacum* was known at that time: *Nicotiana*, *Tabacho*, *Tabacum*, *Tabacum minimum*, *Herba regina*, *Herba reginae*, *Herba sancta*, *Herba S. Croce*, *Sana sancta*, *Buglossum Antarticum*, etc. (Durante 1585; Bauhin 1623; Penzig 1924).

The study on the medicinal properties attributed to *N. tabacum* was limited to what is reported in the major treatises of medicine of the sixteenth century, therefore, coeval to the specimen of the Erbario Estense. Concerning pharmaceutical virtues or harmfulness of the species, subsequent periods were not considered, since only minor authors added some information to what was written by the most famous scholars of the Renaissance. The works were consulted and compared in the original text in universities or public libraries, or using digitised copies whose original is preserved in an Italian library. Finally, a short summary of the most relevant studies concerning the pharmaceutical activity of tobacco was made.

3 Results and discussion

3.1 Tobacco in sixteenth century Italian herbaria

The *exsiccatum* preserved in the Erbario Estense under number 58 (*Tabacho, ouer Herba Regina*) is *Nicotiana tabacum* L. (Fig. 1). The diagnostic characters are the large (25 × 17.5 cm) ovate leaf, with a winged and decurrent petiole, the calyx with laciniae less than the calyx itself, the corolline tube slightly curved and weakly enlarged under the corolla mouth, the stamens slightly exserted, the corolla 3–5 cm long. All parts are thickly covered by short glandular hairs (see Cocucci and Hunziker 2005; Pignatti et al. 2017–2019; Verloove 2020).

The search for samples of *N. tabacum* in the other Renaissance Italian herbaria gave results only for Erbario Aldrovandi, that contains three sheets with *exsiccata* of the species (Soldano 2004; Figs. 2, 3, 4):

- vol. XII, c. 198r.: *Nicotiana, siue Sana sancta, siue Tabacum minimum Lobell.*

- vol. XIV, c. 12r.: *Nicotiana carens pediculo in folijs.*

- vol. XIV, c. 13r.: *Nicotiana carens pediculis in folijs*; on the same sheet some names of this plant are also reported: *Nicotiana siue Tabacum*, *Sana sancta*, *Herba Reginæ*, *Herba sancta*, *Buglossum Antarticum*.

These samples consist of single leaves plus one flower (vol. XII, c. 198r.) or clustered leaves (vol. XIV, c. 12r.); in the remaining case, the inflorescence is also present. According to Soldano (2004), these specimens date from

Fig. 2 The specimen of *Nicotiana tabacum* L. preserved in Erbario Aldrovandi, vol. XII, c. 198r. On the sheet *Nicotiana, siue Sana sancta, siue Tabacum minimum Lobell.* (= *Nicotiana*, or *Sana Sancta*, or *Tabacum minimum* [according to] Lobelius) is written. Erbario Aldrovandi is part of the collections of Erbario dell'Università di Bologna (BOLO). COPYRIGHT © Università di Bologna/Sistema Museale di Ateneo—Erbario e Orto Botanico

1565–1568 (vol. XII) and 1568–1580 (vol. XIV), therefore, they are fairly contemporaneous to (or slightly older than) the sample in Erbario Estense, since the entire herbarium was dated by Camus and Penzig (1885) to 1570–1598. It is interesting to remember that Aldrovandi noted also the provenance of his samples: he obtained the first one (vol. XII, c. 198r.) *ex D. Dionisio Puchero ex India* (= from Mr. D. Pucher, from India—Biblioteca Universitaria di Bologna, Fondo Ulisse Aldrovandi, ms. 125; Soldano 2004), whereas the others were obtained from Ippolito Salviani (ibid., ms. 38/II, t. II, lett. 3 May 1567), who received the seeds from India (Salviani was the first to grow tobacco plants in Rome) and sent him leaves and seeds (ibid., ms. 89-I; Soldano 2004).

At the present stage of research, tobacco specimens present in the Erbario Aldrovandi and Erbario Estense are the most ancient in Europe. Their presence can be clearly explained if we consider the renowned qualities of *N.*

Fig. 3 The specimen of *Nicotiana tabacum* L. preserved in Erbario Aldrovandi, vol. XIV, c. 12r. On the sheet *Nicotiana carens pediculo in folijs* (=*Nicotiana* lacking a leaf petiole) is written. Erbario Aldrovandi is part of the collections of Erbario dell'Università di Bologna (BOLO). COPYRIGHT © Università di Bologna/Sistema Museale di Ateneo—Erbario e Orto Botanico

Fig. 4 The specimen of *Nicotiana tabacum* L. preserved in Erbario Aldrovandi, vol. XIV, c. 13r. On the sheet *Nicotiana carens pediculis in folijs* (=*Nicotiana* lacking leaf petioles) is written; some other names of the plant are also reported: *Nicotiana siue Tabacum*, *Sana sancta*, *Herba Reginæ*, *Herba sancta*, *Buglossum Antarticum*. Erbario Aldrovandi is part of the collections of Erbario dell'Università di Bologna (BOLO). COPYRIGHT © Università di Bologna/Sistema Museale di Ateneo—Erbario e Orto Botanico

tabacum as an important species in medicine and pharmacy. These were recognized very soon after its advent in Europe (Paoli 2019).

3.2 Tobacco and its virtues in the Italian Renaissance

According to Charlton (2004), the very first European illustrators of the tobacco plant are Leonhart Fuchs, who prepared four drawings (which remained unpublished—Meyer et al. 1999) of *Nicotiana rustica* L. and *N. tabacum* (Fuchs 1542), and Rembert Dodoens, who depicted *N. rustica* (sub *Hyoscyamus luteus*), probably based on a specimen (Dodoens 1554).

The work by Nicolás Bautista Monardes Alfaro, a Spanish medical doctor and botanist of the sixteenth century, is a cornerstone for detecting the pharmaceutical properties of plants growing in the Americas (Sonnedecker 1986; Anagnostou 2005; Valverde 2010). His most famous treatise is the *Historia Medicinal de las cosas que se traen de nuestras Indias Occidentales que siruen in Medicina*; in the edition of 1571 tobacco appears for the first time, with the promising title *Del Tabaco y de sus grandes virtudes* (Monardes 1571). The first Italian edition, which comprises the treatise on tobacco, was published only some years later (Monardes 1575). Apart from Monardes, the very first work exclusively dedicated to the pharmaceutical properties of tobacco is a French pamphlet by Jacques Gohori (1572), who declares «*vires eius expertæ sunt in vulneribus sanandis et vulceribus apostematis, contusionibus, lychene, morphea, mentagra*» (=its medicinal properties are experimented in curing wounds and ulcers of abscesses, contusions, lichen, morphea, sycosis vulgaris).

In Italy, tobacco is described for the first time by Castore Durante (1585) in his *Herbario nuovo*, whereas it is not mentioned in his subsequent work *Il Tesoro della sanità* (Durante 1586). The plant is indicated as *Herba S. Croce*, also referred to as *Hiosciamo Peruviano* and *Tabacco*. Durante cites the

same therapeutic virtues indicated by Monardes, with small variations in composition. In galenic preparations, tobacco is proposed as a cure for toothache, afflictions of the respiratory system such as a chronic cough and asthma, and also joint, gastrointestinal and gynaecological pains. Tobacco's oil is defined as alexiterous. It is useful for wounds, ulcers, gangrene and, in dermatology, for polyps of the nose, impetigo, erythematous ringworm, *tinea capitis* and chilblains. Some applications for veterinary use are also mentioned. Warm leaves, juice or poultices can be applied to the pain area. The syrup (decoction of the herb with sugar) is effective as a purgative, anthelmintic and expectorant. The smoke is useful for asthmatics. To treat toothache, the sick tooth is bathed using a cloth wet with juice and a small leaf ball is applied on the tooth itself: it calms the pain and stops putrefaction. The juice and mashed leaves stagnate blood flow, the unguent cures fresh wounds and resolves old ones. It is also reported that tobacco was used by the Indians to remove tiredness, thirst or hunger, by sucking small leaf balls positioned between the lower lip and the teeth (Durante 1585).

A new plant similar to tobacco is cited by Pietro Andrea Mattioli already in 1568: the plant represented in Fig. 1121 (sub *Hiosciamo nero*—Mattioli 1568) has been identified as *Nicotiana rustica* L. (Mariotti 1997). The passage, anyway, is not completely clear, because in the text, the plant that can be interpreted as *N. rustica* is called *Hiosciamo nuouo*, since it arrived in Italy in very recent times. Mattioli describes the medicinal properties of tobacco only in the *De Plantis*, posthumous work of 1586. He names it as «*Hyoscyamus Peruuianus vulgo dictus, quondam Pontiana & Nicotiana. Hispanis,* Petun*, et* Tabaco*. Gall.* Herbe de la Roine Mere*. Germanis,* Indianisch Bundefraut*. Indis,* Picielt» (=Peruvian *Hyoscyamus* commonly, formerly *Pontiana* and *Nicotiana*. For the Spanish, [it is known as] *Petun* and *Tabaco*; for the French, *Herbe de la Reine Mère*; for the German, *Indianisch Bundefraut*; for the Indians, *Picielt*). Therapeutical virtues and formulations are also reported (Mattioli 1586).

It is important to centre the attention on Ferrara, where the Erbario Estense was created (Camus and Penzig 1885), when tobacco appears in the treatises of medicinal botany in Europe. In this sense, the decades around mid-1500 were characterised by many works by the authors working in Ferrara, including Michele Savonarola, Niccolò Leoniceno, Giovanni Manardo, Antonio Musa Brasavola, Amato Lusitano and Paracelsus (Vicentini and Mares 2008). Their works were appreciated in Italy and Europe: Amato Lusitano suggested to those who desired to deepen their botanical knowledge to go to Ferrara, because «*i fierraresi* […] *sono medici dottissimi e profondi conoscitori della natura*» (Mattioli 1554; von Engelhardt 2012).

In the second half of the sixteenth century, however, the sole available information source for defining persons and cultivated plants are the archives, where the lists of plants growing in urban spaces devoted to cultivation of simples are particularly interesting. In this period, in the *studium* of Ferrara various *lectores simplicium* are worthy of attention, because of their relations with other illustrious simplists (in particular Ulisse Aldrovandi and Castore Durante): we remember Alfonso Cattaneo, Alfonso and Alessandro Pancio, Ippolito Obizzi and Evangelista Quattrami (Borsetti 1735; Solerti 1892; Pardi 1902; Muratori and Menini 1946; Franceschini 1970).

Thanks to the frequent epistolary correspondence with the simplists of Ferrara (for exchanging information, seeds and living plants), Ulisse Aldrovandi's archives testify the scientific movement in Ferrara in the second half of the sixteenth century (Biblioteca Universitaria di Bologna, Fondo Ulisse Aldrovandi, ms. 38/II, t. II, n. 2, cc. 8–65; ms. 38/II, t. II, n. 4, cc. 110–179; ms. 136/XXV, cc. 58v.–67r.; ms. 136/XXV, cc. 80r.–81r.; ms. 136/XXV, cc. 122v.–124r.; ms. 136/XXVI, cc. 2v.–5r.; ms. 136/XXVI, c. 38r.; ms. 136/XXVI, c. 214r. etc.; see also Frati et al. 1907). Reading the letters written by Cattaneo (years 1557–1569) and Alfonso Pancio (years 1565–1573) to Aldrovandi, international contacts with Spanish scholars appear. This fact surely favoured the arrival in Ferrara of plants and seeds from the Americas. Pancio, who was particularly interested in the new work by Monardes, could obtain a copy of this text from Aldrovandi and translated it into Italian. It is one of the first editions where tobacco is still absent, that will appear first in 1571. Nevertheless, in one of the letters by Pancio (ibid., c. 130—lett. 2 July 1568), a list of plants of diverse origin, which were sent to Aldrovandi, is reported: among them, the mention *Nicotiana, ò uerbasco affricano* appears; it seems that Pancio is not sure that this plant is tobacco, as one can understand by the disjunctive conjunction *ò* (=*Nicotiana*, or African mullein).[1]

[1] There are 57 letters written by Alfonso Cattaneo to Aldrovandi (from 1 August 1557 to 10 October 1569 – Biblioteca Universitaria di Bologna, Fondo Ulisse Aldrovandi, ms. 38/II, t. II, n. 2, cc. 8–65) and 69 written by Alfonso Pancio (from 20 November 1565 to 9 May 1573 – ms. 38/II, t. II, n. 4, cc. 110–179). In the letter dated 2 July 1568 (ibid., c. 130), a *Nicotiana* is named among the plants that Pancio sends to Aldrovandi, even if he is uncertain of their survival («*Mando al presente benché pensa* [sic]*, che non appiglieranno*») probably because of the torrid climate that he mentions in the letter. Then Pancio asks about Monardes' work (ibid., cc. 130, 138r., 141, 143, 144, 145, 160, 161) and speaks about some Spanish friends (ibid., cc. 136v., 160) and relationships with the Spanish court through the ambassadors of the Duke of Ferrara (ibid., c. 142), that are precious contacts, also in view of the provision of new plant species. Some plants of the New World are also cited: *Guaiacano*, *Salsaparilla*, *Mirabolan*, *Liquidambar* etc. (ibid., c. 136v.). According to the letters written by Cattaneo, Ferrara also welcomes Spanish alumni (ibid., cc. 54, 57). In addition, it has to be remembered that when Castore Durante publishes the *Herbario Nuovo* (1585), containing the monograph on tobacco, Cattaneo, highly esteemed by Durante himself, is in Rome as a professor and archiater of the Pope (Carafa 1751): before he came back to Ferrara, he could easily share his knowledge with the illustrious scholar, probably even about *Nicotiana*.

According to Camus (1895), the simplists of the *studium* of Ferrara meet (and, therefore, share knowledge and new techniques, such as the art of desiccating plants to prepare herbarium specimens) illustrious foreign scholars, like John Falconer from England and Conrad Gessner from Switzerland, who had been studying tobacco already from 1565.

During the sixteenth century, in Ferrara, there were numerous gardens and kitchen gardens realised for diverse purposes (Luzzato 1951). Based on archival sources, in Ferrara, tobacco was present neither in the Duke's gardens (Camus and Penzig 1885) nor in other contexts that could host it, for example, the public garden of which Obizzi was prefect (Frati 1908). Therefore, it seems that the plant was not cultivated within the city, but, as already seen for the *spigo nardo* (Vicentini et al. 2018), was an object of scientific interest at the Este court and in the cultural environment of that epoch. The fact that it is inserted in the Erbario Estense qualifies it as a study object for the simplists of that period. However, the medicinal use would be subsequent to the production epoch of the herbarium: tobacco is not cited in the *Statuti degli Speziali di Ferrara* of the period examined (Biblioteca Comunale Ariostea di Ferrara, Catastro dell'Arte de' Droghieri, Speziali, Medicinali e non Medicinali, Classe I, 478—years 1355–1793). In the seventeenth century, Pope Alexander VII (with *breve* of 29 November 1657) permitted the Municipality of Ferrara to prepare and sell tobacco, although its cultivation, even for personal use, was forbidden to private citizens («*È molto ancora che siaci permesso di averne sino a tre gambi di diversa specie a formar serie delle esotiche piante nel nostro giardino!*»—Cittadella 1868).

3.3 Tobacco's pharmacological properties from Gessner to today

At a European level, the first study about the effects of tobacco on animals was performed by Conrad Gessner, Swiss medical doctor and naturalist of the sixteenth century, a fundamental figure in the scientific panorama of his era (Blair 2017; Leu and Opitz 2019). These effects, which were described in a letter addressed to the physician Adolfo Occoni, dated 5 November 1565 (Gessner 1577), were experimented on a dog, with considerable emetic action after the administration of chopped tobacco leaves mixed with meat: «*cani etiam dedi particulam ejus folij contriti cum carne: qui post aliquot horas satis copiose vomuit*».

Today, nicotine is used to combat tobacco addiction (e.g. Benowitz 1997; Moolchan et al. 2005). Recent studies were performed to evaluate its potential as an anti-migraine (Gupta 2007). Results obtained on animals have encouraged the studies for possible postoperative analgesic treatment (Matthews et al. 2016; Ditre et al. 2016). Transdermal nicotine patches have been indicated for the treatment of skin disorders (Yoshifuku et al. 2013). Its vaunted pesticide activity has been recently confirmed, in particular against multidrug-resistant nematodes and ticks (Charvet et al. 2018; Schorderet Weber et al. 2019). Some neonicotinoids were developed as insecticides (imidacloprid IMD, thiamethoxam TMX, clothianidin CLO). Today, however, these are questioned because of the death of bee colonies, indispensable for pollination (Forfert et al. 2017). Nicotine derivatives have shown an anti-tuberculosis property (Gandhi et al. 2016). The antibacterial activity of tobacco leaves has been attributed to the presence of sclareol (Popova et al. 2019).

4 Conclusion

Between the fifteenth and sixteenth centuries, the Este court was strongly in favour of sustaining culture and sciences in Ferrara, with particular attention for gardens and kitchen gardens. Traces of these are still visible in the urban landscape. Also in Ferrara, as elsewhere in that period, the curiosity for exotic plants was widespread. New species arrived not only for the health of the Duke or his family, but also for purely botanical interests. The arrival of seeds, plants and information linked to them was favoured by the exchanges with other European courts through diplomatic channels. In addition, the *studium* of Ferrara attracted illustrious teachers and scholars who desired to increase their knowledge in a prestigious context.

The *lectores simplicium* and the simplists, charged with the Duke's gardens, formed relationships (of which dense correspondence has remained) with other eminent Italian and European scientists, who used to stay in Ferrara, even for very long periods, as a mandatory training stage. In this cultural environment, it is not surprising that the herbarium here treated was put together, in which a relevant part of the samples is made up of plants recently introduced to Europe, among them a dozen from the New World, among them tobacco, object of the present study. The author of the specimen indicated the plant as *Tabacho, ouer Herba Regina*, and our research confirms what was asserted by Camus and Penzig (1885), who correctly identified the sample as *Nicotiana tabacum*, indicating also that it could be «*il piú antico* [*exsiccatum*] *pervenuto a noi dall'epoca dell'introduzione in Italia*». Based on our investigations, there are only three other sixteenth century herbarium specimens of *N. tabacum*, all of them pertaining to the Emilia-Romagna ambit, preserved in the Erbario Aldrovandi in Bologna, dating from the 1565–1580 period.

Therefore, in Italy, tobacco is confirmed as plant of a precocious and long tradition; a tradition that has survived until today that makes Italy the country with the most abundant tobacco production in Europe.

Acknowledgements The authors are grateful to: Chiara Nepi (Università degli Studi di Firenze), Fiammetta Terlizzi and Francesca Fedeli (Biblioteca Angelica, Roma) for the information about *exsiccata* of *Nicotiana tabacum* in the Erbario Cesalpino, Erbario Merini and Erbario ex Cibo; Stefania Filippi (Biblioteca Universitaria di Bologna) for her precious help in archival research of Aldrovandi's manuscripts; Annalisa Managlia (Sistema Museale di Ateneo, Università di Bologna), for giving us high-resolution images of the samples of *Nicotiana tabacum* preserved in the Erbario Aldrovandi; Mirna Bonazza (Biblioteca Comunale Ariostea di Ferrara) for her valuable advice on archival research and interpretation of manuscripts. Special thanks are also due to Patrizia Cremonini (Archivio di Stato di Modena) for granting us permission to examine the Erbario Estense. Andrea Mary Lord (formerly Università degli Studi di Modena e Reggio Emilia) kindly revised the original English text. Finally, the authors thank the two reviewers for their positive and useful comments to a previous draft of this article.

Author contributions Not applicable.

Funding This work was supported by academic institutional funds (FAR) of the Università degli Studi di Ferrara (person in charge Prof. C.B. Vicentini).

Availability of data and material All the material used for this study is already available in the Archivio di Stato di Modena (the herbarium) and in public Italian libraries (textual sources).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Code availability Not applicable.

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Aggiuntoui à contemplatione de i Pij, e diuoti Professori, vn Catalogo de i Santi Medici. E in qvesta seconda impressione dal dottor Tomaso Donzelli figlio dell'avtore, Accresciuto, non solo con aggiunta in molti luoghi, mà anco con vn'Indice di Morbi, con i rimedij appropriati, che sono descritti nel precedente Teatro. Dedicato all'Illvstrissimo, et Eccellentissimo Signore, il Signore D. Diego D'Avalo D'Aqvino D'Aragona Marchese del Vasto, Prencipe di Francavilla, et Isernia, Conte di Monte Oderisio, Signore di Lanciano, Serra Capriola, Chievti, e dell'Isola di Procida, e Grande di Spagna. In Napoli, Per Gio. Francesco Paci, Geronimo Fasulo, e Michele Monaco, pars III, pp 33–34

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