Vegetation History and Archaeobotany
https://doi.org/10.1007/s00334-026-01143-1

ORIGINAL ARTICLE

# Plant diversity from latrines in Al-Andalus, Iberia: archaeobotanical evidence of diet in the 10th–12th centuries CE

Antonio Peralta-Gómez[1,2] · Leonor Peña-Chocarro[1] · Guillem Pérez-Jordà[3] · Belén Alemán[4] · Rafael Clapés Salmoral[5] · Susana Gómez Martínez[6,7] · José Manuel Márquez Gallardo[8] · María De Fátima Palma[6] · Elena Salinas[9]

Received: 31 December 2025 / Accepted: 1 May 2026


## Abstract

During the Islamic period (8th–15th centuries CE), the Iberian Peninsula emerged as a vibrant cultural crossroads, where Islamic influence reshaped farming and the economy. Latrines, cesspits and sewers, often overlooked in archaeological investigations, have proven to be rich repositories of organic remains, including seeds and fruits. These materials provide archaeobotanists with valuable insights into the diet, farming practices and biodiversity of the period. This study investigates the presence and diversity of plant remains preserved in Islamic latrines in Al-Andalus in the south of the Iberian Peninsula, a type of context that has been little researched so far. Analysis of these remains offers a unique perspective on daily life, farming and cultural interactions within these communities. This article discusses the plant remains from five archaeological sites in the region dated between the 10th and the 12th centuries CE. The samples yielded over 50,000 remains, including 25 cultivated taxa. Among these, previously unrecorded fruit trees such as *Citrus* sp. were identified, along with garden plants and spices including carrots, coriander, fennel and cumin. In addition, several wild plant taxa were found, and insect remains including Diptera (flies) and Curculionidae (weevils) were also recovered.

**Keywords** Islamic · Crops · Diet · Latrines · Sewer · Al-Andalus · South Iberia

## Introduction

The study of ancient latrines, cesspits and drains provides a valuable window into everyday life in the past. Beyond the architectural analysis of the structures, which informs about technology and the evolution of systems for waste disposal (Reklaityte 2016), these contexts offer important insights into the plant diversity, farming and food consumption patterns of the communities that used them. Latrines can be exceptional archaeological deposits for the preservation of organic remains (Greig 1981).

Analyses of latrines and such structures outside the Iberian Peninsula have often concentrated on aspects of health, particularly through the study of parasite remains. Notable examples include a 12th century CE latrine in Cyprus (Anastasiou and Mitchell 2013), the public and private latrines of Ephesus in Turkey (Ledger et al. 2018) and various sites in central and northern Europe (Mitchell et al. 2011). Broader surveys have considered latrines across northern Europe and the Middle East, considering both chronological and geographical perspectives (Søe et al. 2018). Beyond

Communicated by M. Schepers

✉ Antonio Peralta-Gómez
antonio.peralta@cchs.csic.es

1 Instituto de Historia-CSIC, Madrid, Spain

2 Departamento de Historia Medieval, Ciencias y Técnicas Historiográficas, Universidad de Granada, Granada, Spain

3 Departamento de Prehistoria, Arqueología i Hª Antiga, Universitat de València, València, Spain

4 Yacimiento Arqueológico Barrio Andalusí, Ayuntamiento de Almería, Almería, Spain

5 Professional Archaeologist, Córdoba, Spain

6 Campo Arqueológico de Mértola-CEAACP, Mértola, Portugal

7 Universidad de Évora, Évora, Portugal

8 Professional Archaeologist, Mérida, Spain

9 Escuela de Estudios Árabes, CSIC, Granada, Spain

Published online: 20 August 2026

parasitological studies, archaeobotanical analyses have provided valuable insights into the plant component of diets, as seen in research on latrines in Pompeii and Herculaneum (Rowan 2017; Pallecchi et al. 2025) and the analysis of a public latrine in Sagalassos, Turkey (Baeten et al. 2012). Studies into food plants and food processing have also played a significant role (Hondelink and Schepers 2020; Hondelink 2024).

Other studies have emphasised nutritional aspects, including analyses of latrines in south-eastern Germany (Märkle 2005), investigations of organic waste in Danish latrines covering the period from the Viking Age to the Renaissance (Hald et al. 2020), and research on food consumption from Roman times to the early 20th century in the city of York (Hall 2000).

Research on plant remains in Iberia has been a relatively recent development, including broad compilations of Roman and medieval assemblages (Peña-Chocarro et al. 2019) as well as studies of specific sites (Alonso Martínez 2005; Alonso et al. 2014; Kirchner et al. 2014; Rodríguez-Ariza and Montes Moya 2015; García-Rivero et al. 2019; Peña-Chocarro and Pérez-Jordà 2019; Ros et al. 2019, 2025, 2026; Treasure 2020; Seabra 2023). More recently, projects such as Medieval Appetites: food plants in multicultural Iberia 500–1100 CE (MEDAPP) have emphasised the medieval period, and several sites in Al-Andalus are currently under analysis, providing a rich source of information on plant use there between the 6th and 12th centuries CE (Peña-Chocarro and Ordóñez 2024; Peralta-Gómez et al. 2024; Pérez-Jordà et al. 2024; Peña-Chocarro and Pérez-Jordà 2026). Al-Andalus is the part of the Iberian Peninsula which was under Islamic rule from approximately 711 CE, with the Umayyad conquest of Hispania, until 1492 when the last Muslim kingdom fell.

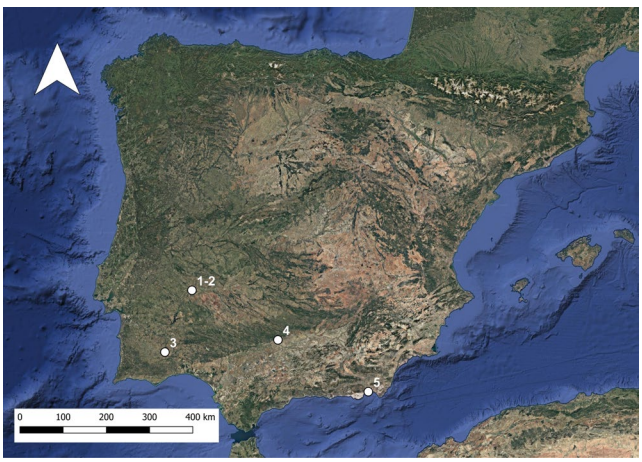


**Fig. 1** Location of the sites analysed in southern Iberia: 1–2, Calles Martín Cansado and Joaquin Costa, Badajoz; 3, Mértola, Portugal; 4, Córdoba; 5, Barrio Andalusí, Almería

What is still lacking, however, is a systematic study of plant remains specifically from latrines and similar structures. To date, the only sites in al-Andalus that have yielded such information are Albalat in Extremadura, whose recent publication represents one of the very few contributions in this area (Ros et al. 2025), and two sites in Catalonia, the city of Lleida (Alonso Martínez 2005) and Pla d'Almatà (Kirchner et al. 2014). Previous research on latrine material from the Iberian Peninsula was almost exclusively on intestinal parasites and related health issues (Knorr et al. 2019; López-Gijón et al. 2025), leaving the plant-based component of medieval diets largely unexplored.

Given this scarcity of direct evidence, our understanding of the plant-based diet in al-Andalus has until recently relied almost entirely on written sources, including treatises and calendars on farming, and texts on medicine and diet (García-Sánchez et al. 2021; Hernández Bermejo et al. 2012). The analysis of plant and animal remains from archaeological contexts such as latrines, that provide direct evidence of of plant consumption from the faecal remains there, is essential to complement written sources.

## Materials and methods

### Archaeological contexts

For this study, five archaeological sites located in the south of Iberia have been studied (Fig. 1). Two of them, Calle Martín Cansado and Calle Joaquín Costa, were investigated in a rescue excavation carried out in several streets in Badajoz; the third comprises two latrines at the archaeological site of Mértola, in Portugal; the remaining two were in Andalucía, one in the city of Córdoba and the other at the site of Barrio Andalusí in the city of Almería. All sites have extensive chronologies from the 10th to the late 12th century.

### Badajoz: Calle Joaquín Costa 32 and Calle Martín Cansado 41

In 2023, excavations at Calle Joaquín Costa 32 in the city of Badajoz, Extremadura, Spain, provided important data on the sewer network of what was the capital of the Taifa kingdom in the 11th century. Various occupation phases were recorded dating back to the Islamic period in the 10th–11th century. Associated with Phase 2 (11th century), a main sewer or *atarjea* represented by stratigraphic units SU336–SU320, was found which was cut as a trench into the clay substrate which sloped gently down towards the Río Guadiana.

SU336.2: The sewer has several contrasting features along its course. The upper (southern section) consisted

of an open air trench filled with rubble and faecal deposits within a dark greenish silty soil matrix containing pottery fragments datable to the 11th century.

SU320.1: The northern section which was closer to the river, was underground, built of limestone blocks and filled with dark greenish-yellow silty sediment. Running beneath the earthen surface of a street, it received secondary sewer channels from houses along the western frontage of the street and an alley on the eastern side. Pottery fragments datable to the 11th century were also recovered there.

SU348.1: This unit was the fill of one of the secondary sewer channels and consisted of dark, blackish silty-sandy sediment.

SU357.1: This sewer channel belonged to a building identified as a *wudu*, wash house for ritual personal cleansing before prayer in the mosque. The structure contained three parallel cubicles for washing, one of which also had a latrine from which the sample was taken. The flow of relatively clean water from the cubicles would have effectively flushed the waste down the channel. The sampled fill, unlike those of the other sewer channels, was less organic, consisting of dark brown sediment with hardly any faecal remains.

In 2024, another archaeological excavation was carried out on Calle Martín Cansadot, approximately 760 m from the previous site, showing the large size of the city during the Taifa period. Two phases from this period were excavated and sampled:

Phase 1 (late 10th–11th century). No structures were recorded, only scattered pits dug into the geological substrate and filled with refuse. Among this material was pottery datable to the end of the Caliphate and the beginning of the Taifa period.

Phase 2 (11th century). Contemporary with Phase 2 at Calle Joaquín Costa, with a building that included a cesspit (SU11.3–SU11.6) and a waste system consisting of sewer channels (SU12.3) that would have joined the main sewer running along the street.

SU11.3–SU11.6: The cesspit had a dry stone lining at the base. It was filled with faecal waste, dark greenish sediment and refuse.

SU12.3: A sewer channel, with stone walls and roof, filled with faecal remains and very dark greenish-yellowish sediment.

## Mértola, southern Portugal

Mértola, Alentejo, is a small town whose port on the Río Guardiana has long given it a strategic role in connecting Mediterranean sea routes with the interior of the western Iberian Peninsula. Continuously inhabited since at least the 8th century BCE, the settlement rose to notable regional prominence from the second half of the 10th century CE onward. Its importance continued through the 11th century, when Mértola served as the capital of a small but short-lived Taifa kingdom, and into the 12th century when its port traded with the western Mediterranean region.

The two latrines studied in Mértola correspond to different chronological phases, as indicated by associated pottery assemblages. The first, castelo, was in the castle area and dates to the 10th century, while the second, biblioteca, which was near the library, belongs to the 11th century. Both were dug directly into the street, had an approximately oval plan, and were lined with courses of stone bonded with earth.

The castelo latrine, situated within the seat of political power, served the domestic buildings built at the end of the 9th century and was abandoned at the close of the 10th century, as suggested by the accompanying pottery. The biblioteca latrine, located in the residential quarter of the town, remained in use slightly longer and was abandoned roughly half a century later, in the course of the 11th century, according to the pottery recovered from its fill.

## Córdoba, Andalusia

Recent archaeological work in the western part of the city of Córdoba has resulted in the excavation of extensive areas of the Islamic period suburb, providing a unique opportunity to examine both its layout and life there at these times. One of the excavated areas, which took shape after the proclamation of the Caliphate of Córdoba in 929, displays a clearly planned grid layout of streets composed of two parallel streets and three regular residential blocks. The streets were surfaced with gravel and equipped with cesspits beside central drainage channels that carried waste water from the houses.

A total of 25 houses were found, each with a courtyard, entrance hall, main hall and latrine, indicating the essential role of waste disposal in Islamic domestic architecture. The latrines were generally located in a corner of the entrance bay although in some cases they were relocated to the eastern bay of the courtyard during later modifications. Most provided direct access from the courtyard, necessitating a door, while others incorporate angled entrances that blocked direct views and made a door unnecessary.

Each latrine consisted of two raised slabs forming the seating surface, with a central opening connected with a steep drainage channel designed to prevent blockages. This channel led to a cesspit located outside the house, usually dug into the street.

Samples were obtained from the lowest deposits of four cesspits (SUs 173, 463, 457 and 585) dated to the Caliphate period (mid 10th to early 11th century).

### Barrio Andalusí, Almería

The Barrio Andalusí site corresponds to one of the suburbs of the city of al-Mariyya (modern Almería), which was occupied intermittently from the foundation of the city by Caliph Abd al-Rahman in 955 CE until its final conquest by the Christians in 1489. The excavated area was in a privileged position within the earliest walled enclosure formed by the medina (walled city) and extended to the foot of the citadel, the centre of political authority.

Archaeological work has identified three main phases of occupation. The first phase (10th–11th centuries) was primarily dedicated to storage activities and contained 18 pits interpreted as silos. Among these were pits 23, 24, 26 and 28, all of which were filled and sealed during the following phase.

The second phase began at the end of the 11th century in the Taifa or Almoravid period, coinciding with the height of commercial prosperity of Almería. At this time, a residential neighbourhood was built, consisting of houses with courtyards and a network of streets. The wells (1 and 102) and the cesspits (121 and 122) analysed in this study belong to this phase. Based on associated material culture, the abandonment of the neighbourhood has been dated to 1147, when the city was first conquered by the Christians, a domination which lasted ten years until the arrival of the Almohads (Salinas et al. 2024). From that moment onward, and continuing until the end of the Middle Ages (phase 3), most of the quarter remained uninhabited, as evidenced by extensive collapse layers and the area probably served as a rubbish dump. However, some dwellings in the eastern part were reoccupied and refurbished, and pottery from both the Almohad and Nasrid periods has been recovered from these contexts.

### The samples

A total of 33 samples from different latrines, cesspits and sewers have been analysed. The samples came from the various archaeological sites, with Barrio Andalusí providing the most remains and greatest variety of taxa across the seven contexts analysed. In total, 53,286 plant remains and 45 taxa have been identified including 25 cultivated plants (S1). The vast majority of the remains were preserved through mineralisation and a smaller proportion were charred. In some cases, the formation of concretions or dense concentrations of remains limited identification to the family or genus level.

The samples were processed at the archaeobiology laboratory of the Institute of History, CSIC, using a flotation machine equipped with a double 1 mm mesh inside the drum and a 0.25 mm mesh on the outside. The use of a double mesh was necessary due to the presence of mineralised together with some charred remains. After flotation, the flots were washed through a column of sieves with meshes of 4, 2, 1, 0.5 and 0.25 mm, with the aim of separating the remains according to size, and thus facilitating sorting and identification. The inner mesh of the drum after flotation of the samples was also examined as many of the mineralised remains did not float due to their size and weight.

Identifications were carried out with a stereomicroscope at magnifications 7.5–60× and using the the reference collection of the archaeobiology laboratory, and complemented by consultation of specialised literature and seed atlases (Hanf 1983; Cappers et al. 2006; Bojňanský and Fargašová 2007; Carruthers and Smith 2020; Sabato and Peña-Chocarro 2021). Taxonomic nomenclature follows *Flora Iberica* (Castroviejo et al. 1986–2015) for wild taxa, while cultivated plants are named according to *Domestication of Plants in the Old World* (Zohary et al. 2012).

The five samples from Mértola Castelo have been combined into one, as they share the same chronology and no differences were observed among them. The same approach has been applied to the latrine from Mértola biblioteca, where the seven samples have also been consolidated as one. The remaining samples from the other sites have been kept separate, as they came from distinct contexts within each site.

Quantification of the remains was carried out consistently across all contexts, with all plant remains in each sample identified and counted. For fruits with particularly high abundance of seeds, such as figs and strawberries, counts were made on a 5 ml subsample and the total number of remains in the full sample was estimated from this.

## Results

### Preservation

Almost all the seed and fruit (carpological) remains were mineralised, as is most common in latrine material. The high presence of phosphates and carbonates, probably resulting from the decomposition of faecal, plant and animal matter, promotes preservation through mineralisation, whereby these minerals replace the plant tissue of seeds and fruits (Green 1979). A smaller proportion of the remains were charred, mainly cereals, as in the case of some contexts from Barrio Andalusí, Mértola and Badajoz. This pattern suggests that the latrines analysed in this study received materials through two distinct depositional pathways. The mineralised remains probably reflect faecal material deposited during the routine use of the latrine, whereas charred remains probably originate from cooking debris or burnt waste that was intentionally discarded either during use

or at a later stage. The very low quantity of charred material, however, limits our ability to assess its precise origin or representativeness. Additional evidence for the disposal of material unrelated to normal latrine use comes from the presence of potsherds and other debris.

Cultivated plants are mainly represented by fruits, with cereals, legumes and garden plants occurring to a lesser extent (Fig. 2). In addition to plant remains, a wide variety of insect remains were found, including beetle remains of Curculionidae (weevils) and pupae of Musci (cesspit flies), as well as amorphous remains that may represent mineralised food scraps or faecal matter.

## Cereals

Three cereals have been identified, *Hordeum vulgare* ssp. *vulgare* (six-row hulled barley), *Triticum aestivum/durum* (free-threshing wheat) and *T. dicoccum* (emmer, hulled wheat). A total of 14 grains (caryopses) were recovered, of which only one naked wheat grain was mineralised, while the remainder were charred. The free-threshing wheat has been identified as *T. aestivum/durum* due to the absence of rachis remains, which would have allowed differentiation between tetraploid *T. durum* and hexaploid *T. aestivum* (Jacomet 2006). Additional cereal fragments could not be identified due to poor preservation.

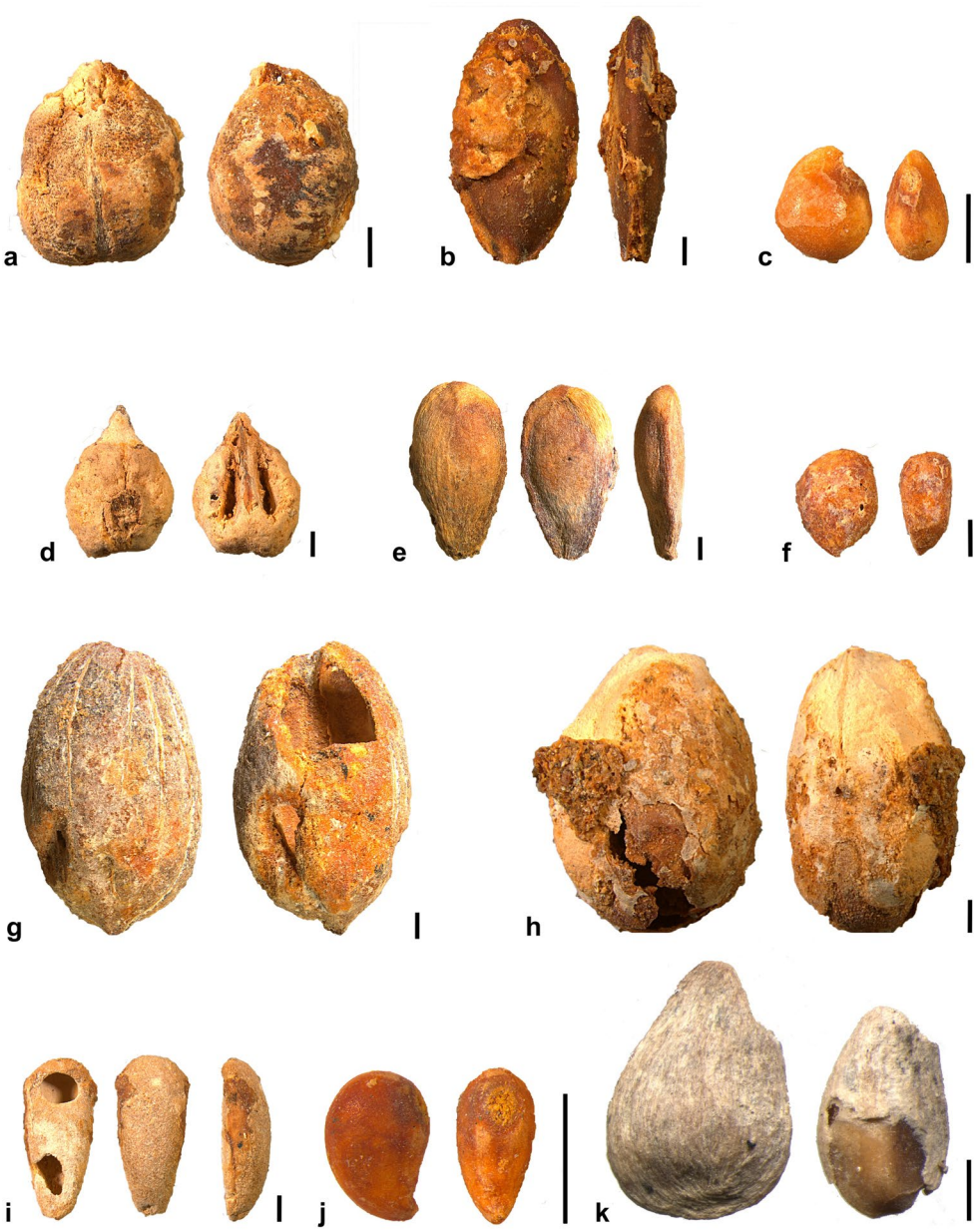


**Fig. 2** Mineralised plant remains found in the studied contexts; **a**, *Cicer arietinum* (chickpea); **b**, *Cucumis melo/sativus* (melon/cucumber); **c**, *Ficus carica* (fig); **d**, *Vitis vinifera* (grape); **e**, *Malus domestica* (apple); **f**, *Morus nigra* (black mulberry); **g**, *Olea europaea* (olive); **h**, *Prunus avium* (cherry); **i**, *Punica granatum* (pomegranate); **j**, *Fragaria vesca* (strawberry); **k**, *Citrus* sp.; scale bar = 1 mm

Cereals, together with legumes, constituted one of the most limited categories in the assemblage. They appeared in only six of the 33 samples analysed, and their presence in the latrines does not necessarily reflect direct consumption. Instead, their deposition may result from secondary processes, either through the disposal of rubbish in the latrines at the time of their use or during later phases of reuse.

### Legumes

Legumes were relatively scarce in the assemblage, with identified taxa including *Cicer arietinum* (chickpea), *Pisum sativum* (pea) and *Medicago sativa* (alfalfa, lucerne). These mineralised remains were most abundant in the latrines from Badajoz and Almería.

### Fruit

This category is distinguished by the high diversity and the abundance of remains, including ten taxa. Some were present in very large numbers, due to the fact that the fruits contain numerous seeds. This is particularly evident in *Ficus carica* (fig). Similarly, *Fragaria vesca* (strawberry) and *Vitis vinifera* (grape) were very abundant, with more than 10,000 remains recorded. Other identified fruits include *Olea europaea* (olive), *Malus domestica* (apple), *Punica granatum* (pomegranate), *Morus nigra* (black mulberry), *Prunus avium* (cherry), *Celtis australis* (hackberry) and *Citrus* spp. (citrus fruits).

Additional remains have been attributed only to the genus *Prunus* due to their poor preservation. Their study is limited by the condition of the remains, which were highly fragmented and attached to amorphous masses, probably due to calcareous concretions, making their correct taxonomic identification difficult. Many of these *Prunus* sp. remains correspond to the fruitstones (endocarps) of the fruit and the seeds within.

### Garden plants

This category includes species such as *Cucumis melo/sativus* (melon/cucumber) from Mértola and Barrio Andalusí and *Capparis spinosa* (caper) only found from Barrio Andalusí. Among the plants classified as flavourings or spices are *Foeniculum vulgare* (fennel), *Lepidium sativum* (cress), *Coriandrum sativum* (coriander) and *Cuminum cyminum* (cumin). *Daucus carota* (carrot) was also recovered from Barrio Andalusí and is further discussed below.

### Oil and fibre plants

Another noteworthy species, recorded from only one of the pits in the Andalusi quarter, is *Linum usitatissimum* (flax). While commonly cultivated in the Islamic world for its fibres, it was also used for its edible seeds and the linseed oil obtained from them.

### Wild plants

Finally, 312 remains of wild plants representing a range of plant families, including Malvaceae, Rosaceae, Fagaceae, Verbenaceae and Solanaceae were identified, although their overall presence was limited. At the species level, only *Verbena officinalis* (common vervain), *Celtis australis*, *Ecballium elaterium* (squirting cucumber) and *Bupleurum rotundifolium* (hare's ear) could be identified. The seeds of *C. australis* were particularly abundant, recorded from one of the pits in the Islamic area. The remaining specimens were identified only to genus level.

## Discussion

The archaeobotanical analysis of samples from these structures offers a clear overview of plant remains from Islamic latrines in southern Iberia, with the exceptional abundance and preservation of fruit remains consistent with most latrine studies (Fig. 3).

However, the pronounced overrepresentation of *Ficus carica* pips (endocarps), driven by their exceptional resistance to degradation and strong propensity for mineralisation, constitutes a major taphonomic bias, exaggerating their apparent importance in the diet relative to other plants. It would exceed the scope of this work to make an exhaustive study detailing the characteristics of each latrine. Nevertheless, the archaeological evidence indicates that the diets of the populations studied were broadly similar and complemented by similar waste disposal practices. Together, these findings suggest a notable convergence in both food consumption strategies and waste disposal patterns in Islamic communities in southern Iberia.

### Cereals

As mentioned earlier, in some of the contexts analysed (Mértola, Barrio Andalusí, and one of the sewer channels of Calle Joaquín Costa), a few charred cereal grains were recovered, that most likely represent the remains of waste discarded in the latrine. No chaff was observed. The three species identified are *Hordeum vulgare* ssp. *vulgare*, *Triticum aestivum/durum* and *T. dicoccum*. *Hordeum* and *T. aestivum/durum*

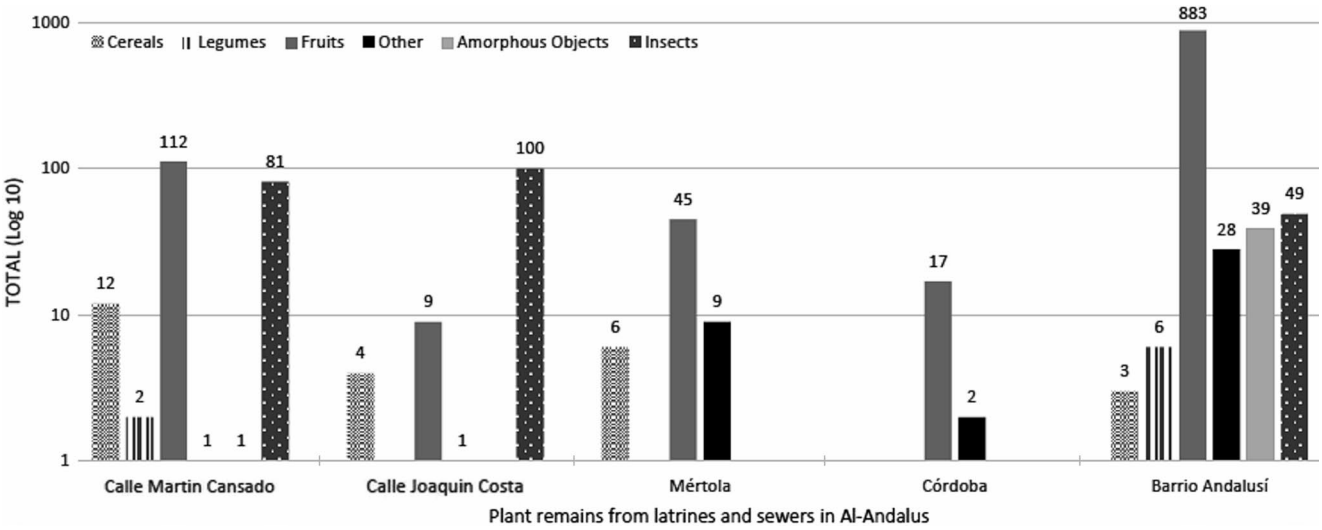


**Fig. 3** Representation of taxa across the sites. The Y axis scale is logarithmic with a base of 10 to improve visibility. Fig, strawberry and grape seeds/pips have been excluded to avoid distortions caused by their overrepresentation

are the most common cereals in the archaeobotanical record of Islamic Iberia (Peña-Chocarro et al. 2019). These cereals were staple foods for these communities as noted by the Andalusian jurist and author of a work on market regulation (*hisba*) Ibn ʻAbdūn in the 12th century (Lévi-Provençal and García Gómez 1992), and their growing is widely recorded in writings on farming in Al-Andalus (García-Sánchez et al. 2021). Their consumption in the Iberian Peninsula dates back to the Neolithic period (Peña-Chocarro et al. 2018), and although the recipe collections currently known postdate the chronologies presented here, these texts show the wide variety of preparations and flours in which these cereals played a fundamental role (Waines 1991; Marín 2007). The occurrence of *T. dicoccum* from Calle Martín Cansado represents the only find in the contexts analysed. Although emmer wheat is not very common in the archaeobotanical record of medieval sites in Iberia, it has been identified from other contemporary, predominantly Christian, sites. Texts about farming from the period frequently mention hulled wheats, though distinguishing between the archaeobotanical remains of *T. dicoccum* and *T. monococcum* (einkorn) is often difficult.

## Legumes

Legumes are typically under-represented in the archaeological record and are also rarely preserved in mineralised form. Remarkably, several seeds of *Cicer arietinum* were identified from one of the latrines in Barrio Andalusí. This is particularly significant, as chickpeas are among the least frequently found legumes in the archaeobotanical record of the Iberian Peninsula. In contrast, written sources identify *C. arietinum* as the most frequently cited legume, often described as a staple food in Al-Andalus (Carabaza Bravo 2025), showing that chickpea was widely consumed, with several different varieties. They could be eaten boiled or ground into flour for bread, and their medicinal properties were also noted. *Pisum sativum* (pea) appears less often in the written sources, but was also consumed, while *Medicago sativa* (lucerne) was mainly grown for animal fodder, though it also had medicinal uses (Carabaza Bravo 2025). Other legumes, such as *Vicia faba* (broad bean), *V. ervilia* (bitter vetch), *Lens culinaris* (lentil) and *Lathyrus sativus* (grass pea) were also grown in Al-Andalus, although their remains have not been preserved archaeologically in the contexts analysed.

## Fruit

The abundance of fruit remains in these contexts follows patterns previously observed in latrines, both within the Iberian Peninsula (Alonso et al. 2014; Ros et al. 2025) and elsewhere in medieval Europe (Hellwig 1997; Bosi et al. 2011; Van Staëvel et al. 2016; De Cupere et al. 2022). A total of ten taxa have been identified, including ones which would have been grown or managed locally, or simply collected from the wild due to their usefulness. Among the fruit identified, some stand out quantitatively due to their large seed numbers. This is the case of *Ficus carica* and *Fragaria vesca*, whose abundance reflects their biological characteristics with large numbers of seeds per fruit, their exceptional resistance to degradation and ease of mineralisation. This taphonomic bias, common in mineralised latrine deposits, serves as a reminder that the visibility of certain taxa often reflects preservation dynamics rather than their actual importance in past diet.

*Vitis vinifera* is another taxon that is very well represented in the assemblages analysed. Both fresh grapes and dried raisins were popular ingredients in medieval cooking (Märkle 2005) and were probably grown close to our sites. The same is true of *Olea europaea*, which was widely used for the olives and also for olive oil, an essential component of medieval diets.

Large amounts of olive stones were recovered from a feature originally interpreted as a well. The presence of whole fruitstones together with numerous fragments and other fruit remains, particularly mineralised seeds or pips of figs, pomegranates and grapes, suggests that this well was later re-used as a latrine.

The consumption of figs, grapes and olives in al-Andalus is well known not only from archaeological evidence, but also from written sources, including Andalusian farming treatises and legal texts (Marín 2003; Kirchner et al. 2014). Their frequent mention in these sources reflects their importance, as they were valued not only for the variety of products and preparations derived from them but also for their ease of storage.

By this period, *Malus domestica* was already a well-known fruit tree, so the remains found at Barrio Andalusí probably represent domestic apples which would have been grown in orchards. Ibn al-ʻAwwām, who wrote a most comprehensive work on farming at the end of the 12th century, notes that it was not only a commonly consumed fruit, but also available in several cultivated varieties (García-Sánchez et al. 2021).

The pomegranate is a fruit that has been known in the peninsula since the Iron Age, and Al-Ṭignarī, author of an influential work on farming in the early 12th century, is among the authors who most frequently mentions this fruit. He discusses not only its varieties and consumption, but also methods of preservation and the different preparations that could be made with it, including juices (García-Sanchez et al. 2021).

The case of *Morus nigra* is particularly interesting, as its fruit was consumed but the plant itself also played an important role in the textile silk industry. Although the mulberry leaves used for feeding silkworms were preferably those of *M. alba* (white mulberry), leaves from *M. nigra* were also widely used. From the 10th century onwards, various writers on farming mentioned the growing of mulberries in Iberia and the importance of silk production in Al-Andalus (García-Sánchez et al. 2021). The presence of *M. nigra* in the Barrio Andalusí latrines is a clear sign that mulberries were eaten in addition to the use of the leaves in the silk industry, a pattern that is also known from other latrines analysed in Iberia (Ros et al. 2019, 2025).

*Prunus avium* was also cultivated by these communities. This species, along with other fruits such as *P. domestica* (plum) and *P. cerasus* (sour cherry) which may be represented among the unidentified *Prunus* sp. remains, could be consumed fresh, dry or processed into fruit pastes like modern *membrillo*.

One of the most notable finds of fruit trees from sites in al-Andalus is the identification of a rare taxon in the Iberian Peninsula: citrus. The two *Citrus* sp. seeds recovered from one of the two latrines in Mértola represent an exceptional find, closely associated with the arrival of the Islamic communities and the changes of the Agricultural Revolution (Watson 1974, 1983). Evidence suggests that *Citrus* spp. were present in Europe earlier than often assumed. As early as the 4th century BCE, Theophrastus wrote about this, cited by Pagnoux (below) and described the fragrance and medicinal properties of a *Citrus* sp. This literary evidence is complemented by archaeobotanical finds from the Roman period, which further support the evidence for the growing and use of citrus fruits in parts of the Mediterranean world (Pagnoux et al. 2013; Barone Lumaga et al. 2020; Rivera et al. 2024). Writers in Al-Andalus since the 10th century frequently mentioned citrus fruit (García-Sánchez et al. 2021), yet their remains are rarely found in the archaeological record. The example from Mértola is the first record of *Citrus* for the Iberian Peninsula. Although its precise identification has not been possible due to its preservation state, the written sources mention at least four different *Citrus* species, *Citrus limon* (lemon), *C. aurantifolia* (lime), *C. aurantium* (sour orange), *C. medica* (citron) and *C. maxima* (shaddock).

Another fruit that features prominently in one sample from Barrio Andalusí is *Celtis australis*. Its wood was often mentioned by writers in Al-Andalusi for making many types of agricultural tools such as pitchforks and other implements, and also water wheels. One such writer, Abū l-Jayr recalled that the leaves of this tree were used to preserve grapes, while the ʻUmda, a botanical and agricultural text that systematically describes plants, their properties, growing and uses in Al-Andalus, mentions that its fruit has aphrodisiac properties (García-Sanchez et al. 2021). The identification of hackberry therefore shows its presence in the Barrio Andalusí, as well as the possible eating of its fruit.

Despite the diversity of fruits identified, several taxa previously found from Islamic period latrines elsewhere in the Iberian Peninsula are notably absent. These include *Corylus avellana* (hazelnut) and *Rubus fruticosus* (blackberry), which appeared in the latrines of Albalat (Ros et al. 2025) as well as *Juglans regia* (walnut), *Amygdalus communis* (almond) and *Prunus persica* (peach) identified from latrines from northeastern Iberia (Alonso et al. 2014). Other fruits commonly mentioned in historical and archaeological contexts, such as *Phoenix dactylifera* (date), *Cydonia oblonga* (quince) and *Mespilus germanica* (medlar), were

also absent from our material. The case of *Prunus armeniaca* (apricot) is noteworthy. Peña-Chocarro et al. (2019) reported its presence at Mértola, citing Pais (1996). However, a careful review of the original source shows that apricot was not mentioned, but this error has been repeated in subsequent publications. The absence of these species is unlikely to represent a genuine absence, and may instead be explained by factors such as regional availability, choices or preservation biases.

## Garden plants

Gardening was an important source of useful plant products in Al-Andalus. Texts describe the growing of a wide range of plants, including leafy and root vegetables, bulbs, fruits, flowers, spices and herbs, which served many purposes. A notable feature of food in Al-Andalus was the regular use of spices and aromatic herbs for their flavour and also to aid food preservation. Beyond their culinary role, these plants were widely used in medicine and perfumery (García Sánchez 2004). Archaeobotanical data on garden plants in medieval Iberia remain limited (Peña-Chocarro and Pérez-Jordà 2019). However, written sources provide abundant information on vegetables, aromatic herbs and spices such as cumin, *Carum carvi* (caraway), *Nigella sativa* (black cumin), *Trigonella foenum graecum* (fenugreek), coriander and *Anethum graveolens* (dill), which were used in the preparation of meat, fish, vegetables and sweets. The archaeobotanical evidence from the latrines confirms the presence of several of these plants, indicating their local consumption. *Foeniculum vulgare* was particularly common from the latrines at Barrio Andalusí and has also been found from one of the latrines at Mértola. *Cuminum cyminum* and *Coriandrum sativum* were likewise identified from Mértola, with cumin representing a previously unrecorded species in the archaeobotanical record of Iberia. These three species, cumin, coriander and fennel, were widely used as flavourings, and it is also likely that their leaves were also used as aromatic herbs. The analysis of the latrines revealed the presence fragments of seeds from the Apiaceae family suggesting their use in cooking. De Cupere et al. (2022) suggested that fragments of *Brassica nigra* discovered in 14th–16th century latrines are indicative of the presence of ground seeds used in making mustard.

Other aromatic plants have been identified from latrines in northeastern and southwestern Iberia, including *Apium graveolens* (celery), *Rosmarinus officinalis* (rosemary) (Alonso et al. 2014) and *Sinapis alba/nigra* (mustard) (Ros et al. 2025), but none of them were found from the latrines in this study.

Of particular interest is *Capparis spinosa*, (caper) which was identified from Barrio Andalusí. It grows wild throughout the Mediterranean basin (Gorzalczany et al. 2026) and was grown in Al-Andalus, as indicated by numerous references in texts that mention its cultivation, uses and ecological preferences (García Sánchez et al. 2021). Its fruits and immature flower buds have a long history of being eaten in the region. (Rivera et al. 2002). Although the pickled flower buds are mainly used now, there is evidence that in antiquity that the fruit may also have been eaten ripe, as they are rich in protein, oil and fibre, making them a valuable food source. According to the botanist Dodoens (1554), both the flowers and fruits were consumed pickled and were exported from the Iberian Peninsula to the Netherlands. Archaeobotanical studies have also recorded caper remains from medieval latrines in Morocco (Van Staëvel et al. 2016) and later, in the late Middle Ages, in Belgium (De Cupere et al. 2022).

A further notable plant is *Cucumis melo/sativus*, which is well represented in Barrio Andalusí and one of the latrines at Mértola. Although sweet melons appear to have been a late introduction to Europe (Paris et al. 2012), writers in Al-Andalus mention a type of sweet melon in Iberia as early as the 11th–12th centuries. However, some identifications from this period may correspond to vegetable melons, either non-sweet cucumber-like elongated Chate melons or members of the *Flexuosus* group (snake melons), which were like cucumbers and widely grown around the Mediterranean (Sabato et al. 2019). These varieties continue to be eaten in Iberia and other Mediterranean regions today, showing the continuity of certain food preferences.

*Daucus carota* mericarps (seeds) have been identified from one of the pits at Barrio Andalusí. Similar finds have been reported from other Islamic sites such as Madīnat al-Zahrā in Córdoba (Peña-Chocarro et al. 2019) and Casa dos Bicos in Lisbon (Queiroz and Mateus 2011). The Andalusian writer Ibn al-Awwam described several varieties, providing information on their growing as well as their medicinal properties and modes of consumption.

Despite the overall archaeobotanical richness of the latrines under study, there are several species, including *Solanum melongena* (aubergine), *Spinacia oleracea* (spinach) and *Beta vulgaris* (chard), which are associated with the Islamic communities, and explicitly cited by A. Watson (1974, 1983) in his compendium of plants introduced by the Arabs, that were not found in our material. As in other cases, these absences should not be taken as evidence of that they were not present, but rather as the result of other factors such as differential preservation, their occurrence in the region and food preferences. While these species do not appear in the contexts analysed here, nor in other known sites in the Iberian Peninsula, they have been found in other parts of medieval Europe and the Near East (Hallavant and Ruas 2014; Primavera 2018; Fuks et al. 2020).

### Oil and fibre plants

A single seed of *Linum usitatissimum* has been recorded from one of the contexts of the Barrio Andalusí. Its presence is most probably related to the use of seeds in food preparations as documented in various written sources. In contrast, some taxa that are usually preserved in latrines are notably absent, including *Papaver somniferum* (opium poppy), a crop widespread in medieval Europe and frequently cited in medicinal texts (De Cupere et al. 2022), *Cannabis sativa* (hemp), also highly prized for its fibres, and *Camelina sativa* (camelina, gold-of-pleasure), which has been recorded from other latrines, including Albalat (Ros et al. 2025), Lleida and Pla d'Almatà (Alonso et al. 2014).

### Wild plants

Due to space limitations, wild plants are not discussed in detail here. We briefly note, however, some plants that may have been grown in gardens, given their known therapeutic properties. Written sources frequently refer to the growing of medicinal plants in gardens in Al-Andalus (Hernández Bermejo and García Sánchez 2000), suggesting that taxa with recognised therapeutic value were also cultivated. However, many were also collected from the wild, making it difficult to distinguish between wild and cultivated specimens in the archaeological record. A single seed of *Verbena officinalis* (vervain) was identified, a plant which is widely distributed and well known for its long-standing use in traditional medicine in many cultural contexts. Its medicinal properties are well documented in ethnobotanical literature and have also been the subject of pharmacological research (Kubica et al. 2020). Archaeobotanical evidence from the Iberian Peninsula is limited, although its presence has been known at least since the Roman period, and also from Islamic contexts between the 8th and 10th centuries (Peña-Chocarro and Pérez-Jordà 2019). The identification of *V. officinalis* in the present assemblage could therefore tentatively reflect small-scale growing for intentional use, potentially for medicine. However, given the isolated nature of the find, alternative explanations, such as the accidental incorporation of wild plants into the latrine, cannot be excluded. Another example is *Bupleurum rotundifolium*, valued for its medicinal uses. Native to the Mediterranean, it could have been gathered from the wild or grown in gardens.

## Conclusions

The excavation of latrines, cesspits and sewers in southern Iberia has provided a rare window into the daily lives and dietary practices of medieval Islamic communities in Al-Andalus. Despite the fragmentary nature of the evidence, the assemblages reveal a remarkable diversity of fruits, including figs, grapes, olives, pomegranates, cherries and strawberries, and more exotic taxa such as citrus, as well as vegetables, aromatic herbs and oil plants that contributed to the diversity of food characteristic of medieval Islamic life. Although the assemblages reveal considerable diversity, several taxa are notably absent. These gaps may result from preservation biases, but other factors such as regional availability or individual preferences probably also played a role. A broader and more exhaustive study covering additional sites and periods could provide further indicators of socioeconomic status through the consumption of particular foods or the presence of less common plants.

These findings demonstrate that the remains preserved in latrines were not merely incidental waste, but reflect broader patterns of food consumption and farming practice. When integrated with information from written sources, such as works on farming in Al-Andalus, archaeobotanical evidence illuminates how urban populations managed resources and diversified their diet. Ultimately, latrines serve not simply as repositories of faeces and refuse but as invaluable archives for understanding the social, economic and environmental dynamics of medieval cities in Al-Andalus.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s00334-026-01143-1.

**Acknowledgements** This work is part of the research Project 'GLOBALM: Mapping the global economy of medieval Almería from the archaeological study of its Andalusi quarter', funded by the Ministerio de Ciencias, Innovación y Universidades (Ministry of Science and Innovation, Spain) PID2021-124325OA-100. We are grateful to E. López-Romero (IH-CSIC) and C. Peña-Chocarro (MEDAPP, IH-CSIC) for the processing of samples and to J. Suñé (MEDAPP, IH-CSIC) for insightful discussions. We thank the two anonymous reviewers whose comments have improved our manuscript.

**Author contribution** AP-G, LP-CH and GP-J; site's data, all authors; materials and methods, results, discussion, AP-G, LP-CH and GP-J; original draft preparation, AP-G, LP-CH; writing, review and editing, AP-G, LP-CH, GP-J; supervision LP-CH. All authors have read and agreed to the published version of the manuscript.

**Funding** Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. This research was funded by the European Research Council (ERC), grant number ERC2021-AdG101054883 through the project Medieval Appetites. Plant foods in multicultural Iberia (MEDAPP) coordinated by LPCH. This paper forms part of APG's doctoral thesis at the University of Granada (UGR) and the Institute of History at the CSIC (IH-CSIC).

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