heritage

MDPI

Article

Persistence and Heritage from Medieval *Bustān* Gardens: Roses in Ancient Western Islamic Contexts and Abandoned Rural Gardens of Spain

Diego Rivera [1,*], Julio Navarro [2], Inmaculada Camarero [3], Javier Valera [1], Diego-José Rivera-Obón [4] and Concepción Obón [5]

[1] Departamento de Biología Vegetal, Facultad de Biología, Universidad de Murcia, Campus de Espinardo, 30100 Murcia, Spain; javier.valera.martinez@gmail.com
[2] Laboratory of Archaeology and Architecture of the City, Escuela de Estudios Árabes (CSIC), Cuesta del Chapiz, 22, 18010 Granada, Spain; julionavarro@eea.csic.es
[3] Contrato Investigador con Cargo a Proyecto, Departamento de Historia Medieval y Ciencias y Técnicas Historiográficas, Facultad de Filosofía y Letras, Campus Universitario de Cartuja, 18071 Granada, Spain; inmacamcastellano@gmail.com
[4] Faculté Jean Monnet, Université Paris-Saclay, 54 Boulevard Desgranges, 92230 Sceaux, France; diego-jose.rivera-obon@universite-paris-saclay.fr
[5] Instituto de Investigación e Innovación Agroalimentario y Agroambiental (CIAGRO), Escuela Politécnica Superior de Orihuela, Universidad Miguel Hernández de Elche, 30312 Orihuela, Spain; cobon@umh.es
* Correspondence: drivera@um.es; Tel.: +34-868884994

Abstract

Medieval Islamic *bustān* gardens in the western Mediterranean played a crucial role in preserving and enriching rose diversity through the cultivation of species from the eastern Mediterranean and western Asia. These gardens, particularly in Al-Andalus, maintained distinctive rose varieties characterized by diverse flower morphology—ranging from white to deep crimson and near-black hues, including various yellow shades—and complex fragrance profiles with multiple olfactory nuances. The botanical heritage from these medieval Islamic gardens demonstrates remarkable persistence, with several of these cultivated rose species still found today in abandoned *cortijos* and *aldeas* throughout the mountains of eastern Spain. This study examines the transmission of rose culture through medieval Islamic *bustān* gardens, analyzing how these gardens served as repositories for ancient cultivars while introducing new varieties from eastern regions. Through examination of historical texts, iconographic evidence, and field documentation of surviving populations, we trace the continuity of medieval Islamic rose cultivation practices and their lasting impact on the rural landscape of eastern Spain. Flower scent is prominent as the leading factor determining preferences for medieval heritage rose cultivars, together with color and shape. The survival of these roses in abandoned settlements provides unique insight into the durability of medieval horticultural systems and the adaptation of cultivated species to semi-wild conditions over centuries.

Keywords: *almunia*; botanical collections; *bustān*; Austrian Briar; cabbage rose; Damask roses; eglantine; iconography; lexicography; medieval heritage roses

Academic Editor: Assunta Florenzano

Received: 26 June 2025
Revised: 1 August 2025
Accepted: 2 August 2025
Published: 7 August 2025

Citation: Rivera, D.; Navarro, J.; Camarero, I.; Valera, J.; Rivera-Obón, D.-J.; Obón, C. Persistence and Heritage from Medieval *Bustān* Gardens: Roses in Ancient Western Islamic Contexts and Abandoned Rural Gardens of Spain. *Heritage* **2025**, *8*, 315. https://doi.org/10.3390/heritage8080315

1. Introduction: Historical Background

Roses have been distinguished by the beauty of their flowers, from the simplicity of those with five petals to those with hundreds of petals, by the purity and intensity of

their colorations, and, especially, by their characteristic, yet restricted, fragrance. When combined with their relative ease of cultivation, profuse flowering, and the persistence of the rose bush over the course of decades, even in abandoned gardens, and the presence of thorns on their stems and foliage, the rose has become imbued with a particularly rich symbolic value, especially across Eurasia.

The genus *Rosa* (Rosaceae) comprises around three hundred species and spans its natural habitat along the Northern Hemisphere covering Eurasia, North America, and the Maghreb, Sudan, Eritrea, Djibouti, Ethiopia, and Somalia in North Africa [1]. Despite their humble origins, starting from only a dozen of these species, humans have developed and utilized hundreds of hybrids and thousands of varieties, exploiting their culinary, medicinal, and ornamental potential across, notably, temperate but also tropical regions globally. Historical rose breeding involved a complex series of interspecific hybridizations among seven to fifteen wild species, contributing to the genetic makeup of modern roses. The exact number of species depends on interpretations of their roles in domestication. Over millennia of spontaneous hybridization and the last three centuries of supervised breeding, this process shaped the genomes of modern cultivars. This unique genetic bottleneck means that genetic diversity in roses now includes two main sources. First, there is the diversity within the genus *Rosa*, which consists of 140 to over 280 wild species. Second, there is the vast number of rose cultivars, currently estimated to exceed 30,000 [2].

The rose held paradoxical status in medieval Western Islamic culture: while it served as a prominent symbol in the literature and gardens [3–7], its visual representation remained notably limited. This scarcity in visual arts can be attributed to Islamic principles regarding naturalistic representation. When roses did appear in medieval Western Islamic visual arts, they manifested primarily as stylized decorative motifs across select artistic contexts.

Architectural ornamentation provides one of the most significant examples, particularly in the palatial city of the Alhambra of Granada, Spain (13th–14th century). Here, stylized roses and floral motifs were integrated into broader geometric and arabesque designs, carved into stucco, wood, and tilework throughout the complex, notably in the Patio de Comares. These representations, while abstracted, contributed to a broader visual vocabulary evoking paradisiacal gardens.

In manuscript illumination, roses occasionally appeared in Arabic botanical texts, particularly those derived from Dioscorides' De Materia Medica. These illustrations served dual purposes: scientific documentation and decorative embellishment. Manuscripts from Al-Andalus and the Maghreb region demonstrate how natural floral forms were adapted to conform to Islamic esthetic principles, resulting in stylized interpretations rather than naturalistic depictions.

The decorative arts incorporated roses in various forms. In ceramics, particularly Al-Andalusian glazed pottery, roses appeared within complex designs that merged floral elements with geometric and arabesque patterns, though often in highly abstracted forms. Textile arts, including Andalusian carpets, silk, and brocade, commonly featured floral motifs symbolizing paradise gardens. However, in Mudejar-style carpets from Alcaraz, the floral motifs more closely resemble daffodils than roses [8] (p. 227), though some designs may represent stylized roses [8] (pp. 262, 263, 265, 268), particularly in Renaissance-style pieces [8] (pp. 350, 364).

We hypothesize that roses in Western Islamic culture possessed multidimensional significance that transcended their ornamental function, encompassing symbolic, literary, and philosophical dimensions that reflect broader cultural values and esthetic principles. The present study aims to (1) reconstruct the cultural significance of roses in Western Islamic civilization through systematic analysis of textual, visual, and material evidence from agricultural treatises, poetry, and philosophical works; (2) establish a provisional catalog of

rose varieties cultivated in this historical context based on interdisciplinary source analysis; (3) trace the transmission of Eastern Islamic rose cultivation traditions—particularly from Persian and Anatolian sources—to Western Islamic territories from classical antiquity through to the medieval period; (4) evaluate the relationship between specific morphological and phytochemical characteristics and historical cultivation preferences; and (5) assess evidence for historical continuity in rose cultivation practices in the western Mediterranean, particularly in light of recent botanical discoveries in the Albacete mountains (Spain). This multidisciplinary approach provides a comprehensive framework for understanding the complex interplay between botanical knowledge, cultural symbolism, and horticultural practice in medieval Islamic societies.

2. Materials and Methods

We extensively revised the Western Arabic literature in fields such as agriculture, architecture, medicine and botany but also poetry to determine not only the rose types recognized by authors of the medieval Western Islamic world but also their provenance, cultivation, and uses. We paid particular attention to morphological characteristics (e.g., flower color and petal number), phenological traits (e.g., blooming season), geographic origin, and reported specific uses to facilitate a more accurate botanical identification. The selection of texts and topics is primarily based on the authors' experience, but a comprehensive review using Google Scholar proved to be useful.

We adopted the standard transliteration of Arabic characters into English, commonly referred to as "Romanization," following the "International Phonetic Alphabet (IPA)".

The lexicographical databases consulted include CORDE from the Real Academia Española for Spanish [9], Harvard Ancient Text Resources [10] for Latin, Stazione Lessicografica VoDIM and ArchiDATA [11,12] for Italian, and the Dictionnaire de l'Académie Française and the Trésor de la langue Française informatisé [13] for French. The selection of images was made from the author's image bank and references from the works consulted.

We paid particular consideration to the iconographic imagery in two significant manuscript documents: the *Bayāḍ wa-Riyāḍ*, Vatican codex Vat. ar. 368 [14–16], and the *Cantigas de Santa Maria* by Alfonso X the Wise. In the latter case, the *Códice Rico* from the Royal Library of the Monastery of San Lorenzo de El Escorial, circa 1280–1284, contains one hundred and ninety-five cantigas (originally two hundred), making it the first manuscript of the four preserved where text, music, and image intertwine. Each poem is accompanied by an illuminated folio illustrating the miracle, with two folios for poems ending in five, a number especially associated with Marian devotion, thus shaping the manuscript's structure [17,18]. Although we analyzed this manuscript for other specific study of Christian Europe medieval and Renaissance roses, it was also useful to contrast with the Arab or Arab–Islamic sources.

In terms of buildings, we focused on the analysis of a vegetal set of scenes on walls and vaults, apparently linked to Western Islamic *bustān* gardens in the Hall of the Kings in the Palace of the Lions of the Alhambra (1396–1408 CE), the palace of the Zisa in Palermo (1165–1180 CE), and the hall of the Norman king Ruggero II (1131–1154 CE) in the royal palace of Palermo. We were without success in terms of analyzing the Sicilian monuments. In earlier and later periods, we have focused our search on recognizable images of roses. Medieval paintings, tapestry, goldsmithing, stained glass, iron forging, and sculpture images of roses were studied directly in the Cluny Museum (Paris) and Cathedral of Rouen to contrast with the scarce images available from Western Arab sources.

We also examined images of Oriental roses depicted in miniatures and other artifacts. These visual resources were studied at the Ethnologisches Museum Dahlem, Pergamon

Museum, and Museum für Islamische Kunst (all in Berlin); the British Museum in London; the Louvre and Musée national des Arts asiatiques—Guimet (both in Paris); the MAO—Museo d'Arte Orientale (Turin); the Museo Nazionale d'Arte Orientale Giuseppe-Tucci (Rome); and the Musée des explorations du monde (Le Suquet, Cannes).

To botanically identify medieval roses, we analyzed a chronological sequence of botanical treatises published from the 16th and 17th centuries, starting with the advent of printing techniques. This comprehensive review included numerous pre-Linnaean publications, many of which contained detailed descriptions and illustrations (*icones*).

We performed an extensive review of the botanical literature from the 16th and 17th centuries, including works by Ruel (1537) [19], Fuchs (1551) [20], Matthioli (1559) [21], de Lobel (1576) [22], Caesalpino (1583) [23], Dodoens (1583) [24], De los Ríos (1592) [25], Clusius (1601 and 1611) [26,27], Bessler (1613) [28], Bauhin (1623) [29], Parkinson (1629) [30], Ferrari (1633) [31], and Cupani (1696) [32]. These publications offer descriptions of various rose types, with some—like those by Clusius, Bessler, and Parkinson—also featuring illustrations.

The Eichstätter Garten rose collections were fundamental to identifying ancient roses. Also known as the Hortus Eystettensis or Bastionsgarten, this botanical garden was established during the Renaissance by Prince-Bishop Johann Konrad von Gemmingen on the bastions of the Willibaldsburg in Eichstätt, Upper Bavaria. The garden's plants were meticulously documented in the famous botanical work *Hortus Eystettensis*, first published in 1613 at the Prince-Bishop's request [28]. Unfortunately, only Bessler's illustrations and descriptions from 1613 [28] have survived.

Following this, we examined a series of post-Linnaean botanical studies. By comparing their descriptions and images with available information from Western Arab literature and evidence of continuous cultivation in Europe from the 16th century onwards (as documented in pre-Linnaean sources), we were able to propose the botanical identity of these medieval roses.

Our research also encompassed a wide array of later botanical works, including those by de Tournefort (1719) [33], Miller (1752) [34], Herrmann (1762) [35], Münchhausen (1770) [36], Jacquin (1770) [37], Gómez Ortega (1784) [38], the *Encyclopedia* of Poiret (1804) [39], Thory (1819) [40], Lindley (1820) [41], Redouté and Thory (1828, 1835a, and 1835b) [42–44], Boutelou (1829) [45], Paul (1848 and 1872) [46,47], Colmeiro (1873) [48], Burnat & Gremli (1887) [49], Willkomm & Lange (1880) [50], Willkomm (1893) [51], Crépin (1897) [52], Boulenger (1925 and 1931) [53,54], Vicioso (1964) [55], and Montserrat et al. (2016) [56], in addition to current botanical databases. We paid particular attention to the illustrations and descriptions found in the monumental work of Redouté and Thory [42–44].

Beyond the published literature, we gathered information from various private gardens across Europe. In Italy, these included gardens in Sardinia, Puglia, Sicily, Campania, Tuscany, and Rome. In Spain, we consulted gardens in Murcia, Castilla-La Mancha, Granada, Seville, Córdoba, Orihuela, Almoradí, and Valencia.

We also studied significant rose collections in France, such as those at the Bagatelle Rose Garden in Paris, the Roseraie du Val-de-Marne (formerly Roseraie de l'Haÿ), the Parc de la Tête d'Or (also known as the Jardin Botanique de la Ville de Lyon), and the Roseraie at the Villa Ephrussi de Rothschild in Saint-Jean-Cap-Ferrat. These French collections boast a wide array of Spanish, French, and Italian roses. Additionally, the rose garden at the University of Murcia was an important resource.

Ancient roses were grown in Molina de Segura (Murcia) from specimens collected in the field but also from specialized nurseries such as André Éve (https://www.roses-andre-eve.com/ accessed on 1 July 2025), David Austin (https://eu.davidaustinroses.com/ accessed on 1 July 2025), Loubert (https://www.pepiniere-rosesloubert.com/ accessed

on 1 July 2025), or Barni (https://shop.rosebarni.it/en/ accessed on 1 July 2025). Finally, descriptions from Western Arab authors were revisited in their original Arabic form to recover the Andalusian names of roses cultivated between the 10th and 13th centuries.

Phytochemical and molecular data were obtained through literature searches in Google Scholar, PubMed, and Scopus, notably using the keywords *Rosa* and essential oil, phylogeny, or hybridization.

The correction of manuscript texts was carried out using DeepL v1.52.0 (updated July 31, 2025), Claude Sonnet 3.5, Deep Seek V3, Conversation on botanical references and URL verification (18 July 2025 interaction), Mistral (Core Models Powering Le Chat Mistral: Magistral Medium 1.1-25,07, Pixtral Large 24,11 and Mistral Large 2.1-24,11), and ChatGPT 3.5 [57–60].

3. Results

3.1. Rosa Species in Western Islamic Bustān Gardens: Medieval Literary Evidence

Etymology and Cultural Significance: The term "*bustān*" (Persian: بوستان) describes gardens featuring fruit trees, flowers, and water elements in the Persian and Arabic literature. Unlike general terms for gardens or orchards, "*bustān*" carries deeper cultural significance within Persian and Islamic traditions, representing, for some authors, an idealized space symbolizing harmony and paradise, particularly fitting for Islamic gardens in the Western Islamic world [3–5,61–65].

The terminological distinction between *bustān* and *munya* reflects important regional and functional differences in medieval Islamic landscape architecture and estate management. The Arabic term *bustān* (بستان) was indeed the standard and widely recognized term throughout the medieval Islamic world for sophisticated aristocratic properties that integrated multiple functions: ornamental gardens, agricultural production, and hunting grounds. This term appears consistently across Arabic texts from the Abbasid period through the later medieval centuries, from Baghdad to Cairo, and to Córdoba, indicating its universal acceptance in high culture.

The *bustān* represented an idealized form of estate that combined esthetic pleasure with economic productivity—embodying the Islamic concept of cultivated landscape that served both spiritual contemplation and material sustenance. These properties typically featured geometric gardens, fruit orchards, vegetable plots, and often enclosed hunting parks, all designed according to Islamic principles of water management and spatial organization.

In contrast, *munya* (منية) developed as a distinctly Andalusi phenomenon, representing a regionalization of Islamic estate culture specific to the Iberian Peninsula. While sharing functional similarities with the *bustān*—combining gardens, agriculture, and leisure—the *munya* evolved characteristics adapted to Iberian geography, climate, and the particular social dynamics of Al-Andalus, where both terms were used. These estates often featured terraced landscapes adapted to Mediterranean topography and integrated Hispano-Roman agricultural traditions with Islamic design principles [3–5,61–65].

The persistence of *munya* in the Spanish term "*almunia*" demonstrates the profound cultural impact of Andalusi civilization on Iberian landscape terminology. Unlike many Arabic loanwords that disappeared after the Christian conquest, "*almunia*" survived because it described a specific type of property that continued to exist and function in post-Islamic Spain, serving similar aristocratic and productive purposes under Christian rule.

Historical Sources and Garden Flora: The Cordova Calendar from the reign of Al-Ḥakam II (Abū al- ʻĀṣ al-Mustanṣir bi-Llāh Al-Ḥakam b. ʻAbd al-Raḥmān) (961–976 CE) provides insight into Umayyad garden flora. This weather almanac lists around one hundred plants, including utilitarian and ornamental varieties such as bay, chamomile, iris, jasmine, marigold, myrtle, narcissus, roses, stock, wallflower, and violet [66].

Roses in Medieval Arab–Islamic Poetry: In medieval poetry from Al-Andalus, roses served as powerful metaphors representing the beloved's cheek and blood, symbolizing beauty, tenderness, freshness, and fragrance. These poems were often composed in the relaxed atmosphere of *almunias* (country estates) during spring and summer gatherings.

Notable poetic examples include Ibn al-Qūṭiyya (c. 950 CE), which compared flowers to human features: "Drink wine beside the fragrant lily that has bloomed. . . One is like a white idol displayed before the passerby; the other, like a cheek slapped on the sorrowful morning of parting" [67].

Aḥmad ibn ʿAbd Allāh ibn Aḥmad ibn Gālib ibn Zaydūn (1003–1071 CE), considered the greatest love poet of al-Andalus, wrote from Madīnat al-Zahra, "In the sunny rose gardens, the red buds shine, enhancing the morning's brightness," emphasizing both the importance of red cultivated roses and the existence of specialized rose gardens [67]. He also wrote "How kind [Madīnat] al-Zahra, with its lovely view, with its aura gentle as a sigh, of diamond purity! Just a glimpse of its beauty is enough to admire, Garden of Eden, river of Paradise. Just by looking at it, life is prolonged. These are the places where I weep for lost love, more tender and fresher than the garden rose" [68].

Other poets portray roses as symbols imbued with erotic, frequently homoerotic, and wine-related connotations. Aḥmad Abū ʿĀmir ibn Šuhayd of Córdoba (992–1035 CE) said "There were roses like cheeks blushing from the gaze of the bold" [68]. Caliph ʿAbd al-Raḥmān V, al-Mustaẓhir (c. 1020 CE), evoked intimate settings: "Have you forgotten the time we spent the night together on a bed of roses, while the stars of the horizon shone like pearls on lapis lazuli?" [67]. Ibn Muqānā (c. 1040 CE), serving Idrīs II ibn Yaḥyà, emir of the Taifa of Málaga, wrote "They drink another wine on the cheek of the cupbearer, as beautiful as a gazelle; a cheek where the rose and jasmine bloom... The wings of the air have been moistened by the rose water of dawn for those who rise early to drink" [67]. Abū Aḥmad al-Munfatil, an 11th-century court poet of the Jewish ministers of the Granada taifa, wrote "On Aḥmad's cheek, there is a mole that enchants every free man: It looks like a rose garden whose gardener is an Abyssinian" [67].

Abū Bakr Muḥammad ibn Ammār, also known as Ibn Ammār of Silves (1031–1086 CE), a poet and vizier of the Taifa of Seville (1031–1086 CE), personified gardens: "The garden is like a beautiful woman, dressed in the tunic of its flowers and adorned with the pearl necklace of dew. . . Or like a youth, blushing with the modesty of the roses and emboldened by the myrtle" [67]. This again draws a parallel with the blush of a cheek and set focus on roses of the Alba and Damascena groups that decline these colors.

The Valencian poet Ibn Jafāŷa (c. 1100 CE), described "We were perfumed by the fragrant orange blossom, intertwined with the rose, like a sweet white mouth smiling, kissing a cheek" [67].

Abū-l-Ḥasan ʿAlī b. Zaqqāq from Valencia (c. 1120 CE) wrote "The roses that fell into the pool, scattered by the wind's breath. They are the blood the wounded knight sheds through his broken armor" [69]. This metaphor links red roses, probably of the Gallica or Damascena groups, with artificial lakes and pools.

Ibn ʿArabī (1165–1240 CE), a Murcian Arab scholar, mystic, poet, and philosopher, profoundly influenced Sufi Islamic thought. His cosmological teachings shaped the world-view in many parts of the Islamic world. In his poetry, he used roses metaphorically to convey deeper meanings [70]. For instance, he likens the rosy blush of shame, arising from meditation and contemplation, to the roses of a verdant meadow. He also describes roses blooming in dew-laden gardens, symbolizing the fulfillment of desires.

In *The Seals of Wisdom*, Ibn ʿArabī uses the rose's scent as a metaphor for truth [71]. He explains that much like a dung-beetle is offended by the rose's fragrance, those who are false in nature are repelled by the truth and prefer falsehood. In *The Book of Divine*

Contemplations [72], he describes encountering a verdant garden in the middle of a desert, filled with roses, various flowers, birds, and fruits as a metaphor of the encounter with God, symbolizing beauty and abundance in unexpected places.

Medicinal and Alimentary Roses: Diyā' al-Dīn Abū Muḥammad 'Abd Allāh ibn Aḥmad al-Mālaqī, commonly known as Ibn al-Bayṭār (1197–1248 CE), was an Andalusian physician, botanist, pharmacist, and scientist. In his *Kitāb al-Jāmi' li-Mufradāt al-Adwiya wa-l-Aghdhiya* (*Compendium on Simple Medicaments and Foods*) [73–75], he mentions roses candied in honey or sugar ([73], No. 504) (cf. *Rosa gallica* L. 'Conditorum') and rose oil ([74], No. 911, No. 962) made by macerating rose petals in olive oil or sesame oil, which is optimal for treating various conditions orally or topically. In addition, he mentions the astringent fruits of the wild shrub rose with white flowers (cf. *Rosa canina* L.) ([74], No. 1579; [75], No. 2281).

Ibn al-Bayṭār compares the medicinal properties of the *nisrîn* rose (Cf. *Rosa moschata* on account of the Persian sources cited) with those of the jasmine ([75], No. 2222, No. 2282) and underlines the emmenagogue properties of the desiccated roses. He also records the name "rose from China" for this peculiar type of rose.

Finally, Ibn al-Bayṭār cites various rose classes ([75], No. 2274): red roses (with anti-inflammatory properties), white roses (strongly scented), yellow roses, and a black rose exclusively from Iraq. He also mentions the Persian rose, the best, but they say its buds often fail to open, suggesting a particular form of *Rosa* × *centifolia*, very aromatic, with a deep red color and petals arranged very tightly. In addition to the above, it presents an exhaustive repertoire of properties and medicinal uses of roses and the confections that are prepared with them ([75], No. 2274).

Agricultural and Horticultural Practices: Ibn al-ʿAwwām (c. 1150 CE) described practical rose cultivation: for decoration (*jimāl*) of the gardens (*basātīn*), roses were planted in October in bundles of six or eight stems for garden decoration (*jimāl*) [76–79]. He detailed a unique method for creating tree-like roses using ceramic tubes (*ʿanābīṭ*) placed over rose bushes. These painted or glazed tubes, about three feet long, were filled with soil and sand, creating the striking appearance of trees with colorful painted trunks [76]. However, we have not found archeological references for this type of ceramics.

Ibn Luyūn (1282–1349 CE) provided comprehensive guidance for *bustān* design, recommending a specific layout: water features (*zafariche*), evergreen plants, flowering species, fruit trees, and grapevines with trellises. His plant list included six types of citrus trees, aromatic plants, and flowers, notably mentioning both regular roses (*ward*) and *Rosa moschata* (*ward al-zīna*).

Ibn Luyūn specified that rose bushes and myrtles should be planted near the central pavilion (*qubba*), which offered views in all directions: "After the *zafariche* [the space designated to place the pitchers containing fresh water], there will be evergreen plants that maintain their freshness. Following this, there will be flowering species, and then the remaining trees. It culminates with grapevines on the sides and trellises in the central parts of the ensemble. And beneath the trellises, there will be pathways (*mamāshī*) encircling the garden area (*al-bustān*) as lateral paths. Among the fruit trees, besides the vines, there will be elms and similar trees, whose wood is useful. Following this, there will be white soil (*al-arḍ al-bayḍā'*) to cultivate whatever one wants to be lush. And at the end [of the white soil], trees like the fig tree or others that are not harmful will be planted. And all the major fruit trees should be planted in the northern part (*jawf*) [of the orchard or the white soil] because it is the most suitable. So, they protect from the northern wind and never obstruct the passage of the sun. And in the center of the garden area (*bustān*), there will be a pavilion (*qubba*) for gathering with views in all directions. . . . And adjacent to [the pavilion], rose bushes and myrtles will be planted, as well as anything that beautifies the

space of the orchard (*arḍ al-bustān*). . . . The entire orchard will be surrounded by a high wall to protect and conceal it. . .” [6,80].

In marginal note 6 (v. 14), Ibn Luyūn lists the plant species ideal for the *bustān*, including ornamental shrubs, six types of citrus trees, aromatic plants, and flowers near the pavilion or leisure area: “Around the pavilion, include myrtles (*rayḥān*) (*Myrtus communis* L.), bitter orange trees (*nāranŷ*) (*Citrus* × *aurantium* L.), pummelo (*zanbū’*) (*Citrus maxima* (Burm.) Merr.), lemon trees (*laymūn*) (*Citrus* × *limon* (L.) Osbeck), bergamot [or pummelo] (*astunbūtī*) (*Citrus* × *bergamia* (Risso) Risso & Poit.), lime trees (*līm*) (*Citrus* × *limon* var. *limetta* (Risso) Ollitrault, Curk & Krueger, citron trees (*utruŷŷ*) (*Citrus medica* L.), laurels (*rand*) (*Laurus nobilis* L.), jasmine (*yāsamīn*) (*Jasminum* sp.pl.), plots of borage-or more likely lemon balm- (*turunŷān*) (*Melissa officinalis* L.), rings of lilies (*sūsan*) (*Lilium candidum* L.), flowerbeds of violets (*banafsaŷ*) (*Viola odorata* L.), narcissus (*bahār*) (*Narcissus tazetta* L.), wallflower varieties (*jayrī*) (*Erysimum* × *cheiri* (L.) Crantz), rose bushes (*ward*) (*Rosa* sp.pl., notably *Rosa* × *damascena* Herrm.), thyme (*nammām*) (*Thymus* sp.pl., and, notably, *Thymbra capitata* (L.) Cav.), mint (*naʿnaʿ*) (*Mentha spicata* L. and others), rue (*šaḏāb*) (*Ruta graveolens* L.), elecampane (*rāsin*), marjoram (*marḏanŷūš*) (*Origanum* sp.pl), chicory (*māmmīṯā*), asparagus (*isfar*), *Rosa moschata* bushes (*ward al-zīna*), colocasia (*qulqāṣ*), and saffron (*za‘farān*)” [6,80].

Archeological and Historical Evidence:

The Agdal of Marrakech: The Agdal, a royal estate south of Marrakech dating to the Almohad era, covers 340 hectares of cultivated orchards [81]. Al-ʿUmarī (1301–1349 CE) documented the *Bāb al-Bustān* (Gate of the Garden) connecting the palace to this estate.

“The [*kasbah*] has three gates exclusive to it: [the first being] the Gate of the Garden [*Bāb al-Bustān*], which is reserved for the Sultan’s family members; it gives access to a garden [*bustān*] called the *Buḥayra”* [63,64,81–83].

ʿAbd al-ʿAzīz ibn Muḥammad al-Fishtalī (1549–1621 CE) vizier of Al-Manṣūr (Abū l-‘Abbās Aḥmad al-Manṣūr bi’llāh), the Saadi Sultan of Morocco, and official historiographer, described the Agdal as featuring “avenues lined with aromatic plants and trees: myrtles, lemon trees, elderberries, rose bushes, *nisrin*, jasmines, and a forest of countless olive trees,” noting at least two species of roses [81,83]. In summary, the great *bustān*, the Agdal of Marrakech, and its surrounding areas, particularly the agricultural landscape, boasted a wealth of citrus fruits, including lemons and oranges, but also at least two species of roses [55,56,63,64].

The Generalife, Granada: Palynological analysis of the Court of the Water Channel at the Generalife identified 47 different types of pollen in medieval strata, including myrtle, cypress, three citrus species, roses, laurels, and possibly jasmine, confirming rose cultivation in Nazari gardens [84,85].

In medieval Al-Andalus (8th–15th centuries), roses held profound cultural significance both as horticultural elements and poetic metaphors. Documentary evidence from the Cordova Calendar through Ibn Luyūn’s treatises reveals sophisticated cultivation techniques, including specialized ceramic tube methods for creating tree-like roses.

Andalusian poets extensively used roses as metaphors for beauty, love, and divine truth, with notable works by Ibn Zaydūn, Ibn ‘Arabī, and others linking roses to human features, intimate settings, and spiritual concepts. It is important to underline the comparison of roses with the red color of lips, and that of blushing cheeks of teenagers, the latter currently represented by, for instance, ‘Blush Damask’, ‘Great Maiden’s Blush’, or ‘Small Maiden’s Blush’ [86,87].

Archeological evidence from sites like the Agdal of Marrakech and the Generalife confirms the widespread cultivation of multiple rose species in Islamic gardens, integrated with citrus trees, aromatic plants, and water features in carefully planned layouts that embodied the *bustān* ideal of power and representation together with that of earthly paradise.

3.2. Rosa Species in Western Islamic Arts and Crafts: Medieval Visual Evidence

The artistic representation of roses and rose bushes in the Western Islamic world is substantially constrained by the limited naturalistic illustration found in manuscripts, ceramics, textiles, and architectural elements. While floral motifs potentially identifiable as roses appear in the ceramics and textiles of Al-Andalus, attributing these to specific species within the genus *Rosa* presents significant taxonomic challenges. Similar interpretative difficulties arise when examining the imagery in the *Bayāḍ wa-Riyāḍ* manuscript and the ceiling paintings of the Hall of Kings (*Sala de los Reyes*) in the Alhambra complex.

Within the manuscript illuminations accompanying the narrative *Hadīth Bayāḍ wa Riyāḍ* [14–16], composed in Seville according to Khemir's attribution and dated to approximately 1175–1230 CE following Robinson's chronological framework (both sources cited in D'Ottone [15]), the botanical species represented demonstrate clear symbolic encoding that would have been readily interpretable by contemporary audiences. While these depictions maintain sufficient botanical accuracy to permit provisional taxonomic identification, our systematic analysis revealed no instances of *Rosa* species within the illustrated flora.

This iconographic limitation stands in marked contrast to Greco-Roman representational traditions; however, this disparity should not be interpreted as indicating a diminished cultural significance of roses in Islamic societies. On the contrary, both agronomic treatises and poetic works demonstrate a clear continuity in the cultivation and appreciation of roses from the classical period through to the Islamic era.

The use of rose images in the decoration of buildings in Western Islamic architecture is scarce; however, the Alhambra complex of Granada offers what seems to be a singular example for white rose cultivation.

The Hall of the Kings, 14th–15th cent CE, is the grand, emblematic space of the Palace of the Lions in the Alhambra complex. The lateral vaults seemingly depict sequential scenes from a medieval romance, featuring knights—clearly identified by their Muslim and Christian attire—engaged in various trials to win the favor of a lady. The narrative, beginning in the left vault, possibly concludes in the right vault, with different episodes such as wild animal hunts, chess games, or knightly jousts [88].

Plants of the Vault of the Fountain of the Youth (Palace of the Lions, Alhambra, Granada, Spain), include orange tree (*Citrus* × *aurantium*), Pinyon pine (*Pinus pinea*), Oleander (*Nerium oleander*) or Moorish myrtle (*Myrtus communis* subsp. *baetica*), cf. a climber rose (*Rosa sempervirens*, *R.* × *alba 'Cymbaefolia'* or, more likely, *R. moschata*), and spreading cherry plum (*Prunus cocomilia*) (1) (Figure 1).

It is noteworthy that freshly opened *R. moschata* flowers exhibit distinctive visual and olfactory characteristics that undergo temporal changes. Upon initial bloom, the petals display a pristine white coloration, while the center appears yellowish-orange due to the dense concentration of numerous stamens. During this early phase, the flowers emit a pronounced spicy fragrance. However, this sensory profile transforms over time: within hours to days, the stamens fade to a pale gray hue, accompanied by a corresponding shift in the floral scent from its initial spicy character to a more characteristic rose fragrance.

The graphical documentation presented in Figure 1 captures these flowers in their earliest developmental stage, thereby preserving the visual record of specimens exhibiting the distinctive spicy aromatic profile described above.

During his visit to Spain between 1524 and 1526 CE, the Venetian traveler Andrea Navaggero [89] described the domestic architecture of Granada, noting that even ordinary houses featured gardens with pools of water surrounded by plantings of myrtle, roses, and musk roses [90]. These musk roses, celebrated in both Spanish and Persian literary traditions, were most likely *Rosa moschata* and the cultivar *R. moschata* 'Nastarana'. The

latter is believed to be a hybrid of *R. moschata* and *R.* × *damascena*, a hypothesis supported by the chemical composition of its essential oil.

Figure 1. Plants of the Sala de los Reyes, emblematic space of the Palace of the Lions in the Alhambra complex (Granada, Spain), 14th–15th cent CE. (**A**,**B**) Vault of the Fountain of the Youth. (**A**) Pinyon pine (*Pinus pinea*) and a white flowered climber rose (cf. *Rosa moschata*). (**B**) Detail of the climber rose cf. *Rosa moschata* "Floribunda.". (**C**–**F**) Vault of the Lady Playing Chess: (**C**) Tree with heart-shaped leaves and rose-like flowers, but also it could be a mulberry tree with a climber rose, cf. *R. moschata.* (**D**) Rose, cf. *Rosa moschata* "Floribunda," climbing on an orange tree (*Citrus* × *aurantium*). (**E**) Similar. (**F**) Isolated rose bush, likely white flowered *Rosa* × *alba*. Images extracted from Simón [91].

The plant species depicted in the *Sala de los Reyes* of the Alhambra de Granada, particularly in the *Vault of the Lady Playing Chess*, can be tentatively identified as follows: bitter orange (*Citrus* × *aurantium* L.), a branched tulip—possibly *Tulipa turkestanica* (Regel) Regel—oleander (*Nerium oleander* L.), and Moorish myrtle (*Myrtus communis* subsp. *baetica* (L.) Casares & Tito). Additional flora includes a blooming tree with heart-shaped leaves, likely representing a species of deciduous mulberry tree with a white blooming climber roes, and an oak tree—a tentative identification suggests *Quercus pyrenaica* Willd. (Pyrenean oak). Also present are representations of stone pine (*Pinus pinea* L.) and a red tulip, possibly *Tulipa sprengeri* Baker. White roses appear in two distinct forms: as climbing plants—possibly *Rosa moschata* or *Rosa sempervirens*—and as a seemingly leafless, isolated shrub bearing radiate white flowers. This latter form may correspond to *Rosa* × *alba* 'Cymbaefolia' or, alternatively, to a robust specimen of *Rosa moschata* (Figure 1).

Artistic representation of roses in Western Islamic art is severely constrained by limited naturalistic illustration in manuscripts, ceramics, and architecture, creating a stark contrast with their documented cultural significance in agronomic treatises and poetry. However, the 14th–15th century ceiling paintings in Granada's Alhambra Hall of Kings at the Palace of the Lions in the Alhambra complex identify specific rose species with white flowers (*Rosa moschata*, *Rosa* × *alba*) that confirm the continuous cultivation and appreciation of roses from classical through Islamic periods. But at present we cannot explain the exclusion of red and "blush" roses from this imagery.

3.3. Rosa Species in Eastern Islamic Gardens: Ancestral Traditions and Literary Sources

Prior to Mohammed, St. Cyprian, who was martyred in 258 CE, and St. Jerome, who lived around 400 CE, praised roses and named them as one of the rewards that martyrs would find in Heaven [92]. The cultivation of geometric gardens, where the rose often holds a place of honor, has a long history in Iran and surrounding regions. We must remember that the center of origin of most of the classical and medieval rose heritage is in Iran and surrounding regions.

Oriental–Islamic poets used rose as one of the most important symbols within the mystical Islamic tradition known as Sufism. Rose is also considered a symbol of the prophet Muhammad, whose perspiration purportedly smelled of rose, and, therefore, rose oil and rose water are highly esteemed and often used in religious ceremonies and rituals throughout Turkey and the Middle East [92,93]. A traditional story tells that Ali ibn Abi Talib, 600–661 CE, Muhammad's son-in-law, died only after smelling the fragrant roses as a last wish.

The scent of the rose soon becomes a poetic equivalent of what Islamic mystics call the ineffable 'taste' (*dhowq*) of the divine, experienced in the depths of ecstasy by the seeker. The underlying message is clear: every mystical quest is a unique and unrepeatable experience. Friends of the wise one must, if they can, venture into the garden of the soul in search of the rose and its ineffable fragrance [94–96].

Some notable examples of rose symbolism in Eastern Sufism include the Sufi master 'Abdulqādir Gīlānī, 1077–1166 CE, known as "the Rose of Baghdad," whose order, the *Qadiriyya*, uses the rose as a symbol. Two significant Sufi-related books are *The Rose Garden* by Saadi and *The Rose Garden of Secrets* by Mahmud Shabistari [96].

The rose is a significant symbol of the Bektashi order of Sufism. Rose is a recurring motif in Rumi's (Jalāl al-Dīn Muḥammad Rūmī or Mewlana) *Masnawi*, 1207–1273 CE, with phrases like "Rose is sent to earth by the gardeners of paradise for empowering the mind and the eye of the spirit" [93].

In Persian poetry, the garden, particularly the rose garden, is pivotal in mystical and spiritual symbolism, as seen in titles like Sana'I's *The Garden of Truth* (*Ḥadīqat al-*

Haqīqa, 1080–1141 CE) and Mahmud Shabestari's *The Garden of Mystery* (*Gol-shan-e raz*, 14th century). The garden represents a realm of spiritual exploration and the soul's journey to the divine beloved, with the rose symbolizing the ultimate goal of these quests [95].

Mahmud Shabestari (1288–1340 CE), a renowned Persian Sufi poet, employs the rose in his *Mystic Rose Garden* to metaphorically depict resurrection, revealed enigmas, and the rejection of overcriticism, while distinguishing between mystical "contemplation" and rational "reflection" in the pursuit of divine knowledge [96,97].

In lyrical ghazals, the beauty of the rose evokes the longing song of the nightingale, a prominent image in the poems of Hafez, Khājeh Shams-od-Dīn Moḥammad Ḥāfeẓ-e Shīrāzī, 1325–1390 CE. The imagery of lovers and the beloved evolved into a representation of the Sufi mystic's quest for divine love, as seen in Ibn Arabi's works, where the rose is equated with the blushing cheek of the beloved and with divine names and attributes.

By the eleventh century, roses boomed in the Islamic world in single and double varieties, in colors such as white, yellow, deep red, 'black,' and pink, as well as musk roses and briars. In 1515, in Herat (Iran), about fifteen kinds were named [98]. Among the garden flowers, the rose (*gol*) stands out as the true queen of every Persian garden.

In Iran, many species of roses have been cultivated since ancient times, including the famous rose of Shiraz, commonly associated with *Rosa* × *damascena*, also known as the Damask rose. This rose is renowned for its exquisite fragrance and is widely cultivated in the region for its use in perfumes and rose water. The Damask rose has a long history in Persian culture, and Shiraz, with its rich cultural heritage and favorable climate, is particularly famous for cultivating these roses. It is no coincidence that another Persian term for garden, especially a 'flower garden,' is *golestan*, which means 'place of roses' or 'rose garden.' Another common term, *bustān* (from bu = smell/fragrance), refers to olfactory qualities and can be translated as 'orchard' [95].

The Rose Garden of Refuge is a 15th-century Ottoman palace in Edirne. 'Rose Garden' symbolized the royal domain, imperial city, Ottoman state order, and the sultan himself, whose presence could transform the palace into a sanctuary, a 'Paradise.' The palace gardens included enclosed private spaces (*bagh*), rose gardens (*gulistan*), vegetable plots (*sebsevat*), and orchards (*bostan*), surrounded by forests and parkland for hunting. The Edirne gardens featured roses, hyacinths, tulips, violets, sweet basil, jasmine, Judas flowers, narcissus, wild roses, wallflowers, peonies, carnations, and many other fragrant flowers. A retreat named *Dolmabahçe* was fragrant with pine and jasmine, and roses planted in a garden called *Gülhane*. The rose variety grown was Trigintipetala, or Kazanlık, named after the town in modern-day Bulgaria, which became a center for rose oil production after the 17th century. The extensive rose gardens in Edirne supplied the court and private customers in Istanbul for years to come [99].

Mughal gardens of India largely paralleled those of Western Islamic traditions. Most of the gardens in Gujarat built by the Mughals followed the typical Mughal style with influence of Western *bustān*. Fateh Bagh was established by Abdur Rahim Khan-i-Khanan at Sarkhej on the banks of the Sabarmati River after his victory over Sultan Muzaffar in 1584 AD. The Shahi Bagh (Royal Garden), covering about 21.87 hectares, was constructed by Prince Shah Jahan when he was the viceroy of Gujarat. Located outside the city walls of Ahmedabad, along the Sabarmati River, it featured classic Mughal garden elements: wells, elegant buildings, porches, towers, reservoirs, long tree-lined walks, pavilions, flower beds, and a central cross layout [100].

Pietro Della Valle, 1586–1662 CE, noted the abundance of roses and jasmine in Ahmedabad's gardens (Gujarat, India). Rose cultivation became commercially significant, with Niccolao Manucci, 1638–1717 CE, reporting that roses were grown in the royal garden for distilling essence for the royal family. Ahmedabad had a special rose garden known as

Gulab Bagh since the Sultanate period. Roses were plentiful in both the Shahi Bagh and Gulab Bagh. During the tenure of Prince Mohammad Azam Shah as governor, perfume and rose water were extracted from the roses in the Rose Garden and the Mulberry Garden (Tut Bagh) for the imperial establishment [100].

The rose's journey through Islamic and Persian civilizations reveals a remarkable transformation from botanical specimen to sacred symbol, integrating spirituality, poetry, politics, and commerce across more than a millennium.

Beginning with early Christian associations of roses with martyrdom and paradise, Islamic culture elevated the flower to unprecedented significance through its connection to the Prophet Muhammad, whose perspiration was said to smell of roses. This sacred attribution made rose oil and rose water essential elements in religious ceremonies throughout the Islamic world.

The Persian and Sufi mystical traditions transformed the rose into the ultimate metaphor for divine love and spiritual quest. From Rumi's *Masnawi* to the gardens of classical Persian poetry, the rose garden became both literal paradise and spiritual landscape where seekers encountered the divine. The Persian terms *golestan* (place of roses) and *bustān* (place of fragrance) reveal how deeply the rose became embedded in concepts of paradise and beauty.

Politically and culturally, the rose served as a symbol of sophistication and divine authority, from the Ottoman Rose Garden of Refuge in Edirne to the elaborate Mughal gardens of Gujarat. The commercial cultivation of varieties like the Damask roses of Shiraz and the Trigintipetala of Kazanlık demonstrates how spiritual symbolism successfully merged with economic enterprise.

This historical narrative illustrates Islamic civilization's remarkable capacity for cultural synthesis, absorbing and transforming diverse elements into a coherent esthetic and spiritual vision. The rose ultimately embodies a worldview where divine beauty manifests in creation, the physical garden maps the spiritual journey, and the pursuit of beauty, fragrance, and transcendence remain fundamentally interconnected. The rose's millennium-long journey thus exemplifies how a single symbol can carry forward civilization's deepest aspirations for beauty, the divine, and paradise, both earthly and eternal.

3.4. Botanical Identification of the Western Islamic Medieval Rose Heritage

In order to conserve this heritage repertoire of roses and rose bushes, it is essential to identify it in botanical and horticultural terms and to look for it among the 30,000 varieties of roses currently listed.

Andalusian botanical scholars identified diverse species and varieties of roses, categorizing them by distinct characteristics such as flower color, petal count, and native habitat. This classification reflects the nuanced understanding of rose biodiversity in medieval Andalusian horticulture and permits a tentative means of botanical identification (Table 1, Figure 2).

Table 1 presents a comprehensive classification of rose species and varieties documented by medieval Andalusian authors between approximately 1020 to 1230 CE, representing the rich horticultural knowledge of al-Andalus. The documentation spans over two centuries and includes works by prominent scholars such as Abū al-Jayr al-Ishbīlī, Ibn Baṣṣāl, al-Ṭighnarī, Ibn al-ʿAwwām, and Ibn al-Bayṭār. These authors meticulously recorded various rose types, their characteristics, and geographical origins, creating what constitutes an invaluable medieval Western Islamic rose heritage.

Table 1. Classification of rose species and varieties cited by Andalusian authors which constitute the medieval Western Islamic rose heritage.

Group and Type	Tentative Identification and Notes	Andalusian Authors and Dates	References
Yellow roses			
Yellow roses from Alexandria	Cf. *Rosa foetida* Herrm. (syn. *R. lutea* Mill.) or *Rosa foetida* f. *persiana* (Lem.) Rehder (syn. *R. lutea* var. *persiana* Lem.) Isolated individuals persist naturalized or around abandoned farmhouses in the mountain areas from Granada to Huesca, through Albacete, in Spain (Figure 2)	Abū al-Jayr al-Ishbīlī, c. 1070 CE, al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–VIII, XIII
Roses the color of yellow daffodils	Cf. *Rosa rapinii* Boiss. & Balansa or *R. hemisphaerica* Herrm.	Ibn Baṣṣāl, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE	I–II, IV–V
Red roses			
Double red roses (*aḥmar al-muḍaʿaf*), which are the most common, with forty to fifty petals, Persian rose	Cf. *R.* × *centifolia* L. 'Common Provence' (syn. *R. provincialis* Herrm.) (Figure 2)	Ibn Baṣṣāl, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, XIII
Bright red roses	Cf. *Rosa gallica* L. (Figure 2) or *Rosa bicolor* Jacq.	Abū al-Jayr al-Ishbīlī, c. 1070 CE, Ibn al-Bayṭār, c. 1230 CE	XIII
Roses that can be candied	Cf. *Rosa gallica* L. 'Conditorum'	Ibn al-Bayṭār, c. 1230 CE	XIII
Magian (*majūsī*) roses with five petals, red, found in the East (*mashriq*) and al-Sham (historical region known as the Levant, encompassing modern-day Syria, Lebanon, Jordan, Palestine, and Israel)	Cf. *Rosa pulverulenta* M.Bieb. (syn. *R. sicula* Tratt.)	al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE	I–II, IV–V
White and red roses			
Double roses of superior quality with forty or fifty petals, white with red tinges (*abyaḍ al-aḥmar*) and a strong fragrance	Cf. *R.* × *damascena* Herrm. (Figure 2), *Rosa* × *damascena* Herrm. 'York & Lancaster', or *R. gallica* 'Versicolor'	Abū al-Jayr al-Ishbīlī, c. 1070 CE, Ibn Baṣṣāl, c. 1100 CE; al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, XIII
"Blush" roses	Cf. *Rosa* × *alba* L. 'Great Maiden's Blush' or similar	Aḥmad Abū ʿĀmir ibn Šuhayd, c. 1020 CE, Ibn ʿArabī, c. 1200 CE	XIV, XV

Table 1. *Cont.*

Group and Type	Tentative Identification and Notes	Andalusian Authors and Dates	References
Roses with shades of blue (*)			
Dark roses (*aswad*, or black), Black roses from Iraq	These roses were likely what we would today call "very dark purple" rather than truly black. Cf. very dark varieties of *Rosa* × *damascena*, known for producing deep purple blooms in certain conditions: dark red, with petals' edges or the entire bloom appearing almost black when in full sun	Abū al-Jayr al-Ishbīlī, c. 1070 CE, Ibn Baṣṣāl, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, XIII
Roses the color of violets, from Syria and Lebanon, Blue roses in various shades (lapis lazuli or sky blue) (*ward azraq* - ورد أزرق)	Even in recent times, more than half the flowers described in seed lists and plant catalogs as blue are some shade of mauve or purple. Very pale lavender *Rosa* × *damascena* roses that appeared bluish in certain lights and mauve or purple roses with a silvery bloom on the petals Perhaps from mistaking 'blue' for crimson, suggesting these mixed-color roses could be forms of *Rosa bicolor* (Figure 2).	Abū al-Jayr al-Ishbīlī, c. 1070 CE, al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE	I–II, IV–V, XI–XII
Multicolored roses with blue shades. Roses with yellow on the inside and blue lapis lazuli on the outside, found in Baghdad and Tripoli of al-Sham	Could have been a variety of *Rosa* × *damascena* showing strong color variation. The "blue" exterior might have been a silvery-violet sheen that appeared blue in certain lights. The yellow interior suggests some relation to yellow rose varieties that were known in Persia	al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE	I–II, IV–V, XI
Roses that are red on the outside and blue inside	The "blue" interior might have been a silvery-lavender color that appeared blue under certain light conditions. The red exterior was like common *Rosa* × *damascena* colorations	al-Ṭighnarī, c. 1100 CE and Ibn al- ʿAwwām, c. 1150 CE	I–II, IV–V
Roses that are yellow on the outside and blue inside	Roses yellow on the outside (abaxial) and red on the inside (adaxial) are known (*Rosa bicolor*) but blue roses might have been obtained by watering the plants with indigo water	Ibn al- ʿAwwām, c. 1150 CE	I–II, IV–V, XII

Table 1. *Cont.*

Group and Type	Tentative Identification and Notes	Andalusian Authors and Dates	References
Roses from China (**)			
Chinese roses (*Ward al-ṣīnī*)	Cf. *Rosa moschata* type, or variety *Rosa moschata* 'Nastarana', or their hybrids, that was traditionally grown in Tunisia during centuries for its essential oil. These are the "mosquetas" found in Seville and Granada (Figure 2).	Abū al-Jayr al-Ishbīlī, c. 1070 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, IX–X, XIII
White roses			
White roses that grow in the land of the Slavs (Eastern Europe) and the lands of the Magi (historically referring to Persia, modern-day Iran)	Cf. *Rosa* × *alba* L., or *Rosa* × *alba* 'Semiplena' (Figure 2), or *Rosa* × *alba* 'Cymbaefolia'	Abū al-Jayr al-Ishbīlī, c. 1070	V
White orchard rose bush, smaller than the previous one, with narrower leaves and smaller flowers	Cf. *Rosa sempervirens* L. or *R. canina* L.	Abū al-Jayr al-Ishbīlī, c. 1070	5
Intensely white or camphorated roses with more than a hundred petals (*abyaḍ al-muḍaʿaf*)	Cf. *Rosa* × *alba* 'Maxima', *Rosa* × *damascena* of the type 'Mme. Hardy', or a white *R.* × *centifolia* of the type 'Blanchefleur'. Double white rose, called *kafuri*, with more than a hundred petals, very beautiful and fragrant. This can be identified as the white rose (*Rosa* × *alba* L.), possibly the same one mentioned by the Anonymous Sevillian Botanist under the name *yentu fülyas*	Abū' al-Jayr al-Ishbīlī, c. 1070 CE, Ibn Baṣṣāl, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, XIII
Wild roses			
Wild mountain roses (*Ward jabalī*)	Cf. *Rosa canina*, with red or less often white flowers	Abū'l-Jayr al-Ishbīlī, c. 1070 CE	V
Wild white mountain roses (*Ward jabalī*)	Cf. *Rosa canina*, with white flowers and astringent fruits	al-Ṭighnarī, c. 1100 CE and Ibn al-ʿAwwām, c. 1150 CE, Ibn al-Bayṭār, c. 1230 CE	I–II, IV–V, XIII
Wild white, to somewhat red, mountain roses, with twenty to thirty petals	Cf. Feral *Rosa gallica* or *Rosa* × *damascena* (Figure 2)	al-Ṭighnarī, c. 1100 CE	V
Wild roses (*Nisrin*), onto which cultivated roses are grafted	Cf. *Rosa canina*	Abū'l-Jayr al-Ishbīlī, c. 1070 CE	V

Notes: Codes: I, [76]; II, [77]; III, [84]; IV, [78]; V, [79]; VI, [56]; VII; [101]; VIII, [102–104]; IX, [105]; X, [40]; XI, [106], XII, [86]; XIII, [73–75]; XIV, [68]; XV [70]. (*) Roses with shades of blue. This confusion may stem from using 'rose' to describe unrelated plants, but we cannot set aside the use of artificial coloring. Although blue roses might be artificial, as Ibn al- ʿAwwām describes, "If one desires a lapis lazuli-colored rose, one should use *fāliḥ*, a bright and aromatic indigo. Apply it as was done with saffron (for yellow color), and the rose will emerge with a lapis lazuli color." Al-Ghazzī in *al-ʿĀmirī's Jāmiʿ farāʾiḍ al-milāḥa fī jawāmiʿ fawāʾid al-filāḥa* (circa 1500 CE) enumerates among rose varieties those with a lapis lazuli shade [106]. (**) The Chinese rose might have been *Hibiscus rosa-sinensis* or represent an earlier introduction in the western Mediterranean of *Rosa chinensis* Jacq. Or *R. indica* L., that had not reached continuity, but it is more likely *Rosa moschata* "Nastarana", or its hybrids, that had already reached the West, leading to some remontant roses being available long before the eighteenth century.

Figure 2. Flowers of selected medieval rose heritage (MRH) varieties. (**A**) *Rosa foetida*, Mesones (Albacete, Spain); (**B**) *Rosa* × *alba* 'Semiplena', Roseraie de Bagatelle (Paris, France); (**C**) *Rosa gallica*, Molina de Segura (Murcia, Spain); (**D**) *Rosa foetida* fa. *persiana*, Molina de Segura (Murcia, Spain); (**E**) *Rosa hemisphaerica*, Bienservida (Albacete, Spain); (**F**) *Rosa bicolor*, Molina de Segura (Murcia, Spain); (**G**) *Rosa bifera*, Horsh Ehden (Ehden, Lebanon); (**H**) *Rosa* × *centifolia*, Giardino Bardini, Oltrarno (Florence, Italy); (**I**) *Rosa moschata* 'Umbrella', Molina de Segura (Murcia, Spain); (**J**) *Rosa* × *damascena*, Molina de Segura (Murcia, Spain). Images by Concepción Obón and Diego Rivera.

The classification reveals remarkable diversity in cultivated roses, ranging from yellow varieties imported from Alexandria (likely *Rosa foetida*) to sophisticated double roses with 40–50 petals, particularly the Persian red roses (*Rosa* × *centifolia*) and fragrant white–red varieties (*Rosa* × *damascena*).

Particularly fascinating are the documented "blue" roses from Syria and Lebanon, which were likely deep purple or mauve varieties that appeared bluish under certain lighting conditions. The authors also described multicolored roses and even attempted artificial coloration techniques, such as watering plants with indigo water to achieve blue hues, demonstrating advanced horticultural experimentation.

The geographical scope of this rose cultivation network was extensive, with varieties sourced from Alexandria, Persia, Iraq, Syria, Lebanon, Baghdad, China, Eastern Europe, and various regions of al-Andalus itself. Notable entries include Chinese roses (*Rosa moschata* types) that became the "mosquetas" still found in Seville and Granada, and wild mountain roses (*Rosa canina*) used as rootstock for grafting cultivated varieties. This documentation not only preserves medieval botanical knowledge but also illustrates the sophisticated trade networks and cultural exchanges that facilitated the spread of horticultural varieties across the medieval Islamic world.

4. Discussion

4.1. Fragrance as a Determinant of Rose Appreciation in Western Islamic Medieval Heritage

Rose bushes are ornamental plants cultivated for visual and olfactory delight in medieval Western Islamic gardens. They were planted along the sides of gardens, in walkways, or near pavilions on some estates for their flowers. Besides their numerous uses in human and veterinary medicine, roses were used to produce rose water. Concerning their scent, it is recommended by authors from Al-Andalus to plant garlic among rose bushes to enhance the fragrance of the flowers [76–79].

In the realm of MRH rose species and ancient hybrids, distinct chemotypes exhibit fascinating aromatic profiles that have been extensively documented through scientific analysis (Table 2). An analysis of the chemical composition of rose essential oils reveals the presence of seven key compounds with high discriminatory value: citronellol, phenylethyl alcohol, geraniol, eugenol, nerol, nonadecane, and heneicosane. Based on these compounds, four distinct groups of samples can be identified, each characterized by a specific chemical profile that reflects both botanical and geographic diversity.

The first group is defined by a high concentration of citronellol, averaging 31.8%, and includes samples of notably *R.* × *damascena* (including the Gülbirlik and Kazanlak rose oil types), primarily from Turkey and Iran, as well as additional examples from China and Bulgaria, *R.* × *bifera* 'Quatre Saisons Blanc Mousseux' from India, and *R. gallica* from Iran. These samples also contain moderate to high levels of geraniol (Table 2), low phenylethyl alcohol (1.9%), and minimal eugenol (0.4%).

The renowned *Rosa* × *damascena* specimens from Gülbirlik and China are characterized by their geraniol and citronellol composition, yielding an enchanting combination of sweet, rose-like fragrances enhanced by fresh, green notes and citrusy undertones. This group includes roses characteristic of perfumery and rose waters, but is also excellent in the elaboration of jellies, jams, and liqueurs, and very probably was one of the rose types characteristic of the gardens and orchards of the Islamic West.

Table 2. Percentage of major components in MRH *Rosa* flower essential oils responsible for their scent.

Group	**1**							**Intermediate**			**2**					**3**		**4**					
Compounds of the Essential Oil/Taxa	***R.d.* Gülbirlik**	***R.d.***	***R.d.***	***R.g.***	***R.b.***	***R.d.***	***R.d.* Kazanlak**	***R.d.***	***R.d.***	***R.c.***	***R.d.* Isparta**	***R.d.* (Single Flower)**	***R.d.* (Double Flower)**	***R.d.***	***R.m. Nastarana***	***R.a.***	***R.m.***	***R.o.***	***R.p.***	***R.a.***	***R.a.***	***R.f.***	***R.h.***
Country	Turkey	Turkey	China	Iran	India	Bulgaria	Iran	Lebanon	Pakistan	Pakistan	Turkey	Turkey	Turkey	Morocco	Iran	Tunisia	Iran	Lebanon	Lebanon	Bulgaria	Bulgaria	Iran	Iran
Citronellol	31–44	30.5	30.7	40	25	26	30	10–34	65–62	51–55	6–17	7–22	6–32	10.1	-	-	-	-	-	9–18	5–7	-	-
Phenylethyl alcohol	1–2	1.9	1.32	3	-	-	2	7–45	19–21	31–36	33–47	33–48	23–75	66.5	30–70	13	-	2	5	-	-	-	-
Geraniol	9–21	36.2	16.1	1	55	-	2	2–6	1–2	1–2	10–22	12–22	3–24	5.6	-	-	-	1	-	18	-	-	2
Eugenol	-	-	-	-	-	-	1	0–5	-	-	-	-	-	1.6	1–2	39	37–39	-	-	-	-	-	-
Nerol	5–11	11.2	7.6	-	16	10.4	-	-	0–1	-	1–3	1–3	0–-3	2.8	-	-	-	-	-	8	2	-	-
Nonadecane	8–15	0.5	16.9	15	-	10	16	7–15	-	-	3–4	1	0–5	0.8	6–14	6	5–6	1	4	11–17	36–37	26	40
Nonadecene	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	1–30	-	-	-	-	-	9	-	-
Heneicosane	2–4	0.3	7	13	-	-	14	3–15	-	-	0–1	0–1	0–1	-	4–8	4	21–22	6	12	13–16	41–43	17	32
Hexadecanol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-
Docosane	-	-	-	-	-	-	-	0–2	-	-	-	-	-	-	-	-	-	1	12	-	-	-	-
Heptacosane	-	-	-	-	-	-	-	0–13	-	-	-	-	-	-	-	-	-	15	17	-	2	-	-
Pentacosane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-
Nonacosane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-
Heptadecane	-	-	-	1	-	-	2	0–2	-	-	1–3	1	0–6	-	1–3	1	1	-	-	-	1	4	1.5
Tricosane	-	-	0.5	7	-	1.1	5	0–9	-	-	-	-	-	-	3–4	2	5	11	13	3–4	-		8
	I	**III**	**III**	**IX**	**XI**	**III**	**IX**	**XVI**	**VII**	**VII**	**II**	**II**	**II**	**XV**	**XIII**	**VI**	**VIII**	**XII**	**XV**	**IV–V**	**XIV**	**X**	**III**

Abbreviations: R.a., R. × alba; R.b., R. × bífera 'Quatre Saisons Blanc Mousseux'; R.c. R ×. centifolia; R.d., Rosa × damascena; R.f., R. foetida; R.g, R. gallica; R.h., Rosa hemisphaerica; R.m., R. moschata; R.o., R. corymbifera; R.p., R. phoenicia. Codes: I, [93]; II, [107]; III, [108]; IV, [109]; V, [110]; VI, [111]; VII, [112,113]; VIII, [114]; IX, [115]; X, [116]; XI, [117]; XII, [118]; XIII, [119]; XIV, [120]; XV, [121]; XVI, [122].

The second group, distinguished by dominant levels of phenylethyl alcohol (average 39.0%), is largely composed of *Rosa* × *damascena* samples from Turkey and Morocco, including the Isparta type, and *R. moschata* "Nastarana". This group also displays moderate concentrations of citronellol (19.3%) and geraniol (13.2%), with very low levels of eugenol (0.3%). These yield the most typical rose scent and essential oil used in perfumery. The phenylethyl alcohol chemotype delivers a delicate yet distinctive floral bouquet. This chemical composition produces sweet, subtly spiced aromatics with gentle honey-like undertones and could have been a relevant note in medieval Western Islamic gardens.

An intermediate group between the second and first groups present relatively high levels of citronellol (46%) and moderate phenylethyl alcohol (26.5%) and is composed of *Rosa* × *damascena* samples from Lebanon and Pakistan, and *Rosa* × *centifolia* from Pakistan. Pakistani varieties of *R.* × *damascena* and *R.* × *centifolia* demonstrate a unique citronellol and phenylethyl alcohol chemotype. This combination creates an intricate aromatic profile that harmoniously balances fresh, citrusy notes with deep, rose-like characteristics, making it particularly valuable in perfumery applications. Although it is not obvious, we cannot rule out that these intermediate varieties were also cultivated in Western Islamic medieval gardens.

A third, more specialized group is notable for its elevated eugenol content (average 19.1%), a trait largely absent from the other groups. It includes *Rosa moschata* and *Rosa* × *alba* samples from Tunisia and Bulgaria and is further characterized by low citronellol (6.5%), very low geraniol (0.5%), and moderate phenylethyl alcohol (6.5%). In this case, we find roses with a spicy aroma, especially clove, and to which the "*mosqueta*" of the gardens of the medieval Islamic West in Seville and Granada would belong. The eugenol chemotype, prevalent in *Rosa* × *alba* from Tunisia and *R. moschata* var. *moschata* from Iran, presents a markedly definite olfactory signature. This variant manifests a spicy, warm profile with pronounced clove-like characteristics, accompanied by subtle woody undertones and a distinctive musky quality. The sensory experience extends beyond aroma to include a notably bitter, astringent taste profile with lingering acrid notes.

The fourth group is rich in long-chain alkanes, especially nonadecane and heneicosane, and consists of *R.* × *alba* from Bulgaria, but also ancestral species such as *R. corymbifera* and *R. phoenicia*, with additional representation of yellow flowered species *R. foetida* and *R. hemisphaerica*. This group shows very low levels of citronellol (6.6%) and phenylethyl alcohol (2.7%), moderate geraniol (12.2%), and negligible eugenol.

Several *R.* × *damascena* samples from the first and second groups present moderate nonadecane levels. The nonadecane and heneicosane chemotype, characteristic of Bulgarian *R.* × *alba* and Iranian *R. hemisphaerica*, presents a more subdued aromatic profile. These compounds contribute subtle, waxy, and slightly oily olfactory notes typically associated with paraffin-like substances.

Finally, the heptacosane and tricosane chemotype, identified in Lebanese R. *corymbifera* and *R. phoenicea*, as well as Iranian *R. foetida*, exhibits similar waxy, paraffin-like characteristics. This chemical composition results in clean, neutral scents characteristic of long-chain hydrocarbons. This leads us to think that the interest in these particular roses in the gardens of the medieval Islamic West was based more on color, especially the yellow ones.

These findings reveal complex interactions between rose taxonomy, geographic origin, and essential oil composition. They offer a valuable framework for enhancing quality control measures, guiding selective breeding, and optimizing processing techniques in the rose oil industry. Moreover, the geographic patterns observed suggest that environmental factors and cultivation practices may play roles as significant as genetic heritage in shaping essential oil profiles. This underlines the importance of conserving a broad range of rose

genotypes and developing localized quality standards that reflect the distinctive chemical signatures of different growing regions.

Hybridization appears to drive the development of diversity in cultivated roses, even in the case of ancient cultivars, often resulting in viable seeds from open pollination leading to highly varied forms. An example is *Rosa* × *damascena*, as analyzed by Baydar et al. [107], where offspring exhibited wide variation in flower characteristics, including petal colors ranging from white to red and petal counts from 5 to 115. Additionally, there was considerable variability in floral scent molecules among seed-derived plants (Table 2), with phenylethyl alcohol ranging from 23 to 75%, citronellol from 6 to 32%, and geraniol from 3% to 27%. The clonally propagated plants used in the experiment [107] also exhibited high levels of 2-phenylethyl alcohol but within a shorter range (33–47%), followed by geraniol (10–22%), citronellol (6–17%), and linalyl formate (4–12%).

Usually, *Rosa* × *damascena* displays crimson-colored flowers with c. 30 petals and yields, from commercially exploited crops in Turkey, essential oil with citronellol 6–44%, geraniol 9–36%, nonadecane 1–15%, and 2-phenylethyl alcohol 1–21%, among others [93,123] (Table 2). This explains the significant role of pedigree and seedling cultivation in the development of rose perfume diversity.

4.2. Contemporary Remnants of Medieval Western Islamic Rose Heritage

4.2.1. Survival of Medieval Cultivars in Traditional Rural Settlements of Southeastern Spain

Under the auspices of the Instituto de Estudios Albacetenses "Don Juan Manuel" and with the collaboration of the Asociación de Amigos del Jardín Botánico de Castilla la Mancha, an exhaustive revision of the rose cultivars persisting in the vicinity of farmhouses in Albacete (Spain), most of them abandoned for decades, has raised evidence for the persistence of living ancient roses (Table 3) [102,104].

Table 3. Distribution and altitudinal ranges of ancient *Rosa* species and varieties in different areas of Albacete (Spain). Data include taxonomic classifications, geographic occurrence, and elevation preferences (in meters above sea level, MASL).

Species/Variety	Location(s)	Altitude Range (MASL)	Essential Oils Group *	Related Medieval Type **
R. foetida Herrm.	Campos de Montiel	900–1000	4	Yellow roses from Alexandria
R. foetida f. *persiana* (Lem.) Rehder	Alcaraz area	900–1150	4	Yellow roses from Alexandria
R. bicolor Jacq.	Alcaraz area	900–1000	4	Roses that are yellow on the outside and blue inside (blue for crimson?)
R. hemisphaerica Herrm.	Campos de Montiel, Alcaraz area	850–1050	4	Roses the color of yellow daffodils
R. hemisphaerica var. *plena* Rehder	Campos de Montiel, Corredor de Almansa, Segura	850–1050	4	Roses the color of yellow daffodils
R. gallica L.	Corredor de Almansa, Segura and Alcaraz areas	850–1100	1	Wild white, to somewhat red, mountain roses, with twenty to thirty petals
R. gallica var. *officinalis* (Andrews) Thory	Segura area	~1000	1	Bright red roses
R. × *damascena* Herrm.	Corredor de Almansa, Manchuela, Campos de Montiel, Segura, Alcaraz areas	(600)850–1050	1, 2	Double roses of superior quality with forty or fifty petals, white with red tinges (*abyaḍ al-aḥmar*) and a strong fragrance
R. × *alba* L.	Alcaraz area	900–1000	3	Wild white, to somewhat red, mountain roses, with twenty to thirty petals

Table 3. *Cont.*

Species/Variety	Location(s)	Altitude Range (MASL)	Essential Oils Group *	Related Medieval Type **
R. × *alba* var. *semiplena* Ser.	Campos de Montiel, Manchuela, Alcaraz, Segura areas	750–1150	3	Intensely white or camphorated roses with more than a hundred petals (*abyaḍ al-muḍaʿaf*)
R. × *centifolia* L.	Manchuela, Segura, Alcaraz areas	(600)750–1100	Intermediate	Double red roses (*aḥmar al-muḍaʿaf*), which were the most common, with forty to fifty petals

Data elaborated by the authors from Verde et al. [102,104]. * Essential oil groups of Table 2 are here tentatively allocated on taxonomic grounds pending further chemical analysis of the Spanish samples. ** Medieval types described in Table 1.

The climatic regime of these regions, characterized by annual rainfall between 450 and 900 mm and mean temperatures ranging from 12 to 15.8 °C, provides favorable conditions that may account for the long-term survival of these rose cultivars without supplemental irrigation [124,125].

Recent research has found some of these roses also in high areas of Cuenca, such as Uña (with 900 mm and 9.5 °C) or Tragacete (with 1100 mm and 10.2 °C), at altitudes of 1100 to 1300 MASL, of Teruel, such as Cañada de Benatanduz (Figure 3) (with 600 mm and 9 °C), at 1500 MASL, and the Murcia region in the Jumilla-Yecla plateau (with c. 310 mm and 15 °C), at altitudes between 300 and 900 MASL, but even in the Huerta of Murcia at only 40 MASL (with 288 mm and 17.7 °C) [124,125].

Figure 3. *Cont.*

Figure 3. Remnants of medieval rose heritage (MRH) varieties in Morocco and eastern Spain. (**A**,**B**) *Rosa* × *damascena*, Kelaat M'Gouna (M'Goun Valley, Morocco); (**C**) *Rosa* × *alba* var. *semiplena*, Cañada de Benatanduz (Teruel, Spain); (**D**) *Rosa* × *damascena*, Uña (Cuenca, Spain); (**E**,**F**) *Rosa bicolor* + *Rosa foetida* chimera, Austrian Copper and Austrian Briar chimera at El Robledo in 1987 (Albacete, Spain); (**F**) *Rosa bicolor*, Molina de Segura (Murcia, Spain); (**G**) *Rosa foetida* f. *persiana*, Mesones (Albacete, Spain); (**H**) *Rosa foetida* f. *foetida*, Mesones (Albacete, Spain). Images by Concepción Obón and Diego Rivera.

Although modern varieties of roses are also grown in these areas, the only ones that survive in the farmhouses and villages (*cortijos* and *aldeas*) abandoned for decades are those that we include in the medieval Western Islamic rose heritage group (Tables 2 and 3), which seem to be more resilient. We must recognize that in non-Islamic medieval Europe, there was also a remarkable diversity of white, pink, and red roses coming from the heritage of the classical world but also from introductions from Asia and exchanges with the Western Islamic world.

4.2.2. Medieval Cultivars in the Global Rose Economy

The medieval rose heritage (MRH), particularly the Western Islamic medieval rose heritage (WIMRH), represents one of history's most significant contributions to contemporary global biodiversity and economic systems. This heritage manifests prominently in today's rose economy, where historical varieties developed through centuries of Mediterranean, Iranian, and Anatolian cultivation practices continue to underpin major commercial sectors worldwide.

The genetic architecture of modern rose cultivation reveals the profound influence of medieval breeding practices. Figure 4 demonstrates the ancestral contributions and hybridization patterns in garden rose development [86,126–136], illustrating a complex network structure that underscores the disproportionate influence of key ancestral species from the MRH and WIMRH. Most notably, *Rosa gallica* L. (European origin) contributes to 15 different hybrid lineages, while *Rosa chinensis* Jacq. (Chinese origin) introduced the revolutionary repeat-flowering trait to European rose breeding in the 18th century. This

genetic diversity has enabled the development of modern hybrid groups, with Floribunda and Tea Hybrid roses incorporating genetic material from more than ten ancestral species across three continents.

The clustering patterns reflect the historical sequence of rose breeding evolution. Early European hybrids (*R.* × *alba*, *R.* × *damascena*), likely predating medieval periods, demonstrate simple two-parent crosses. In contrast, 19th- and 20th-century developments (*R.* × Bourbon, *R.* × Hybrid Perpetual, *R.* × Tea Hybrids) exhibit increasingly complex multi-generational pedigrees. The network topology illustrates how geographically distant species were progressively integrated through historical trade routes, with Central Asian species (*R. webbiana*, *R. foetida*) and much later East Asian species (*R. multiflora*, *R. gigantea*), contributing specialized traits including cold-hardiness, yellow pigmentation, and cluster flowering.

Interactive analysis (Supplementary Figure S1) reveals the modular nature of rose breeding, where specific wild species contributed distinct phenotypic characteristics: fragrance from *R. moschata*, disease resistance from *R. canina*, and repeat flowering from *R. chinensis*. These traits were systematically combined through medieval cultivation practices to create modern garden roses with multiple desirable characteristics.

The economic transformation of medieval rose heritage encompasses diverse commercial applications, ranging from ornamental horticulture to high-value aromatic products including rose oil, rose water, rose concrete, rose absolute, and specialized food products such as rose jam and lokum [93]. The economic foundation of this industry rests primarily on the cultivation of distinct chemotypes of *Rosa* × *damascena* in Turkey's Isparta region and Bulgaria's Kazanlak valley, alongside *Rosa* × *centifolia* 'Rose de Mai' in Morocco's Dades Valley and the territories surrounding Grasse in Provence, France—regions that perpetuate centuries-old cultivation traditions [137–139].

Morocco's cultivation of roses occupies a particularly unique position within the agricultural landscape, especially in regions such as Kelaa M'Gouna and the broader Drâa-Tafilalet region. Beyond its cultural significance, the rose industry stimulates ecotourism, generates substantial income, and empowers local communities through the implementation of sustainable agricultural practices [140].

The remarkable economic scale of this medieval heritage is exemplified by the contemporary global rose trade, valued at USD 3.14 billion in 2022. The Netherlands leads exports at USD 900 million, followed by Ecuador (USD 809 million) and Kenya (USD 537 million), while the United States represents the largest market with imports of USD 713 million according to the Observatory of Economic Complexity [141].

The specialized rose oil sector demonstrates the extraordinary value concentration inherent in these medieval varieties. Dominated by Bulgaria and Turkey with their combined production of approximately 3 tons annually, this sector requires 3500–4000 kg of fresh roses to produce merely 1 kg of rose oil, yet commands prices of EUR 4600 per kg [93,142]. This economic structure, where 80–90% of global rose oil demand is satisfied by these two countries alone, underscores how medieval rose cultivation practices have evolved into contemporary high-value agricultural systems that continue to shape international trade patterns while preserving genetic diversity and cultural heritage established centuries ago [143,144].

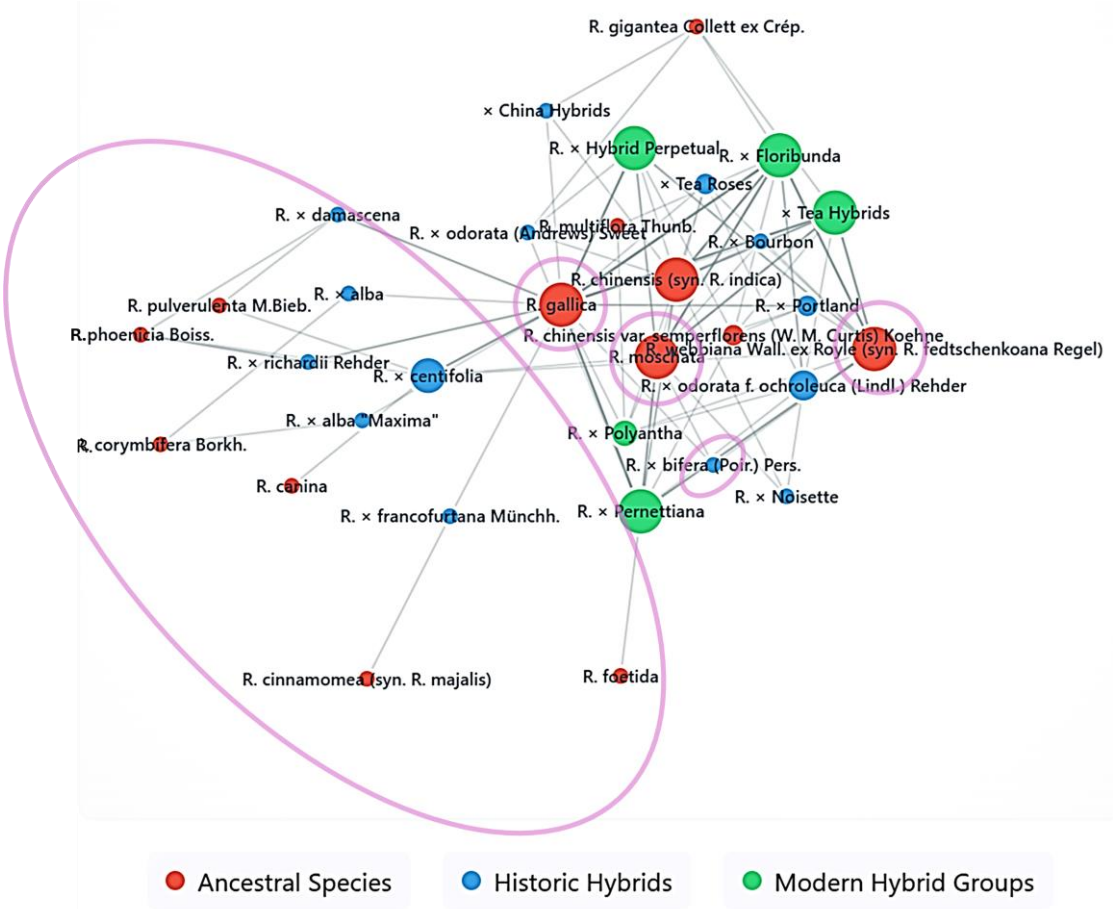

Figure 4. Phylogenetic network diagram illustrating the ancestral contributions and hybridization patterns in garden rose development. This interactive network visualization, available as Supplementary Figure S1, maps the complex genealogical relationships between wild *Rosa* species and their cultivated hybrid descendants. Nodes represent individual species or hybrid groups, with size proportional to the number of genetic connections (degree centrality). Color coding distinguishes three categories: ancestral wild species (red), historic hybrid cultivars developed before 1800 (blue), and modern hybrid groups established after 1800 (green). Lines (edges) represent direct parent–offspring relationships based on documented breeding records and genetic analysis. The ellipses and circles with purple lines surround the species and hybrids that constitute the medieval heritage of roses (MRH) and especially the Western Islamic medieval heritage of roses (WIMRH). Data source: Comprehensive survey of *Rosa* species breeding records and documented hybrid genealogies [86,126–136]. Network analysis performed using D3.js force-directed layout algorithm.

4.2.3. Conservation Challenges and Sustainability Concerns

Despite this remarkable legacy, the rose heritage presents notable constraints that threaten its sustainability. The production of cut roses, a major economic sector, often faces high transaction costs due to ineffective institutions, leading to inefficient production as observed with farmers in Gunungsari, Batu City, Indonesia. These transaction costs, combined with fixed and variable costs, burden farmers and reduce profit margins, as they cannot arbitrarily raise prices [143].

Furthermore, garden rose production faces a critical disconnect between breeder selection criteria and public preferences. Research by Chavez et al. [145] revealed that heat and disease tolerance were the most important attributes for consumers in the southern United States, followed by drought tolerance and bloom size, while foliage coverage was the least valuable attribute. This contrast between breeder priorities and consumer valuations highlights the importance of incorporating customer preferences into breeding programs.

A recent comprehensive study on rose oil production in Turkey [146] identified several critical concerns and recommendations for the sustainable management of this rose heritage. Key suggestions include implementing stable pricing policies, distributing informative materials on diseases, pests, and maintenance procedures, and organizing educational seminars to promote conscious agricultural practices among farmers. Addressing manpower shortages, particularly during harvest periods, through advanced technology adoption is crucial for sector viability.

Additionally, regular calculation of production costs and monitoring of international market conditions are essential to keep farmers informed and competitive. The development of detailed marketing strategies for rose products, both nationally and internationally, along with providing enhanced technical information and technological support to farmers, is vital for the sector's continued growth and stability.

5. Conclusions

Medieval Islamic *bustān* gardens served as crucial repositories for rose diversity, preserving and expanding upon Persian and eastern Mediterranean varieties through sophisticated cultivation practices. The roses cultivated in these Western Islamic gardens displayed remarkable diversity in flower morphology, color range, and fragrance profiles, as documented by medieval scholars like Ibn al-ʿAwwām, who categorized varieties by petal count, color, origin, and habitat characteristics.

Rose cultivation in Western Islamic *bustān* gardens was guided by both practical considerations—including fragrance intensity and medicinal properties—and symbolic significance within Arab–Islamic culture. The integration of roses into *bustān* design reflected sophisticated understanding of plant ecology and esthetics, creating gardens that functioned as both productive and contemplative spaces.

The heritage of *bustān* roses extends beyond their initial cultivation period, demonstrating exceptional persistence in the landscape. Several species originally cultivated in medieval Islamic gardens continue to thrive in abandoned *cortijos* and *aldeas* throughout the mountains of eastern Spain, providing living testimony to the durability of these horticultural systems. This botanical continuity offers unique insights into medieval Islamic garden design principles and cultivation techniques.

The medieval rose heritage, particularly the Western Islamic medieval rose heritage, represents a remarkable example of how historical agricultural practices continue to shape contemporary global biodiversity and economic systems. From the complex genetic networks that underpin modern rose breeding to the high-value aromatic industries that sustain rural communities across traditional cultivation regions, this heritage demonstrates the enduring value of preserving and sustainably managing traditional agricultural knowledge. However, addressing current challenges through improved institutional frameworks, better alignment of breeding programs with consumer preferences, and enhanced support for traditional producers will be essential for maintaining this invaluable legacy for future generations.

Future research should focus on documenting surviving *bustān* rose populations in abandoned rural settlements, employing molecular techniques to establish genetic relationships with historical varieties. Transdisciplinary approaches combining archeobotanical evidence, historical texts, and field documentation of persistent populations will enhance our understanding of medieval Islamic horticultural heritage and its contemporary relevance for garden design and plant conservation.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/heritage8080315/s1, Figure S1: Phylogenetic network diagram illustrating the ancestral contributions and hybridization patterns in garden rose development interactive network visualization.

Author Contributions: Conceptualization, D.R. and C.O.; methodology, D.R., J.N. and I.C.; software, D.-J.R.-O.; validation, C.O.; formal analysis, D.R.; investigation, J.V.; resources, J.N.; data curation, J.V. and I.C.; writing—original draft preparation, D.R.; writing—review and editing, all authors; visualization, D.R. and C.O.; project administration, J.N.; funding acquisition, J.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Agencia Estatal de Investigación (Ministerio de Ciencia e Innovación), PID2022-141272NB-I00, and project ArqMUNIA "Arquitecturas de prestigio en las almunias medievales: transmisión de modelos desde la Antigüedad al Renacimiento".

Data Availability Statement: The original contributions presented in the study are included in the article and Supplementary Materials; further inquiries can be directed to the corresponding authors.

Acknowledgments: We acknowledge the support given by Alonso Verde and the collaborators of the project "Rosas antiguas de la provincia de Albacete", which spotted hundreds of individuals of ancient roses and recovered the living materials used for experiments.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

MASL	Meters above sea level
MRH	Medieval rose heritage
WIMRH	Western Islamic medieval rose heritage

References

1. POWO. Plants of the World Online. 2024. Available online: https://powo.science.kew.org/ (accessed on 15 April 2024).
2. Smulders, M.J.M.; Arens, P.; Bourke, P.M.; Debener, T.; Linde, M.; De Riek, J.; Leus, L.; Ruttink, T.; Baudino, S.; Hibrant Saint-Oyant, L.; et al. In the Name of the Rose: A Roadmap for Rose Research in the Genome Era. *Hortic. Res.* **2019**, *6*, 65. [CrossRef]
3. Clark, E. *The Art of the Islamic Garden*; Crowood Press: Malbury, UK, 2010.
4. Ruggles, D. *Islamic Gardens and Landscapes*; University of Pennsylvania Press: Fairchild, CA, USA, 2008.
5. Petruccioli, A. *Il giardino Islamico: Architettura, Natura, Paesaggio*; Electa: Milan, Italy, 1994.
6. Dickie, J. The Hispano-Arab Garden: Its Philosophy and Function. *Bull. Sch. Orient. Afr. Stud.* **1968**, *31*, 237–248. [CrossRef]
7. Di Pasquale, G.; D'Auria, A. Roses, botany and mankind. In *The Ancient Rose of Pompeii*; De Carolis, E., Lagi, A., Di Pasquale, G., D'Auria, A., Avvisati, C., Eds.; L'Erma di Bretschneider: Roma, Italy, 2016; pp. 53–57.
8. Sánchez-Ferrer, J. *Alfombras de Alcaraz y Liétor*; Instituto de Estudios Albacetenses "Don Juan Manuel": Albacete, Spain, 2013; 472p. Available online: https://iealbacetenses.dipualba.es/viewer.vm?id=0000013392 (accessed on 7 January 2025).
9. RAE. Banco de Datos CORDE. 2024. Available online: https://www.rae.es/banco-de-datos/corde (accessed on 15 April 2024).
10. Harvard University. Department of the Classics: Ancient Texts Tools. 2025. Available online: https://classics.fas.harvard.edu/type/ancient-text-tools (accessed on 15 July 2025).
11. VoDIM. Stazione Lessicografica VoDIM. 2024. Available online: https://www.stazionelessicografica.it/ (accessed on 16 April 2024).
12. ArchiDATA. ArchiDATA—Archivio di (Retro)Datazioni Lessicali. 2024. Available online: https://www.archidata.info/ (accessed on 15 April 2024).
13. TLFi. Trésor de la Langue Française Informatisé. *ATILF—CNRS & Université de Lorraine.* 2024. Available online: https://www.atilf.fr/ressources/tlfi/ (accessed on 16 April 2024).
14. D'Ottone, A. Il manuscrito Vaticano Arabo 368 *Hadīth Bayāḍ wa Riyāḍ*. Il codice, il testo, le imagini. *Riv. Stor. Della Miniatura* **2010**, *14*, 55–70.
15. D'Ottone, A. *La Storia di Bayāḍ e Riyāḍ (Vat. Ar. 368). Una Nuova Edizione e Traduzione*; Biblioteca Apostólica Vaticana: Cittá del Vaticano, Italy, 2013.

16. Vatican Library. Manuscript—Vat.ar.368. 2024. Available online: https://digi.vatlib.it/view/MSS_Vat.ar.368 (accessed on 16 April 2024).
17. Alfonso, X. Cantigas de Santa María, Códice Rico. 2024. Available online: https://rbme.patrimonionacional.es/s/rbme/item/11337 (accessed on 15 April 2024).
18. Patrimonio Nacional. Cantigas de Santa María, Códice Rico. *Alfonso X, Rey de Castilla.* 2024. Available online: https://www.patrimonionacional.es/colecciones-reales/cantigas-de-santa-maria-codice-rico (accessed on 15 April 2024).
19. Ruel, J. *De Natura Stirpium*; Oficina Frobeniana: Basel, Switzerland, 1537.
20. Fuchs, L. *De Historia Stirpium Commentarii Insignes*; Balthazarem Arnolletum: Leyden, The Netherlands, 1551.
21. Mattioli, P.A. *Commentarii in Sex Libros Pedacii Dioscoridis*; Vincenzo Valgrisi: Venice, Italy, 1559.
22. de l'Obel, M. *Plantarum seu Stirpium Historia*; Christophori Plantini: Antwerp, Belgium, 1576.
23. Cesalpino, A. *De Plantis Libri XVI*; Giorgio Marescotti: Florence, Italy, 1583.
24. Dodoens, R. *Stirpium Historiae Pemptades Sex*; Christophe Plantin: Antwerp, Belgium, 1583.
25. de los Ríos, G. *Agricultura de Jardines*; P. Madrigal: Madrid, Spain, 1592.
26. Clusius, C. *Rariorum Plantarum Historia*; Plantin (Jan Moretus): Antwerp, Belgium, 1601.
27. Clusius, C. *Curae Posteriores*; Plantin (Raphelengy): Antwerp, Belgium, 1611.
28. Besler, B. *Hortus Eystettensis*; Basilius Besler: Eichstätt, Germany, 1613; Volume 1.
29. Bauhin, C. *Pinax Theatri Botanici*; Ludwig König: Basel, Switzerland, 1623.
30. Parkinson, J. *Paradisi in Sole Paradisus Terrestris*; Humphrey Lownes & Robert Young: London, UK, 1629. Available online: https://www.gutenberg.org/files/69425/69425-h/69425-h.htm#Page_412 (accessed on 25 April 2025).
31. Ferrari, G.B. *De Florum Cultura Libri IV*; Excudebat Stephanus Paulinus: Roma, Italy, 1633.
32. Cupani, F. *Hortus Catholicus*; Franciscum Benzi: Neaples, Italy, 1696.
33. De Tournefort, J.P. *Institutiones Rei Herbariae*, 3rd ed.; Typographia Regia: Paris, France, 1719.
34. Miller, P. *The Gardeners Dictionary*, 6th ed.; John & James Rivington: London, UK, 1752.
35. Herrmann, J. *Dissertatio Inauguralis Botanico-Medica de Rosa*; Joh. Henrici Heitzii: Strasbourg, France, 1762.
36. Münchahusen, O. *Der Hausvater. Teil 5*; Nic. Forsters und Sohns Erben: Hannover, Germany, 1770.
37. Jacquin, N. *Hortus Botanicus Vindobonensis seu Plantarum Rariorum*; Kaliwoda: Vienna, Austria, 1770.
38. Gómez Ortega, C. *Continuación de la Flora Española*; Joachin Ibarra: Madrid, Spain, 1784; Volume 6.
39. Poiret, J.L.M. *Encyclopedie Méthodique Botanique*; Agasse: Paris, France, 1804; Volume 6.
40. Thory, C.A. *Rosa Candolleana*; Hérissant Le Doux: Paris, France, 1819.
41. Lindley, J. *Rosarum Monographiae. Or a Botanical History of Roses*; Ridgway: London, UK, 1820.
42. Redouté, P.J.; Thory, C.A. *Les Roses*; Dufart: Paris, France, 1828; Volume 1.
43. Redouté, P.J.; Thory, C.A. *Les Roses*; Dufart: Paris, France, 1835; Volume 2.
44. Redouté, P.J.; Thory, C.A. *Les Roses*; Dufart: Paris, France, 1835; Volume 3.
45. Boutelou, C. *Tratado de las Flores*, 2nd ed.; Francisco Martínez Dávila: Madrid, Spain, 1829.
46. Paul, W. *The Rose Garden*; Sherwood, Gilbert & Piper: London, UK, 1848.
47. Paul, W. *The Rose Garden*, 3rd ed.; Kent & Co.: London, UK, 1872.
48. Colmeiro, M. Rosáceas de España y Portugal. *Anal. Soc. Esp. Hist. Nat.* **1873**, *2*, 1–83.
49. Burnat, E.; Gremli, A. *Genre Rosa: Révision du Groupe des Orientales*; H. Georg: Geneva, Switzerland, 1887.
50. Willkomm, H.M.; Lange, J. *Prodromus Florae Hispanicae*; E. Schweizerbart (E. Koch): Stuttgart, Germany, 1880; Volume 1.
51. Willkomm, H.M. *Supplementum Prodromi Florae Hispanicae*; K. Hofbuchdruckerei Zu Guttenberg (Carl Grüninger): Stuttgart, Germany, 1893.
52. Crépin, F. La question de la priorité des noms spécifiques envisagée au point de vue du genre *Rosa*. *Bull. Herbier Boissier* **1897**, *5*, 129–163.
53. Boulenger, G.A. Les roses d'Europe de l'herbier Crépin. *Bull. Jard. Bot. État Bruxelles* **1925**, *10*, 193–398.
54. Boulenger, G.A. Les roses d'Europe de l'herbier Crépin. *Bull. Jard. Bot. État Bruxelles* **1931**, *12*, 1–192. [CrossRef]
55. Vicioso, C. *Estudios sobre el Género "Rosa" en España*, 2nd ed.; Instituto Forestal de Investigaciones y Experiencias: Madrid, Spain, 1964.
56. Montserrat, P.; Gómez-García, D.; Ferrández, J.; Bernal, M. *Rosas de Aragón y Tierras Vecinas*; Instituto Pirenaico de Ecología-CSIC: Jaca, Spain, 2016.
57. DeepL. DeepL Translator. 2024. Available online: https://www.deepl.com/translator (accessed on 15 April 2024).
58. Anthropic. Claude Sonnet 3.5 [Large Language Model]. 2024. Available online: https://anthropic.com/claude (accessed on 15 November 2024).
59. DeepSeek Chat. Conversation on rose references and citation formatting. *DeepSeek*, 17 June 2025.
60. OpenAI. ChatGPT. 2024. Available online: https://openai.com/chatgpt (accessed on 15 April 2024).
61. Weber, E. Jardins et Palais dans Le Coran et les Mille et Une Nuits. *Sharq Al-Andal.* **1994**, *10–11*, 65–81. [CrossRef]

62. García-Sánchez, E. Cultivos y espacios agrícolas irrigados en Al-Andalus. In *Agricultura y Regadío en Al-Andalus, Síntesis y Problemas: Actas del Coloquio*; Cara-Barrionuevo, L., Malpica-Cuello, A., Eds.; Instituto de Estudios Almerienses: Almería, Spain, 1995; pp. 17–38.
63. Navarro-Palazón, J.; Puerta, J.M. Las huertas de Marrakech en las fuentes escritas: *Bustān, buḥayra, ŷanna, rawḍ y agdāl* (siglos XII-XX). In *Almunias. Las Fincas de las élites en el Occidente islámico: Poder, Solaz y Producción*; Navarro-Palazón, J., Trillo, C., Eds.; CSIC: Granada, Spain, 2018; pp. 285–305.
64. Navarro-Palazón, J.; Garrido, F. El paisaje periurbano de Marrakech: La Menara y otras fincas de recreo (siglos XII-XX). In *Almunias. Las Fincas de las élites en el Occidente Islámico: Poder, solaz y Producción*; Navarro-Palazón, J., Trillo, C., Eds.; CSIC: Granada, Spain, 2018; pp. 195–284.
65. Navarro-Palazón, J.; Garrido, F.; Torres-Carbonell, J.M. El Agdal de Marrakech. Hidráulica y Producción de Una Finca Real (ss. XII-XX). In *Phicaria: Uso y Gestión de Recursos Naturales en Medios Semiáridos del Ámbito Mediterráneo*; Universidad Popular de Mazarrón: Mazarrón, Spain, 2014; pp. 54–115.
66. Harvey, J.H. Plants of Moorish Spain: A Fresh Look. *Gard. Hist.* **1992**, *20*, 71–82. [CrossRef]
67. García Gómez, E. *Poemas Arabigoandaluces*; Espasa Calpe: Madrid, Spain, 1985.
68. Rubiera Mata, M.J. *Literatura Hispanoárabe*; Mapfre: Madrid, Spain, 1992.
69. García Gómez, E. *Ibn al-Zaqqāq, Poesías*; Instituto hispanoárabe de Cultura: Madrid, Spain, 1956.
70. Nicholson, R. *The Tabjuman al-Ashwaq a Collection of Mystical Odes by Muhyi'ddin Ibn al 'Arabi*; Royal Asiatic Society: London, UK, 1911.
71. Ibn 'Arabī, M. *The Seals of Wisdom*; Ibn Diwan Press: Bradford, UK, 2020.
72. Ruspoli, S. *Ibn 'Arabī Le Livre des Contemplations Divines (Kitâb Mashâhid l-asrâr al-Qudsiyya wa Matâli' al-Anwâr al-Ilâhiyya)*; Sindbad—Actes du Sud: Arlés, France, 1999.
73. Al-Baytar, I.; al-Mlaq, A.A.I.A. *Traité des Simples*; Tome Premier/par Ibn El-Beïthar; Translated from Arab by L. Leclerc; Notices et Extraits des Manuscrits de la Bibliothèque Nationale; Imprimerie Nationale: Paris, France, 1877; Volume 23, pp. I–XVI, 1–476.
74. Al-Baytar, I.; al-Mlaq, A.A.I.A. *Traité des Simples*; Tome Deuxième/par Ibn El-Beïthar; Translated from Arab by L. Leclerc; Notices et Extraits des Manuscrits de la Bibliothèque Nationale; Imprimerie Nationale: Paris, France, 1881; Volume 25, pp. I–II, 1–489.
75. Al-Baytar, I.; al-Mlaq, A.A.I.A. *Traité des Simples*; Tome Troisième/par Ibn El-Beïthar; Translated from Arab by L. Leclerc; Notices et Extraits des Manuscrits de la Bibliothèque Nationale; Imprimerie Nationale: Paris, France, 1883; Volume 26, pp. 1–483.
76. Banqueri, J.A. *Libro de Agricultura. Su autor el Doctor Excelente Abu Zacaria Iahia Aben Mohamed ben Ahmed En El Awam Sevillano*; Imprenta Real: Madrid, Spain, 1802. Available online: https://archive.org/details/b30457282_0001/page/n5/mode/2up (accessed on 24 April 2024).
77. Clément-Mullet, J. *Le Livre d'Agriculture d'Ibn al Awam*; Albert L. Hérold: Paris, France, 1864.
78. Hernández-Bermejo, J.E.; García-Sánchez, E.; al-'Awwām, I. *Kitāb al-Filāḥa. Libro de Agricultura*; Banqueri, J.A., Ed. and Translator; 1802 (ed. Facsimil); Ministerio de Agricultura: Madrid, Spain, 1988; 2 Volumes; pp. 314–324.
79. García-Sánchez, E.; Carabaza, J.M.; Hernández-Bermejo, J.E. *Flora agrícola y Forestal de al-Andalus*; Ministerio de Agricultura, Pesca y Alimentación: Madrid, Spain, 2021; Volume 2.
80. Akef, W.; Almela, I. Nueva lectura del capítulo 157 del tratado agrícola de Ibn Luyūn. *Al-Qanṭara* **2021**, *42*, 1–26. [CrossRef]
81. Navarro-Palazón, J.; Garrido, F.; Torres, J.M.; Triki, H. Agua, arquitectura y poder en una capital del islam: La finca real del Agdal de Marrakech (ss. XII-XX). *Arqueol. Arquit.* **2013**, *10*, e007. [CrossRef]
82. Navarro-Palazón, J.; Garrido, F.; Almela, Í. The Agdal of Marrakesh (Twelfth to Twentieth Centuries): An Agricultural Space for Caliphs and Sultans. Part I: History. In *Muqarnas, An Annual on the Visual Cultures, of the Islamic World*; Necipoğlu, G., Metzler, M.J., Eds.; Brill: Leiden, The Netherlands, 2017; Volume 34, pp. 24–32.
83. Navarro-Palazón, J.; Garrido, F.; Almela, Í. The Agdal of Marrakesh (Twelfth to Twentieth Centuries): An Agricultural Space for Caliphs and Sultans. Part II: Hydraulics, Architecture and Agriculture. In *Muqarnas, An Annual on the Visual Cultures, of the Islamic World*; Necipoğlu, G., Metzler, M.J., Eds.; Brill: Leiden, The Netherlands, 2018; Volume 35, pp. 1–64.
84. Harvey, J.H. Gardening Books and Plant Lists of Moorish Spain. *Gard. Hist.* **1975**, *3*, 10–21. [CrossRef]
85. Tito-Rojo, J.; Casares-Porcel, M. *El Jardín Hispanomusulmán: Los Jardines de al-Andalus y su Herencia*; Editorial Universidad de Granada: Granada, Spain, 2011.
86. HelpMeFind. Loubert Roses. 2024. Available online: https://www.helpmefind.com/rose/index.php (accessed on 27 June 2024).
87. Loubert. Roses, Clematis and Peonies and Everything Gardening Related. 2024. Available online: https://www.pepiniere-rosesloubert.com/ (accessed on 27 June 2024).
88. Alhambra Patronato. Sala de los Reyes. 2024. Available online: https://www.alhambra-patronato.es/edificios-lugares/sala-de-los-reyes (accessed on 30 April 2024).
89. Navaggero, A. *Viaje por España: (1524–1526)*; Fabie, A.M., Ed.; Turner: Madrid, Spain, 1983.
90. Harvey, J.H. Gardens in Their Historical Background. *Gard. Hist.* **1974**, *3*, 7–14. [CrossRef]

91. Simón, E. Pinturas de la sala de los Reyes—La Alhambra, Granada. 2020. Available online: https://andalfarad.com/pinturas-de-la-sala-de-los-reyes-la-alhambra-granada/ (accessed on 16 April 2024).
92. Touw, M. Roses in the Middle Ages. *Econ. Bot.* **1982**, *36*, 71–83. [CrossRef]
93. Başer, K.H.C. Rose Mentioned in the Works of Scientists of the Medieval East and Implications in Modern Science. *Nat. Prod. Commun.* **2017**, *12*, 1327–1330. [CrossRef]
94. Wikipedia. Rose Symbolism. 2024. Available online: https://en.wikipedia.org/wiki/Rose_symbolism (accessed on 16 April 2024).
95. Saccone, C. I giardini fioriti dei poeti persiani. In *Prati, Verzieri, Pomieri. Il Giardino Medievale. Culture, Ideali, Società*; Caraffi, P., Pirillo, P., Eds.; Edifir: Florence, Italy, 2017; pp. 75–86.
96. Ghazani, R.R.; Topaloğlu, A. Mystical Contemplation or Rational Reflection? The Double Meaning of Tafakkur in Shabistarī's Rose Garden of Mystery. *Islam Contemp. World* **2023**, *1*, 9–30. [CrossRef]
97. Shabestarī, M. *Gulshan I Raz: The Mystic Rose Garden*; Tübner & Co.: London, UK, 1880.
98. Harvey, J.H. Turkey as a Source of Garden Plants. *Gard. Hist.* **1976**, *4*, 21–42. [CrossRef]
99. Scollay, F.S. The Rose Garden of Refuge': The Fifteenth Century Ottoman Palace at Edirne/Adrianople. Ph.D. Thesis, La Trobe University, Bundoora, Australia, 2012.
100. Sadaf, F. Gardens in Mughal Gujarat. *Proc. Indian Hist. Congr.* **2011**, *72*, 441–452.
101. Anthos. Anthos, Sistema de Información Sobre las Plantas de España. Available online: http://www.anthos.es/ (accessed on 18 June 2025).
102. Roldán, R.; Escobar, J.; Valdés, A.; Verde, A.; Fajardo, J.; Rivera, D. El papel de la asociación de amigos del jardín botánico de Castilla-La Mancha (Albacete) en la recuperación del patrimonio biocultural: Proyecto "Las rosas antiguas de la provincia de Albacete", un ejemplo de la ciencia ciudadana. In *Colecciones Vivas: Reservorio de Genes y Conocimientos Tradicionales Relativos a la Biodiversidad*; Ríos, S., Ed.; CIBIO: Alicante, Spain, 2024; p. 30. Available online: https://torretes.es/xvii-congreso-de-la-aimj-del-14-18-de-mayo/ (accessed on 16 June 2024).
103. Verde, A.; Rivera, D.; Obón, C. *Etnobotánica en las Sierras de Segura y Alcaraz: Las Plantas y el Hombre*; Instituto de Estudios Albacetenses, Diputación de Albacete: Albacete, Spain, 1998.
104. Verde, A.; Rivera, D.; Escobar, J.L.; Roldán, R.; Fajardo, J.; Valdés, A.; Ríos, S.; Obón, C.; Sánchez-Gómez, P.; Cánovas, J.L.; et al. Las Rosas Antiguas en la Provincia De Albacete, un Patrimonio Biocultural en Recuperación a Través de Ciencia Ciudadana. *Sabuco* **2024**, *18*, 23–58. [CrossRef]
105. Desfontaines, R. *Flora Atlantica*; Desgranges: Paris, France, 1798; Volume 1.
106. Hamarneh, S.K. Medicinal Plants, Therapy and Ecology in Al-Ghazzi's Book on Agriculture. *Stud. Hist. Med.* **1978**, *2*, 223–263.
107. Baydar, H.; Erbas, S.; Kazaz, S. Variations in floral characteristics and scent composition and the breeding potential in seed-derived oil-bearing roses (*Rosa damascena* Mill.). *Turk. J. Agric. For.* **2016**, *40*, 560–569. [CrossRef]
108. Safaei-Ghomi, J.; Bamoniri, A.; Hatami, A.; Batooli, H. Determination of volatile components in Iranian *Rosa hemisphaerica*. *Chem. Nat. Compd.* **2007**, *43*, 738–740. [CrossRef]
109. Mileva, M.; Kusovski, V.K.; Krastev, D.S.; Dobreva, A.M.; Galabov, A.S. Chemical composition, *in vitro* antiradical and antimicrobial activities of Bulgarian *Rosa alba* L. essential oil against some oral pathogens. *Int. J. Curr. Microbiol. Appl. Sci.* **2014**, *3*, 11–20.
110. Jovtchev, G.; Stankov, A.; Georgieva, A.; Dobreva, A.; Bakalova, R.; Aoki, I.; Mileva, M. Cytotoxic and genotoxic potential of Bulgarian *Rosa alba* L. essential oil–in vitro model study. *Biotechnol. Biotechnol. Equip.* **2018**, *32*, 513–519. [CrossRef]
111. Hosni, K. *Rosa* × *alba*: Source of essential minerals and volatile oils. *Nat. Prod. Bioprospect.* **2011**, *1*, 57–61. [CrossRef]
112. Younis, A.; Khan, M.A.; Khan, A.A.; Riaz, A.; Pervez, M.A. Effect of different extraction methods on yield and quality of essential oil from four *Rosa* species. *Floric. Ornam. Biotechnol.* **2007**, *1*, 73–76.
113. Younis, A.; Riaz, A.; Khan, M.A.; Khan, A.A.; Pervez, M.A. Extraction and identification of chemical constituents of the essential oil of *Rosa* species. *Acta Hortic.* **2008**, *766*, 485–492. [CrossRef]
114. Honarvar, M.; Javidnia, K.; Khosh-Khui, M. Essential oil composition of fresh and dried flowers of *Rosa moschata* from Iran. *Chem. Nat. Compd.* **2011**, *47*, 826–828. [CrossRef]
115. Shamspur, T.; Mostafavi, A. Chemical composition of the volatile oil of *Rosa Kazanlak* and *Rosa gallica* from Kerman Province in Iran. *J. Essent. Oil Bear. Plants* **2010**, *13*, 78–84. [CrossRef]
116. Mirjalili, M.H.; Akhoondi, R.; Hadian, J. Chemical composition of the aliphatic compound-rich essential oil of *Rosa foetida* from Iran. *Chem. Nat. Compd.* **2015**, *51*, 171–172. [CrossRef]
117. Caissard, J.C.; Bergougnoux, V.; Martin, M.; Mauriat, M.; Baudino, S. Chemical and histochemical analysis of 'Quatre Saisons Blanc Mousseux', a moss rose of the *Rosa* × *damascena* group. *Ann. Bot.* **2006**, *97*, 231–238. [CrossRef]
118. Zgheib, R.W.N.; Azzi-Achkouty, S.; Sadaka, C.; Ouaini, N.; El Beyrouthy, M. Essential oil chemical composition of *Rosa corymbifera* Borkh., *Rosa phoenicia* Boiss. and *Rosa damascena* Mill. from Lebanon. *J. Essent. Oil Bear. Plants* **2020**, *23*, 1161–1172. [CrossRef]

119. Jandoust, S.; Karami, A. Seasonal variation in floral scent of Persian Musk rose (*Rosa moschata* Hermm.). *J. Med. Plants By-Prod.* **2015**, *2*, 243–247.
120. Rusanov, K.; Kovacheva, N.; Rusanova, M.; Atanassov, I. Flower phenotype variation, essential oil variation and genetic diversity among *Rosa alba* L. accessions used for rose oil production in Bulgaria. *Sci. Hortic.* **2013**, *161*, 76–80. [CrossRef]
121. Wanner, J.; Schmidt, E.; Bail, S.; Jirovetz, L.; Buchbauer, G.; Gochev, V.; Girova, T.; Atanasova, T.; Stoyanova, A. Chemical composition, olfactory evaluation and antimicrobial activity of selected essential oils and absolutes from Morocco. *Nat. Prod. Commun.* **2010**, *5*, 1349–1354. [CrossRef]
122. Najem, W.; El Beyrouthy, M.; Wakim, L.H.; Neema, C.; Ouaini, N. Essential oil composition of *Rosa damascena* Mill. from different localities in Lebanon. *Acta Bot. Gall.* **2011**, *158*, 365–373. [CrossRef]
123. Widrlechner, M.P. History and Utilization of *Rosa damascena*. *Econ. Bot.* **1981**, *35*, 42–58. [CrossRef]
124. Elías, F.; Ruiz, L. *Estudio Agroclimático de la Región Castilla-La Mancha*; Departamento de Agricultura de la Junta de Comunidades de Castilla-La Mancha: Madrid, Spain, 1981.
125. Font, I. *Climatología de España y Portugal*; Instituto Nacional de Meteorología: Madrid, Spain, 1983.
126. Roberts, A.V.; Gladis, T.; Brumme, H. DNA amounts of roses (*Rosa* L.) and their use in attributing ploidy levels. *Plant Cell Rep.* **2009**, *28*, 61–71. [CrossRef]
127. Harmon, D.D.; Chen, H.; Byrne, D.; Liu, W.; Ranney, T.G. Cytogenetics, ploidy, and genome sizes of rose (*Rosa* spp.) cultivars and breeding lines. *Ornam. Plant Res.* **2023**, *3*. [CrossRef]
128. Grossi, C.; Jay, M. Chromosomes studies of rose cultivars: Application into selection process. *Acta Bot. Gall.* **2002**, *149*, 405–413. [CrossRef]
129. Končalová, M.N.; Klášterský, I. Cytology and chromosome numbers of some Czechoslovak roses III. *Folia Geobot. Phytotax.* **1978**, *13*, 67–93. [CrossRef]
130. Jowkar, A.; Kermani, M.; Kafi, M.; Mardi, M.; Hoseini, Z.S.; Koobaz, P. Cytogenetic and flow cytometry analysis of Iranian *Rosa* spp. *Floric. Ornam. Biotechnol.* **2009**, *3*, 71–74.
131. Klášterská, I. Cytology and some chromosome numbers of Czechoslovak roses I. *Folia Geobot. Phytotax.* **1969**, *4*, 175–189. [CrossRef]
132. Martin, M.; Piola, F.; Chessel, D.; Jay, M.; Heizmann, P. The domestication process of the Modern Rose: Genetic structure and allelic composition of the rose complex. *Theor. Appl. Genet.* **2001**, *102*, 398–404. [CrossRef]
133. Raymond, O.; Biolley, J.P.; Jay, M. Fingerprinting the selection process of ancient roses by means of floral phenolic metabolism. *Biochem. Syst. Ecol.* **1995**, *23*, 555–565. [CrossRef]
134. Parsons, S.B. *Parsons on the Rose. A Treatise on the Propagation, Culture, and History of the Rose*; Orange Judd Company: New York, NY, USA, 1883.
135. Reynders-Aloisi, S.; Bollereau, P. Characterisation of genetic diversity in genus Rosa by randomly amplified polymorphic DNA. In *II International Rose Symposium*; Acta Horticulturae; International Society for Horticultural Science (ISHS): Leuven, Belgium, 1995; Volume 424, pp. 253–260.
136. Paris, C.D.; Maney, T.J. *Rosa multiflora* and Its Progeny. *Proc. Iowa Acad. Sci.* **1939**, *46*, 149–160. Available online: https://scholarworks.uni.edu/pias/vol46/iss1/18 (accessed on 24 June 2025).
137. Cristiano, L.; De Martino, G. *Viaggi e Profumi*; AnimaMundi Edizioni: Otranto, Italy, 2022.
138. Roques, D. *El buscador de Esencias*; Siruela: Madrid, Spain, 2022.
139. Roques, D. Sources et Sourceurs de Parfums. In *Parfums d'Orient*; Boghanim, H., Carayon, A., Eds.; Institut du Monde Arabe: Paris, France, 2023; pp. 73–81.
140. El Malahi, S.; Ganoudi, M.; Hssaini, L.; Lahrech, M.T.; Hassani, L.M.I. Damask Rose: A Symbol of Sustainability and Resilience in Morocco's Bioeconomy. In *Sustainable Bioeconomy Development in the Global South*; Ogwu, M.C., Izah, S.C., Merritt, H., Wise, R.D., Jintrawet, A., Eds.; Springer: Singapore, 2025; pp. 425–452. [CrossRef]
141. Observatory of Economic Complexity. The Latest Trade Data of Roses. 2023. Available online: https://oec.world/en/profile/hs/roses (accessed on 15 June 2025).
142. Kovacheva, N.; Rusanov, K.; Atanassov, I. Industrial cultivation of oil-bearing rose and rose oil production in Bulgaria during 21st century, directions and challenges. *Biotechnol. Biotechnol. Equip.* **2010**, *24*, 1793–1798. [CrossRef]
143. Abbas, M.H.; Yusida, E.; Priambodo, M.; Prastiwi, L.; Istiqomah, N. Identifying production costs of cut roses: An institutional economics perspective. *IOP Conf. Ser. Earth Environ. Sci.* **2024**, *1338*, 01206. Available online: https://iopscience.iop.org/article/10.1088/1755-1315/1338/1/012064/pdf (accessed on 25 June 2025). [CrossRef]
144. Rosarium. Europa Rosarium. 2024. Available online: https://www.europa-rosarium.de/de/unser-rosarium/rosensammlung (accessed on 26 June 2024).

145. Chávez, D.E.; Palma, M.A.; Byrne, D.H.; Hall, C.R.; Ribera, L.A. Willingness to Pay for Rose Attributes: Helping Provide Consumer Orientation to Breeding Programs. *J. Agric. Appl. Econ.* **2020**, *52*, 1–15. [CrossRef]
146. Gul, M.; Kazaz, S.; Baydar, H.; Sirikci, B. A Study About Technical, Economical Situation, Problems and Improvement of Oil Rose (*Rosa damascena* Mill.) in Turkey. *J. Essent. Oil Bear. Plants* **2015**, *18*, 613–626. [CrossRef]