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Beyond the *ṭirāz*: ninth to 13th centuries domestic textile production in al-Andalus

Abstract

This article explores domestic textile production in al-Andalus between the ninth and 13th centuries, with a focus on spinning tools and their archaeological contexts. While previous scholarship has prioritised elite textiles and state-sponsored workshops (*ṭirāz* (s.), *ṭurūz* (pl.)), this study highlights the material remains of non-elite, household-scale production. Drawing on data from over seventy sites, it documents technical changes in spinning tools – including ceramic and bone spindle whorls and metal spindle tips – and argues for a process of increasing standardisation and specialisation. These developments reflect broader economic transformations linked to the internal market, fiscal policy, and labour organisation under the Islamic state. By analysing these everyday artefacts, the study reconstructs patterns of production, exchange, and social reproduction, demonstrating the centrality of textiles to Andalusi material life. Textile production emerges as an important sector for approaching economic dynamics and social structures in the medieval western Islamic world.

Keywords: Archaeology, textiles, spinning, al-Andalus, economy, tools

Introduction

Historiography on textiles in al-Andalus has tended to coalesce around two major axes of investigation. On the one hand, scholarly attention has privileged the study of textiles in their commercial, economic, and political dimensions, with particular emphasis on their central role in Mediterranean exchange networks and in the fiscal structures of the Islamic state. The significance of this activity has led to characterisations of the medieval Islamic period as a veritable “textile civilisation” (Lombard 1978), a view supported by an extensive corpus of references found in chronicles, administrative records, and mercantile inventories that attest to the circulation of textiles among the major urban centres of the Islamic Mediterranean (Remie Constable 1997).

This approach has been closely linked to analyses of the state-sponsored textile workshops – the *ṭurūz* – and their role in the formation and consolidation of political authority, initially under the Umayyad emirate (756–929 CE) and subsequently during the

caliphate (929–1031 CE). In this study, the term *ṭirāz* is used not only to refer to inscribed textile bands, but also in its institutional sense, as state-owned and state-controlled textile production centres intended for the political elite, high-ranking administration, and diplomatic purposes, functioning as symbols of authority and political legitimacy. These manufacturing centres, inherited from Byzantine and Sasanian models, functioned not only as large-scale economic structures but also as key ideological instruments in the representation of sovereign power, particularly in urban hubs such as Córdoba or Almería (López Martínez 2023, 23–35). The production of luxury textiles intended for ceremonial use, clientelist distribution, or diplomatic gifting has received particular attention in the historiography, owing to the richness and abundance of documentary references relating to these practices.

In the same vein, the study of preserved textiles held in royal or ecclesiastical collections has provided a complementary material perspective – for example,



Fig. 1: From cloth to thread. Left: Textile from Las Águilas (Almería, 12th century). Right: Spinner from al-Ḥarīrī (Les Maqāmāt de al-Ḥarīrī, 13th century manuscript, fol. 138v). A) Distaff component; B) Spindle whorl; C) Spindle rod (Images: left: reproduced with the permission of M. Ramos 2022, 535; right: digital version released into public domain by <https://gallica.bnf.fr/ark:/12148/btv1b8422965p/f36.item.r=maqamat%20al%20hariri#>)

the *Tejido de las Águilas* of Saint Bernard of Calvo or the *Tejido de los Grifos* from the reliquary of Santa Librada (Saladrigas 2017, 64–65). Through technical and stylistic analyses of these pieces – often produced in silk, including samite, taqueté, or lampas – it has been possible to reconstruct aspects of the technological complexity of Andalusī textile production and to propose the existence of specialised production centres, such as that documented in twelfth-century Almería (Barrigón 2022, 50–69) (fig. 1, left). Nevertheless, the Medieval period has received relatively limited attention from a systematic perspective focused on textile production as a whole, beyond its elite manifestations.

Textile production should be understood as a phenomenon whose study requires a holistic approach to the *chaîne opératoire*: from the cultivation or gathering of plant fibres, metallic threads, and the breeding of fibre-producing animals, through the successive phases of spinning (fig. 1, right), weaving, dyeing, finishing, and distribution. This perspective – informed by textile-archaeological methodologies in other medieval contexts (Andersson Strand 2021; Andersson Strand et al. 2010, 151) – breaks the process

down into stages and actors, contributing to the reconstruction of past ways of life, social relations, and economic structures.

The archaeology of textile production in al-Andalus

The historical issue at stake here lies in understanding how, why, and by what means thread and cloth were produced in al-Andalus. From an archaeological perspective, the available material evidence – despite the breadth of activities comprising the textile *chaîne opératoire* – is concentrated chiefly in the tools associated with spinning and weaving, recovered from archaeological contexts, most notably from the ninth century onwards. From this period, significant changes become evident, such as the appearance of new types of looms and spindle whorls, the use of new raw materials, and, above all, the availability of a larger archaeological record that allows these evidences to be more clearly traced.

The study of textiles in al-Andalus has traditionally held a secondary position compared to sectors such as ceramics or metallurgy, owing both to the limited archaeological visibility of textile materials and to a historiographical tendency to privilege other forms

of production. However, since the 1990s, medieval urban excavations have uncovered new evidence that highlights the significance of textile production. It is within this framework that the first textile tools from al-Andalus began to be documented, appearing in monographs on key sites such as Mértola (Luzia et al. 1984, 49–51), Ciudad de Vascos (Izquierdo 1999, 126, 166, 171), and Castillo del Río (Azuar 1994, 172, 239). At the same time, more focused studies were published addressing specific categories of implements, such as horizontal looms (Retuerce 1987) or bone spindle-whorl components (Torres 1986). Progress in this line of research during the 1980s was uneven. Most publications of the time focused on the technical or typological description of objects, without addressing their articulation with the economic and social systems underpinning textile production.

This limitation, however, is now beginning to be overcome. In recent years, there has been a marked increase in studies that have explored the organisational complexity of state-controlled textile production in al-Andalus, drawing on historical sources (López Martínez 2023). At the same time, growing attention is being paid to approaches that integrate less visible or traditionally underestimated productive sectors, beyond the well-documented sphere of silk manufacture. Noteworthy in this regard are recent contributions that assess the scale and quality of staple textile production (Fábregas 2022, 130–133) and highlight its significance in the broader dynamics of medieval economic development.

The historiography of Andalusí textiles

The study of textiles and their inherent complexity require holistic approaches that integrate, in a coordinated manner, textual sources, archaeological evidence – including both the material remnants of decayed fabrics (fibres, dyes, weave or knit structures) and the spatial contexts in which textile tools are found, such as houses, neighbourhoods, villages, castles, or citadels – together with insights from experimental research. This approach, developed in works such as those by Margarita Gleba and Susanna Harris (2019) and Eva Andersson Strand et al. (2010), not only enables the reconstruction of specific technical materialities, but also supports broader interpretations concerning political structures, forms of social organisation, and economic dynamics. In the case of al-Andalus, textile production was embedded within a particularly complex framework, marked by the coexistence of multiple economic scales. The diversity of social classes – each with its corresponding levels of consumption and differential access to

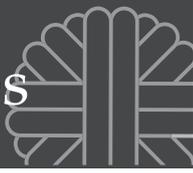
textile goods – was compounded by a plurality of organisational forms of production, including both domestic arrangements and extramural workshops. These operated within networks shaped by social, fiscal, political, and geographical factors (Grömer 2016, 241; Moreno-Narganes 2024, 98–100).

Recent studies have re-evaluated traditional interpretative models. In *The Donkey and the Boat* (Wickham 2023), the author proposes a re-reading of textile production and circulation in the early Middle Ages, challenging the longstanding historiographical bias that privileged textiles mentioned in written sources – frequently associated with aristocratic elites or state apparatuses – over more local or regionally produced textiles, which are more difficult to trace yet quantitatively predominant. Wickham’s proposal, in line with recent studies (Moreno-Narganes 2020, 241–252; 2023), calls for renewed attention to internal trade and exchange networks between countryside and city, or among rural settlements, to explain the central role of textile production in medieval economies. It highlights the predominance of non-elite textile labour and allows for a reinterpretation of archaeological evidence related to spinning and weaving as key to understanding the economic functioning of al-Andalus. Far from being secondary remains, these artefacts stand as direct indicators of everyday productive dynamics and the social structures sustaining them.

Textile production centres

In this context, a recent study examined the richness and complexity of domestic textile production in al-Andalus (Moreno-Narganes 2024). Based on the systematic analysis of more than seventy archaeological sites (fig. 2) across the southern and southeastern half of the Iberian Peninsula, it has become possible to begin delineating the general features of this type of production. Given the diversity and inherent difficulty of encompassing the entirety of textile production over such a broad chronological span, the research focused on domestic production between the ninth and 13th centuries.

The study concentrated on tools associated with two fundamental phases of the production process: on the one hand, those linked to thread manufacture – such as spindle whorls, spindle rods, and distaff components – and on the other, implements associated with vertical and horizontal looms, including weaving picks and *templenes*. *Templenes*, or “temple claws,” were devices used to preserve the working width of the fabric during weaving on horizontal ground or treadle looms, by maintaining tension and preventing lateral shrinkage.



In order to understand how this production was structured within the framework of a developed and territorially interconnected political economy, a range of sites was selected – including rural settlements (sg. *qarya* pl. *qurā*) fortified centres, and urban nuclei – with the aim of identifying patterns, contrasts, and regularities in modes of production and consumption. Through this lens, it becomes possible to trace regional and social diversity in these practices, and to examine how they were shaped by, and in turn contributed to, the territorial structure of the state. The study of working tools in domestic contexts provides access to a social segment that is generally underrepresented in historical sources: a relatively homogeneous group in terms of household structure and socio-economic position, composed of both urban and rural labourers whose work underpinned a substantial part of the productive base of the Andalusi state (Chalmeta 2021). The breadth of the archaeological record, as demonstrated by territorial-scale studies focused on the Mediterranean littoral and the Garb al-Andalus, particularly in the southern Alentejo region (Moreno-Narganes 2024, 765–771) – reveals a strong regionalisation of thread and textile production centres. This territorial fragmentation suggests the existence of productive units primarily oriented towards the supply of nearby markets, with dynamics comparable to those observed in the case of Islamic ceramics, for the Guadiana valley (Gómez 2014, 34–36) and the Vinalopó Valley (Azuar 2020, 213–214). The hypothesis of a regionalised market, long argued in ceramic studies, may likewise be applied to textile production: the majority of cloth consumed in al-Andalus was likely produced in local centres, integrated into well-organised market networks operating from at least the tenth century onwards.

Although al-Andalus has been extensively studied as the westernmost terminus of the great commercial routes of the Mediterranean – connected to the Silk Road and to the reception of goods from the Near East, including textiles inspired by models originating in present-day Iraq and Iran (Idrīsī 1999, 281–282) – this focus on long-distance exchange should not obscure the structural significance of internal and short-range networks, largely overland in nature, which operated continuously and often independently of shifting political frontiers within al-Andalus. The consolidation of these networks was closely linked to the development of the Andalusi state apparatus (López Martínez 2020) and contributed to a certain standardisation of production and consumption patterns, a phenomenon observable in ceramics (Amorós-Ruiz 2022, 66–67; García Porras 2020,

162–169) and, as this study proposes, also increasingly evident in textiles – a sector that this research seeks to place at the centre of economic reconstructions for the period.

This account of a territory which, from the eighth century onwards, entered into a transformative dynamic that reshaped its material foundations, reflects both the internal complexity of each region and the accumulation of inherited traditions. From the ninth century, long-established production practices – such as the use of flax and wool, present since prehistoric times – converged with the expansion of new raw materials, such as cotton and silk, whose production and consumption increased significantly during this period (Dozy 1961), though their true scale has yet to be fully measured through the archaeological record. These fibres were cultivated and produced for the first time in the Iberian Peninsula during this period, marking a significant shift in the region's agrarian and artisanal landscape.

Spinning technologies

The spatial and typological breadth of the present study makes it possible to document systematically the technical transformations in spinning and weaving tools from the eighth century onwards, providing a robust empirical basis for analysing these changes in relation to the evolving social and economic structures of the period. Spinning, in particular, constitutes a key stage in the textile *chaîne opératoire*, not only from a technical perspective but also in terms of its structural economic significance. Its study enables critical questions to be addressed regarding the gendered and social division of labour, the dynamics of domestic and specialised production circuits, and the role of textiles in the mechanisms of economic redistribution driven by the Andalusi state. In this respect, the analysis of spinning tools – spindle whorls, spindles, and distaff components – offers privileged access to the modes of production employed by the urban and rural working classes, whose activities, though scarcely recorded in written sources, were essential to the maintenance of the state economy.

Nonetheless, current understanding of spinning practices prior to 711 CE remains extremely limited. Despite the considerable number of archaeological excavations conducted in Visigothic and Late Antique contexts, publications documenting materials associated with spinning are exceedingly rare, making it difficult to identify technological continuities or ruptures between Late Antiquity and the Islamic period. This methodological and evidentiary gap underscores the need to reassess the study of spinning

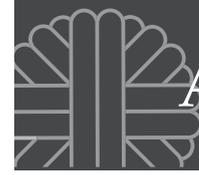


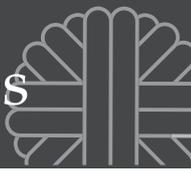
Fig. 2: Distribution of sites with evidence of textile production (9th–13th centuries). Blue: urban centres; red: fortified settlements; green: rural settlements; orange: cases identified exclusively through secondary literature (Map: José María Moreno-Narganes)

as a long-term historical phenomenon – one that is crucial not only for understanding technical change, but also for interrogating the political and social logics that underpinned the economic development of al-Andalus.

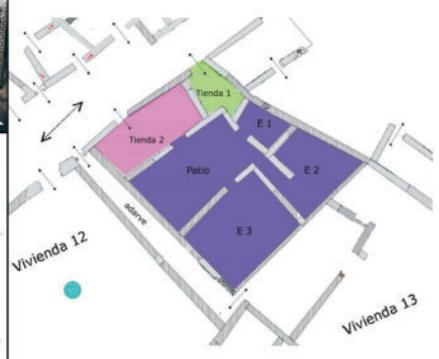
Spindle whorls

Spinning, though a fundamental stage in the textile *chaîne opératoire* determining thread quality and type, has received limited scholarly attention. More than a preparatory task, it represents a key phase of technical design shaping the final outcome. The earliest references for the medieval period are found in written sources such as Isidore of Seville's *Etymologies* (seventh century) (2004, 1311), which mention instruments related to spinning but fail to provide sufficient technical descriptions to establish clear material correlates within the archaeological record. This documentary gap continues well into the eighth and even the ninth century. Nevertheless,

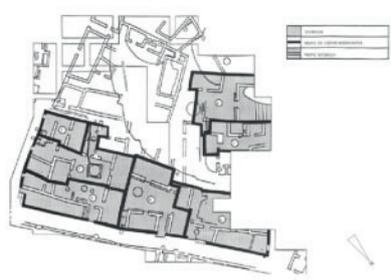
recent re-evaluations of assemblages from sites such as Tossal de la Vila (Serra d'en Garcerán, Castellón) and Tolmo de Minateda (Hellín, Albacete) have begun to yield significant evidence concerning spinning practices during this period. In these cases, spindle whorls exhibit notable morphological and technical variability: artefacts include pieces fashioned from sawn animal femur heads, reused fragments of protohistoric ceramics employed as flywheels, and even Iberian-period spindle whorls redeployed within Umayyad contexts (Moreno-Narganes 2024, 131–143). This assemblage reflects a marked absence of standardisation, consistent with a loosely structured economic landscape and a technology still undergoing consolidation. The use of animal femur heads as counterweights for spinning – also attested in early medieval contexts such as the caves of Las Peñas (Cantabria, seventh to eighth centuries) (Gutiérrez and Hierro 2010, 262–267) – highlights the persistence of archaic craft practices during the early centuries of the



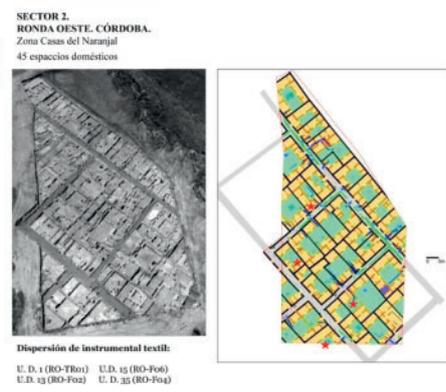
1. Cercadilla (Córdoba)
(Fuertes Santos, 2021, p. 64).



2. Marroquies Bajos (Jaén).
(Navarro Sánchez, 2017, p. 527).



3. Baýyāna (Pechina, Almería).
(Acién, Castillo y Martínez, 1990).



4. Ronda Oeste (Córdoba)
(Camacho Cruz, 2018).

Fig. 3: Selected case studies from the 10th to 11th centuries. Right: urban archaeological sites. Top: recovered spindle whorls (Image: José María Moreno-Narganes)

Islamic period. This suggests a degree of continuity in domestic production practices, particularly in rural or peripheral areas. However, from the ninth century onwards – coinciding with the economic, social, and political developments accompanying the expansion of the Andalusí state and the process known as the “agrarian” or “green revolution” – a significant transformation in spinning technologies can be observed (Moreno-Narganes 2023). This shift is evident in both the increased abundance of material indicators and the formal homogenisation of tools at a territorial scale.

Excavations in numerous urban neighbourhoods dating to the tenth and 11th centuries – in cities such as Zaragoza, Madrid, Jaén, Córdoba, and Almería – (Moreno-Narganes 2023, 64, fig. 1) have yielded spindle whorls displaying recurrent typological characteristics, indicating the presence of interconnected production and distribution circuits (fig. 3). These mould-made spindle whorls are typically rectangular in section with rounded edges, and exhibit stamped decoration on their upper and lower faces. The decorative motifs range from circular bands to symbolic figures such as the six-pointed star or Seal of Solomon. Within Islamic material culture, these designs were not mere embellishments but part of a shared symbolic language linking art and architecture to notions of divine unity and order. Geometric patterns based on circular grids expressed faith and sacred power

through abstraction, while symbols like the star held protective and apotropaic meanings. Their presence on everyday objects such as spindle whorls reveals the transmission of these religious and cosmological connotations into domestic contexts, where the act of spinning itself was integrated into a wider symbolic universe (Abdullahi and Bin Embi 2013, 245–248).

The study of spinning goes beyond technical aspects, offering insight into labour organization and social dynamics in al-Andalus. Spinning tools, imbued with economic and political meaning, reflect the structural transformations of the ninth to eleventh centuries, as evidenced by the clear formal standardisation of spindle whorls during this period. The specimens analysed display a consistent diameter – predominantly between 2.5 and 3.5 cm – albeit with a range of weights varying from 10 to 30 g (fig. 4, in red). This correlation between weight and size suggests a formal standardization, possibly aimed at optimizing the work process through the repetition of specific characteristics. Rather than indicating complete homogenization, the variation in weight – which remains between 10 and 30 g – points to a technical horizon oriented toward the production of well-defined types of yarn. This, in turn, reflects differentiated consumption needs and, consequently, a deliberate planning in the design of these tools.

The application of experimental models developed in other European contexts (Andersson Strand et al.

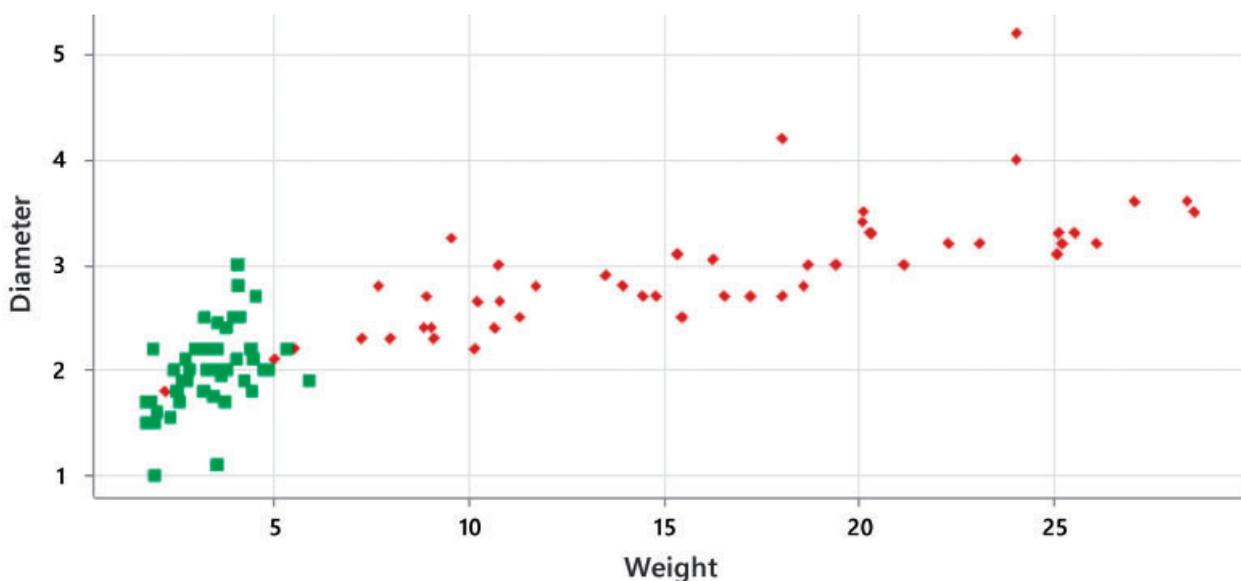


Fig. 4: Scatter plot (diameter vs weight). Red: Ceramic spindle whorls (10th–11th centuries). Green: Bone spindle whorls (12th–13th centuries). For the graph, cases have been selected from the 10th–11th centuries: Zona Arqueológica de Marroquíes Bajos, Bayyāna, Cercadilla, Ronda Oeste, and Vascos. For the 12th–13th centuries: Torre Bofilla, Lonja de los Caballeros, Sotanillo II, Torre Grossa, Torre de Haches, San Esteban, Alcazaba de Almería, Mesón Gitano, Mojácar, Baza, and Torre d'en Galmés (Image: José María Moreno-Narganes)

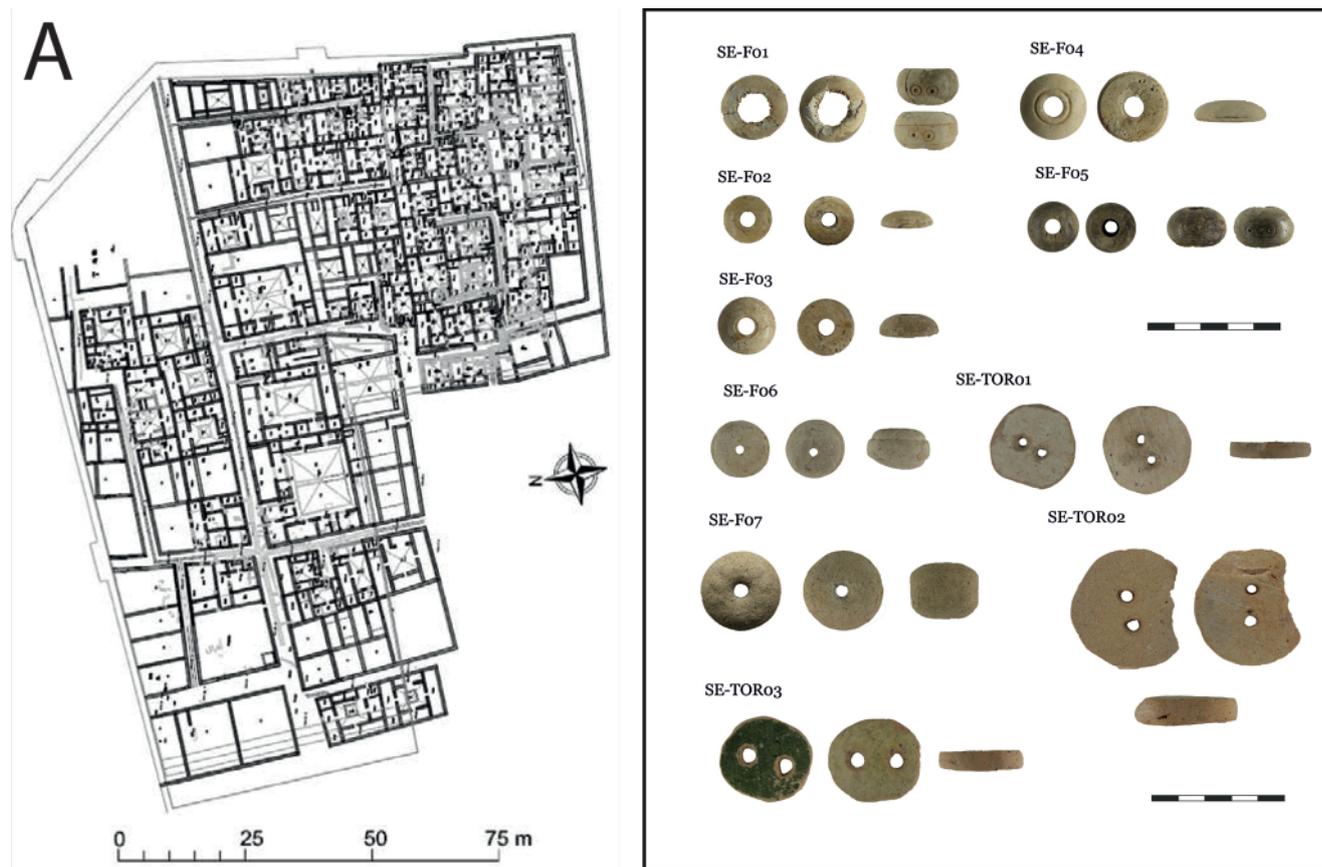


Fig. 5: San Esteban Quarter (northern sector of the city of Murcia, 12th–13th centuries). Left: Excavated urban neighbourhood. Image: reproduced with permission of P. Jiménez Castillo. Right: Bone spindle whorls (F01–05), ceramic spindle whorls (F06–07), and twisting implements (TOR 01–03) recovered during the excavation (Image: José María Moreno-Narganes)

2010; Mårtensson et al. 2006) ought to be extended to the medieval contexts of al-Andalus in order to assess whether this dimensional variability was linked to producing threads of varying thicknesses and optimising raw material processing. Although it is not currently possible to establish a direct correlation between the type or quality of thread produced and the weight of the spindle whorl, the regularity observed suggests tighter technical control over the spinning process. This hypothesis is further supported by the discovery of spindle whorls with these characteristics in pottery production contexts – such as those in Córdoba and Toledo – where they have been found among the refuse of ceramic workshops (Aguado 1999, 174), pointing to their manufacture by specialised potters within organised production circuits.

In parallel, from the ninth century onwards, various documentary sources – particularly the *hisba* treatises (urban economic regulation manuals) – explicitly mention the activity of female spinners, as well as the products derived from spinning (wool, flax, cotton).

These include measures aimed at ensuring consistent quality and preventing market fraud: “Cotton and linen threads must not be sold in skeins, because it invites fraud, as women are accustomed to hiding foreign objects in the skeins to increase their weight” (Seville, twelfth century, Ibn ‘Abdūn 1992, 169). This normative oversight indicates the strategic importance of spinning in the Andalusi urban economy, as a foundational activity for other essential manufactures – from garment-making to domestic furnishings and naval applications.

This shift in tools cannot be dissociated from the broader processes of political and fiscal transformation driven by the Andalusi state, especially from the ninth century onwards. The consolidation of state apparatus brought about the systematic taxation of artisanal production as part of an economy grounded in fiscal extraction (Manzano 1998), which may explain the progressive standardisation and specialisation observed in spinning tools. From the 11th century onwards, a significant innovation in the materials used for spinning tools is observable, marked by the

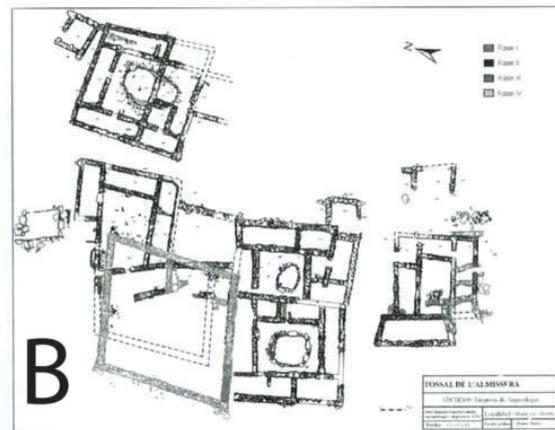
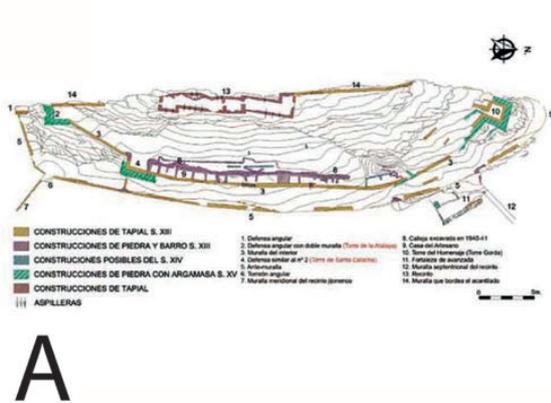
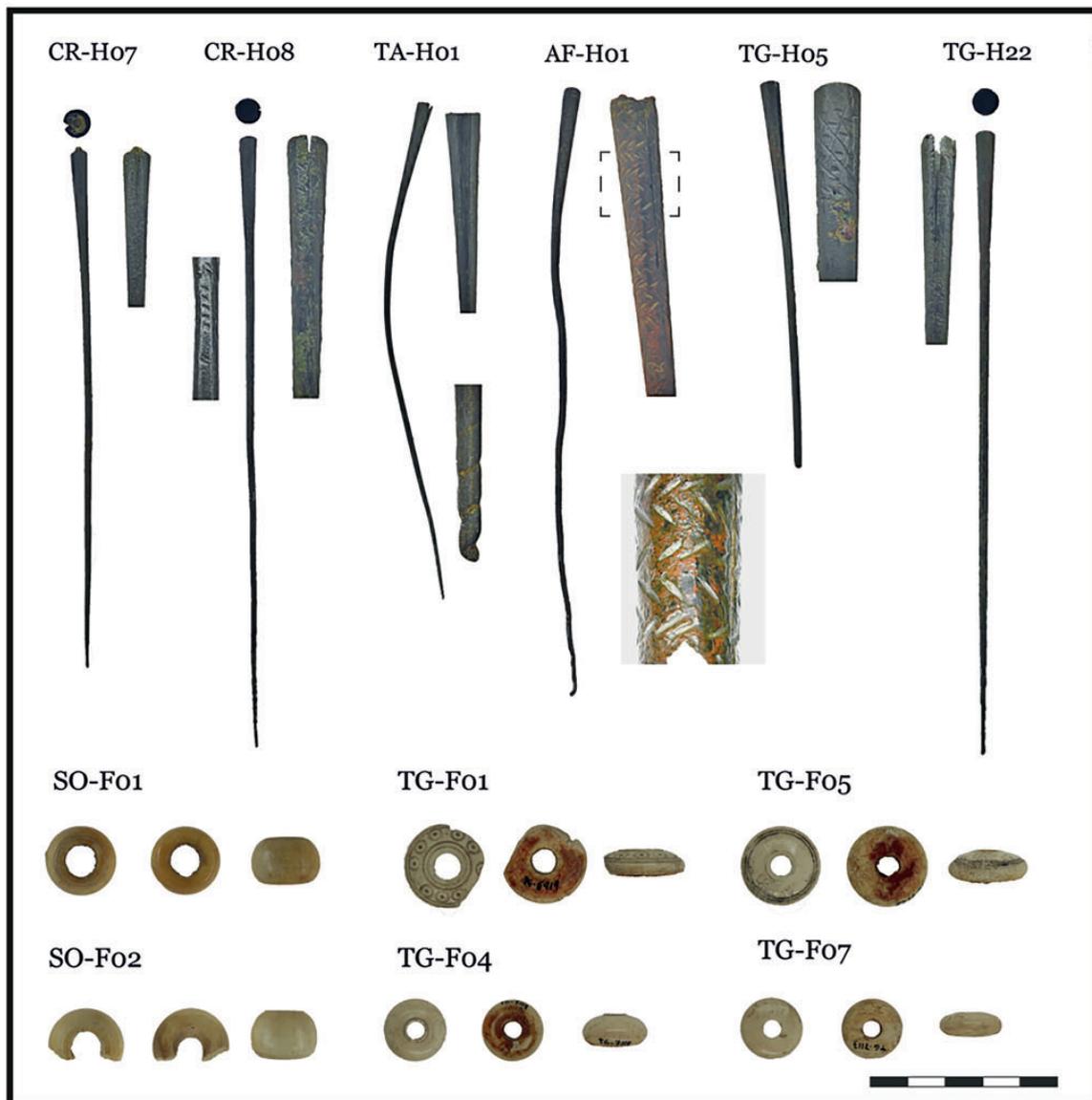


Fig. 6: Examples of textile production from the 12th–13th centuries in rural and fortified settlements. Top: Examples of spindle rods and spindle whorls from various rural settlements; bottom: A) Castle of Torre Grossa (Alicante, Spain); B) Village of Almiserà (Alicante, Spain). Image: reproduced with permission of R. Azuar (A) and J. R. García (B)); (Image: José María Moreno-Narganes)



Fig. 7: Examples of metal spindle rods: 1: Ronda Oeste, Córdoba; 2: Vascos, Toledo (10th–11th centuries); 3–6: Cercadilla, Córdoba (12th–13th centuries). The tips preserve a threading hook used in the spinning process (Image: José María Moreno-Narganes)

emergence – and subsequent standardisation – of spindle whorls made of bone (Moreno-Narganes 2024, 694–701). Although during the Caliphate (tenth to 11th centuries) this type remained a minority compared to ceramic whorls, from the 12th century onwards, a widespread expansion of bone spindle whorls is documented across a broad territorial spectrum, from al-Gharb al-Andalus (present-day Portugal) to Sharq al-Andalus (the Spanish Mediterranean coast). These bone whorls are characterised by more regular shapes, typically lenticular in section, and by finely incised decoration: circular bands, concentric dots with marked centres, and geometric lines, which recall

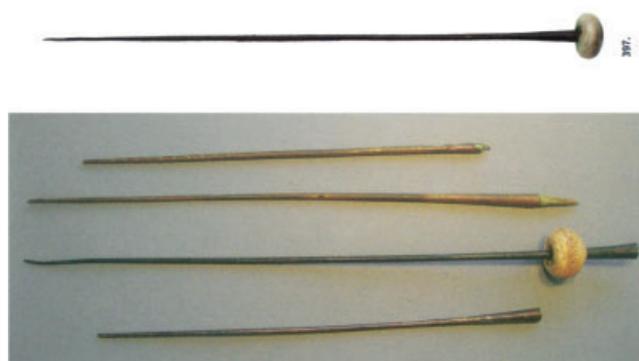


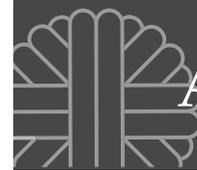
Fig. 8: Examples of spindle rods with bone spindle whorls in situ. Top: Tavira. Bottom: Mértola (Images: reproduced with permission of S. Gómez Martínez 2008, 59)

earlier ceramic decorative repertoires reinterpreted through incision.

From a technical perspective, they exhibit smaller diameters and a significant reduction in weight (fig. 4, in green), which – following experimental models of efficiency (for example Andersson Strand 2008, 75; and Grömer 2005, 111, fig. 6) – may be interpreted as a deliberate search for finer threads and greater efficiency in raw material processing. The discovery of spindle whorls weighing less than 4 g – well below the average recorded for earlier periods – suggests a high level of technical refinement in spinning. Although no definitive explanation exists for this shift, experimental studies on wool spinning indicate improvements in thread quality and fineness resulting from the reduced weight of spinning tools. However, the very low weight of many spindle whorls is difficult to associate with wool or flax, suggesting their use with finer fibres such as cotton or silk. This may relate to the adoption of cotton in al-Andalus from the ninth century onwards, particularly in urban contexts—a fibre that also required lighter spinning implements than those used for wool or linen (Kossoeska-Janik 2016, 109, fig. 2). The correlation between raw material, tool type, and technical outcome reinforces the notion of increasingly specialised production adapted to emerging market demands.

The expansion of bone spindle whorls did not, however, entail the disappearance of ceramic ones, suggesting functional diversification rather than complete technological replacement – a phenomenon possibly derived from consumer preferences, material availability, or other procurement strategies. Despite the general shift from ceramic to bone spindle whorls, from the twelfth century onwards, in some cases, both types appear within the same context, indicating the coexistence of multiple spinning techniques aimed at producing threads of varying thickness, strength, or intended use. A paradigmatic example is the suburb of San Esteban (Murcia, 12th–13th centuries) (fig. 5), a newly founded settlement to the north of the Umayyad city, where excavations have revealed ceramic and bone spindle whorls of differing weights and dimensions dispersed across domestic dwellings. Other twelfth-century examples include Albalat (Cáceres, Spain), which exemplifies the diversity of tools found within the same urban quarters (Moreno-Narganes 2021), or the *qarya* (pl. *qurā* – village or rural settlement) of Almiserà (Alicante, Spain), where similar implements have been recovered (fig. 6).

Taken as a whole, this survey demonstrates that from the tenth century onwards, spinning practices in al-Andalus underwent significant



transformations, characterised by reduced tool weight, increased material specialisation, and typological standardisation across broad areas of the territory. The combined analysis of both urban and rural contexts reveals that these transformations were not isolated developments, but rather part of a deeper process linked to the expansion of internal markets and the growing homogenisation of textile production and consumption. This phenomenon, reflecting an economy in expansion, demonstrates that spinning was not a marginal activity, but a structural component of the economic and political development of medieval al-Andalus.

The technological development of the spindle

Due to its frequency in the archaeological record and generally good state of preservation, the spindle whorl is one of the most reliable indicators for understanding spinning practices in al-Andalus. Nevertheless, it is not the only material evidence. Alongside the improvement and standardisation of spindle whorls – with variations in typology and raw materials – there is evidence, from the ninth century onwards, of a progressive increase in the use of spindle tips made from copper alloys, a phenomenon that intensifies in subsequent centuries. These artefacts may trace their origins to similar forms known from Late Antiquity, possibly small metallic hooks used as spindle terminations (Gutiérrez and Hierro 2010, 266, fig. 5). From the tenth century, they exhibit specific technical features in urban contexts such as Córdoba and Jaén, and from the twelfth century, they are widely attested throughout the Andalusi territory (Moreno-Narganes 2023, fig. 4; Moreno-Narganes 2024, 362–369).

From a technical standpoint, these are slender metal rods (predominantly brass, according to compositional analyses conducted on several specimens: Bottaini et al. 2022, 5–6), produced by cold-rolling sheets – approximately 0.1 cm thick – around a mould to create a cylindrical form. The lower end of the piece is hollow, allowing for the insertion of a slender wooden shaft (approximately 0.5 cm in diameter), while the upper end gradually narrows and becomes solid, terminating in a point. In some cases, this point is simply rounded; in others, it features a fine helical groove that appears to have functioned as a guiding track, helping to keep the thread in place and ensuring its continuous twist during rotation – as observed in at least one of the studied examples (fig. 7).

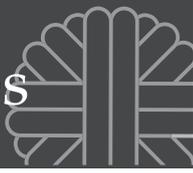
The dimensions of these items vary in both length and weight, yet a clear correlation between the two parameters can be observed, which may reflect either a technical rationale in their design or basic physical

constraints adapted to the type of thread produced. This correlation between weight and size has often been interpreted as a sign of functional standardisation, possibly intended to optimise spinning processes for threads of specific characteristics. However, experimental research has shown that there is “no reliable connection between weight or MI of spindles and the resulting thread length, yardage, or thickness” (Kania 2013, 15), since the variation in yarn properties largely overlapped across all spindle types. The decisive factor proved to be the spinner, not the tool. Thus, rather than a strict technical determinism, these patterns should be understood as part of a broader horizon of practices, where morphological regularities in whorls may reflect tendencies towards recurrent solutions, while still allowing for a wide spectrum of functional possibilities.

In three well-documented cases – including that of Saltés, where a complete spindle assembly was recovered with a spindle whorl made from a lightweight fish vertebra (Bazzana and Bedia 2005, 342, fig. 258) – spindle tip and whorl were found associated in situ (fig. 8). These finds have made it possible to confirm their use as spinning implements and to dismiss alternative hypotheses that had suggested other functions (Moreno-Narganes 2024, 251). These findings demonstrate increasing technical sophistication within the textile sector, extending from ceramic to metalworking crafts. The introduction of copper reflects greater investment in tools and possibly enhanced productivity, though it may also result from its growing availability and lower cost. Overall, its adoption should be understood within a broader framework of technological choices adapted to changing material conditions.

Arabic textual sources confirm this process: several twelfth-century authors mention the “spindle-maker” in cities across the western and eastern Islamic Mediterranean, indicating the existence of specialised workshops and a sustained market demand for such implements (al-Idrīsī 1999, 143). Moreover, the recurring presence of these items in large assemblages – such as those recorded at Mértola or Silves (Moreno-Narganes 2024, 748) – suggests that their function was not limited to direct use as spindles. It is plausible that they also served as storage bobbins, adapted for varying thread qualities and intended to organise and preserve spun threads, classified according to type or thickness.

This hypothesis is reinforced by references in technical treatises such as that of al-Saqaṭī: “*linen thread differs from silk... because the latter is of a single type, whereas linen thread comes in many varieties*” (Málaga, 13th



century, al-Saqaṭī 2014, no. 138), or the earlier reference in Ibn ʿAbdūn (1992, 169), which describes how women spinners inserted weights into skeins – likely as part of a process of preparation for sale, in which the thread was transferred from a spinning device to a storage implement. This detail reinforces the notion of organized production: the skein served as a storage medium, and the addition of weights indicates an intention to standardize and classify the thread for market circulation. The study of metal spindle tips thus reveals a technological innovation embedded within a complex artisanal network—potters, metalworkers, and spinners—linked to a structured demand and to the broader economic and political development of al-Andalus between the 10th and 13th centuries.

Discussion: fibres, techniques, and thread markets

The morphometric analysis of spindle whorls, with the aim of interpreting their specific functionality – that is, their relationship to the production of threads of differing thicknesses and qualities – presents significant methodological limitations. Although experimental studies have helped identify certain general trends, such as the gradual decrease in the average weight of spindle whorls over time, numerous unresolved questions remain, which cannot be answered through the archaeological record alone. In addition to the type and quality of the fibre and the technical skill of the spinner – all of which are decisive factors in the outcome of spinning (Médard 2005) – the total weight of the operative ensemble depends not only on the whorl itself, but also on the spindle’s wooden and metal components, whose mass and morphology are rarely preserved.

These challenges underscore the need to continue collecting both archaeological and experimental data through a comparative and quantitative approach, to advance functional interpretations of these tools. Even within such constraints, the systematic study of spindle whorls offers scholars a privileged window into long-term technical and economic processes. From the tenth century onwards, for instance, there is clear evidence of technical improvement in the tools, with greater control over weight, shape, and regularity – suggesting a deliberate effort to produce more homogeneous threads, suited to increasing demand both in volume and in the diversity of their applications. This expansion and standardisation of textile production chains should not be viewed as an isolated phenomenon, but rather as part of a broader transformation in the material world of al-Andalus, also evident in the increasing sophistication of ceramics, glass, and architectural forms. Textiles, as a basic necessity, emerge as a key

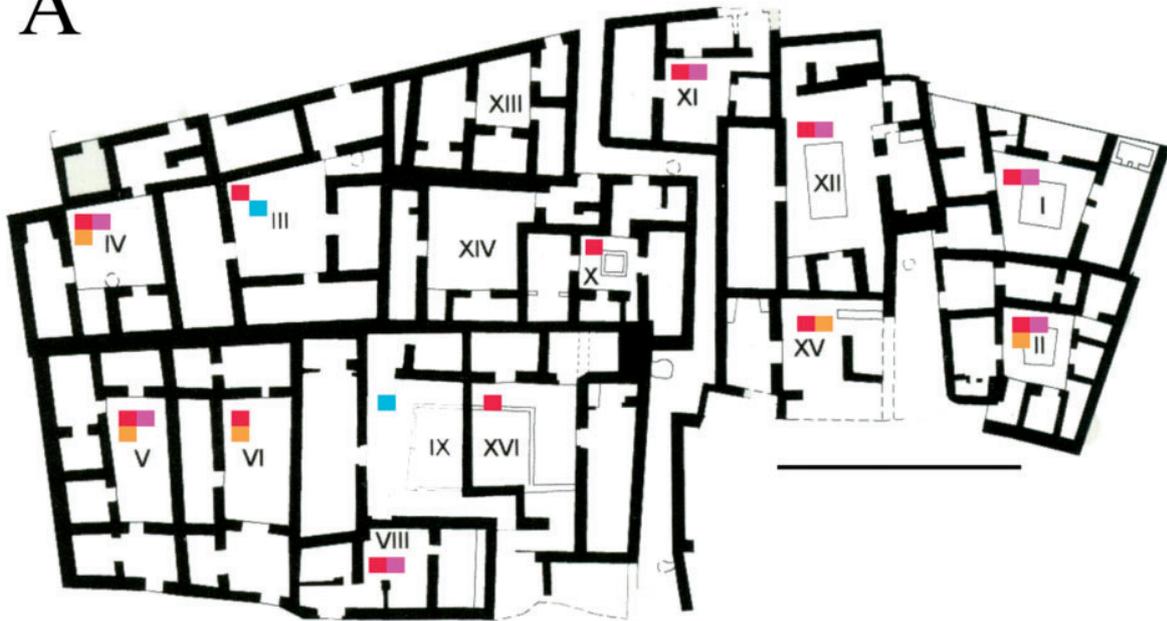
indicator for analysing the socio-economic dynamics of the period, serving as a thread through which to understand the interconnections between technology, economy, and society.

A clear and definitive correlation between specific tool types and thread characteristics has yet to be established. The archaeological record offers only indirect information: for instance, the presence of flax seeds in archaeobotanical assemblages, the identification of subadult to adult sheep slaughtering patterns in faunal contexts, and written references to wool, flax, and cotton from the ninth century onwards together provide a general picture of the textile raw materials in use in al-Andalus. However, we still lack precise knowledge about how these fibres corresponded to particular types of spindle whorls. To date, only two fragments of linen textiles (*Linum usitatissimum*) have been documented in medieval Islamic archaeological contexts on the Iberian Peninsula: a mineralised fragment from Albalat (Extremadura, Spain), dated to the early 12th century, and a burial shroud recovered from a *maqbara* (cemetery) in Crevillente (Alicante, Spain), dated to the 14th century. Both specimens indicate the use of relatively fine linen. In the case of Albalat, the thread diameter does not exceed half a millimetre, ranging between 0.32 mm and 0.22 mm, with a fabric density of 22 × 22 threads per cm (Gilotte and Cáceres 2017, 171). The analysis of the Crevillente textile reveals a plain weave tabby (1/1), a high-quality and balanced construction, with a density of 15 (warp) × 19 (weft) threads per cm, and thread thicknesses of 385.28 microns in the warp and 392.61 microns in the weft. In both cases, the yarns exhibit a Z-twist torsion (Trelis et al. 2009, 189).

Although few in number, the linen fragments from Albalat and Crevillente are valuable due to their diverse origins—domestic and funerary—and their locations at the western and eastern edges of al-Andalus. They offer insight into the use of linen across different social contexts, even if their scarcity prevents broader conclusions about its overall prevalence. The fineness of the threads suggests the use of lightweight spindle whorls, around 4 grams, as documented in several Andalusi archaeological contexts. However, current experimental research suggests that some fibres, such as wool, are difficult to spin efficiently using spindle whorls lighter than 8 g (Mårtensson et al. 2006, 11; Andersson Strand 2008, 76; 2010, 13). This apparent contradiction indicates that lighter tools may have been employed for shorter or finer fibres (such as flax or cotton), or that a broader variability of spinning practices and raw materials needs to be considered when interpreting the archaeological record.



A



B



Plano 2019 © Proyecto Albalat

Fig. 9: A) Intra-muros quarter of Mértola; B) Intra-muros quarter of Albalat; Red: Spindle whorls; orange: metal spindle rods; purple: distaff components; blue: *templenes* (horizontal loom) (Images: A) reproduced with permission of Campo Arqueológico de Mértola; B) reproduced with permission of Albalat project)



This suggests that the numerous Andalusí specimens weighing below this threshold – frequently attested from the 12th century onwards – may have been associated with the spinning of other fibres, such as cotton or shorter-staple varieties, whose torsion requires less inertia. Spindle whorls weighing less than 3 g, which are unlikely to be suitable for spinning coarse wool or flax, could plausibly be linked to cotton – a raw material widely cited in agronomic treatises from the late medieval period, such as those of Ibn Baṣṣāl (1050–1100 CE) and Ibn al-ʿAwwām (circa 1100–1170 CE), particularly in the urban centres of the Guadalquivir Valley (Camarero 2008, 128).

Although direct archaeological evidence for cotton cultivation in al-Andalus is still lacking – in contrast to Mazara (Sicily), where it has been documented (Fiorentino et al. 2021, 560) – the hypothesis that cotton was a technical factor underpinning the use of ultra-light spindle whorls remains valid and may provide a basis for future research. This body of evidence, still preliminary, points to a possible progressive specialisation in the spinning of flax and cotton from the tenth century onwards, in line with the growing presence of these fibres in textual sources and their association with warm climates and highly productive irrigated agricultural zones (Jiménez and Camarero 2021, 27).

This interpretation must also be contextualised within broader critiques of the idea of “self-sufficient”

domestic production disconnected from the market – a notion that has dominated many traditional interpretations, which have often overlooked textile production as a significant sector warranting thorough analysis. Both the material analysis – which reveals increasing technical investment in tools – and the numerous Arabic sources that refer to dedicated markets for female spinners and embroiderers, together with references to quality control and anti-fraud regulations, point to a form of production oriented towards commercial exchange. In this regard, in *Risāla* No. 87 by Ibn ʿAbd al-Raʿūf (11th century), it is mentioned that, in Emirate Córdoba, women “were the ones who spun flax, rubbing it with water to improve its appearance and increase its weight. For its sale, it was advisable that they employ only pious and virtuous elderly men. This is because these intermediaries interact with women, conversing with them during the delivery or payment (of their spun thread). It was recommended that they have a designated gathering place to sell their thread and that they not be allowed to establish themselves in shops” (al-Raʿūf 2019, 73 [trans.] – 36 [Arabic]). Similarly, Ibn ʿAbdūn (d. 1134 CE) warns: “Only trustworthy and honourable men, whose integrity and reliability are well known to all, should engage in commercial transactions with women, and this responsibility should fall to the guild members. Women should be prohibited from entering the marketplace of embroiderers, for they are all prostitutes” (Ibn ʿAbdūn 1992, 146 [trans.] – 143 [Arabic]). In another reference

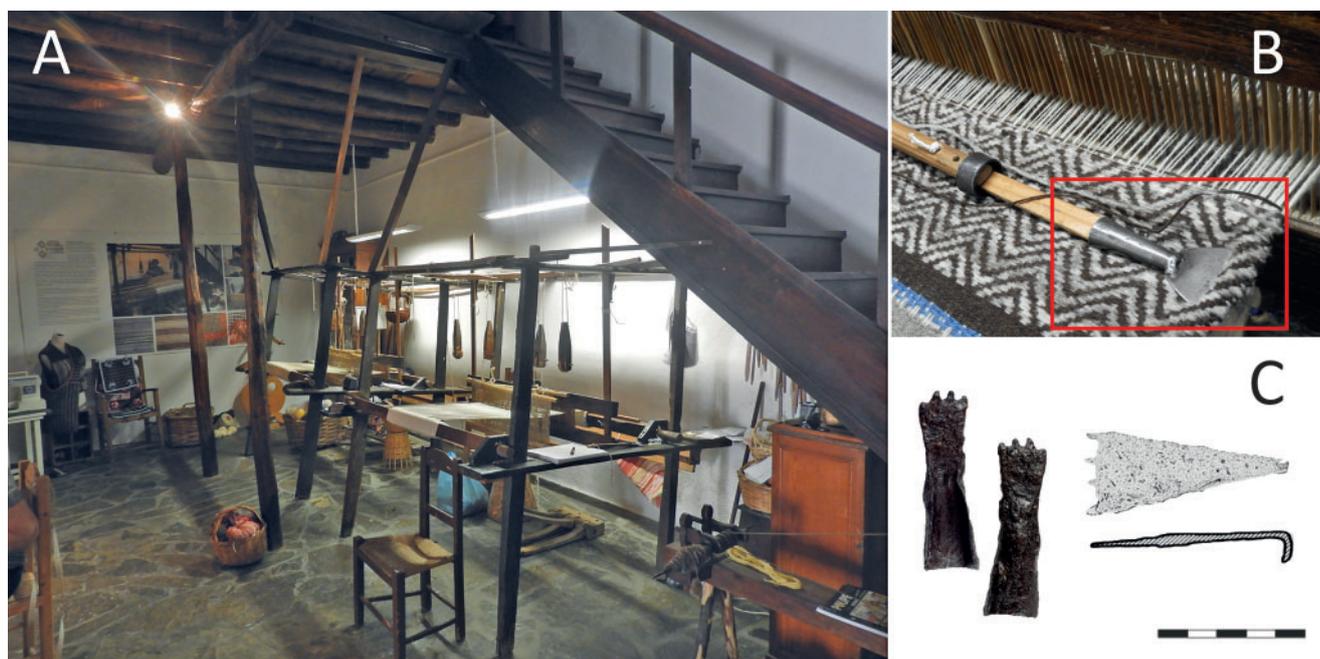
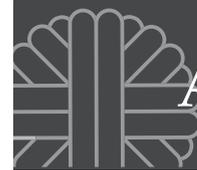


Fig. 10: A) Traditional foot-treadle loom from the textile cooperative of Mértola (Alentejo, Portugal). B) Modern *templén* of a horizontal loom; C) *Templenes* from Albalat (left) and Mértola (right) (Image: José María Moreno-Narganes)



(*Risāla* No. 199), the same author denounces: “Women often insert foreign bodies into cotton and flax skeins to increase their weight”.

The importance of spinning is also evident in political chronicles, which record that Caliph al-Nāṣir reproached his late grandfather, Emir ‘Abd Allāh (d. 912), for “having involved himself in overseeing a woman’s spinning, when such matters were the responsibility of the ‘alamīn of the thread market” (Ibn Sa‘īd 1997, 180). These activities were subject to control mechanisms governing measures and weights, intended to preserve order and functionality – a perspective that underscores the textile sector’s importance, on a par with agriculture and livestock production. Moreover, from a volumetric perspective, it can be concluded that over 40% of the professions listed in *ḥisba* documents from the ninth to 13th centuries (including Ibn ‘Abd al-Ra‘ūf (2019) – Córdoba, mid-tenth century; Ibn ‘Abdūn (1992) – Seville, 12th century; and al-Saqaṭī (2014) – Málaga, 13th century) relate to some aspect of the textile *chaîne opératoire*. This highlights the essential importance of these crafts for the daily functioning of urban life in al-Andalus.

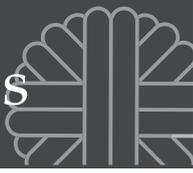
Chronicles also document examples that challenge the notion of household self-sufficiency. One account notes that al-Manṣūr Ibn Abī ‘Āmir, the *ḥājib* Almanzor (tenth–11th centuries), sold threads spun by his mother in the marketplace during his youth (Marín 2000, 268). Similarly, a juridical ruling (*fatwa*) records the case of a poor woman who spun at home, whose bequeathed possessions were subject to formal valuation (Lagardère 1995, *fatwā* 49). These episodes – drawn from both chronicles and legal sources – alongside the costs of production, tool maintenance, and the accumulated technical knowledge required, invite a reconceptualisation of the household not merely as a unit of consumption, but as a productive node embedded in local or regional commercial networks for the manufacture of thread and cloth. The study of textile materiality and the cited historical references allow us to interpret that, moreover, such work could provide single women with economic independence, enabling them to support their families or accumulate capital over time.

Recent studies on specific neighbourhoods such as Mértola (Alentejo, Portugal) and Albalat (Cáceres, Spain) (Moreno-Narganes 2021, 38–39) offer crucial new insights into the historical and economic significance of textile labour within these communities. Both large-scale analyses encompassing wide areas of al-Andalus and more regionally focused case studies – such as those concerning the garb – have demonstrated the central importance of local textile production centres,

whose output was primarily intended to meet local or regional demand. These economic dynamics, often undervalued or insufficiently explored until recently, have gained new interpretative significance thanks to recent research. This scholarship moves beyond outdated economic paradigms by placing market-based supply and demand – specifically within local markets – at the core of processes of transformation and economic development (Wickham 2023, 664).

Excavations in the intramural quarters of Mértola and Albalat (fig. 9) provide a deeper understanding of how families interacted socially and economically through textile production (Moreno-Narganes 2021, 431–432). These connections, articulated around the *chaînes opératoires* of spinning and weaving, reflect the complexity of the socio-economic networks sustaining everyday textile demand and reveal a degree of productive specialisation distributed among households and family units. In both urban sites, the archaeological evidence reveals a marked presence of tools associated with spinning – primarily spindle whorls and spindles – indicating that the vast majority of households were actively engaged in these tasks. In Albalat, spinning tools were documented in 12 of the 20 analysed domestic units (eight spindle whorls, five spindle tips), while in Mértola, 27 spindle tips and 50 spindle whorls were recovered from 12 of the 16 excavated dwellings (Moreno-Narganes 2021, 37–38). The archaeological evidence indicates that spinning was a common domestic activity and that significant economic interaction existed among families within each community. The inconsistent correlation between spindle whorls and spindle tips may reflect the use of perishable wooden components or, as in Mértola, the storage of these tools as bobbins or for specific thread types.

Regarding textile production using looms, the identification of *temple claws* (Retuerce 1987) – metal implements associated with horizontal treadle looms, although in principle such tools could also be employed with warp-weighted or two-beam looms, as attested in northern Europe. However, in the Iberian Peninsula, no evidence currently links vertical looms to the use of temple claws, making their association with horizontal treadle looms the most plausible interpretation in this context. These tools therefore remain the most reliable archaeological indicators of weaving activity (Moreno-Narganes 2019) (fig. 10). Such finds have been documented in two specimens at Albalat and two at Mértola, suggesting a comparable presence of this activity in both sites, revealing a notable disparity amounting to a ratio of roughly 6:1. This disparity may be attributed to the considerable



amount of thread required to operate the looms, and although the archaeological record remains limited, the available evidence confirms the economic significance of the textile sector within these urban quarters.

These indicators clearly demonstrate that textile activity not only structured the domestic economy but also fostered economic connectivity and interdependence among many households, creating a robust network of production oriented towards the regional market. Archaeological evidence reveals how certain sectors of the urban fabric formed a productive web of interdependence, with some households engaged in animal husbandry or flax cultivation, others in spinning, and others in weaving – all participating in constant flows of exchange and commerce (Fábregas 2022, 129). This model of neighbourhood-based (Costin 2020), territorialised economy places domestic production at the centre of analysis as the quantitatively dominant form of economic activity, restoring its central role in the dynamics of everyday life (Wickham 2023, 664).

Conclusion

In recent years, historiography has begun to reconsider the structural impact of the so-called “Green Revolution” in al-Andalus – a phenomenon that not only transformed the agricultural landscape of the Iberian Peninsula but also profoundly reshaped the political, economic, and social life of medieval Europe (García-Contreras et al. 2025). However, the role of the textile sector in this process of transformation has, until now, received relatively little attention, despite being an activity inseparable from the development of human societies since prehistoric times.

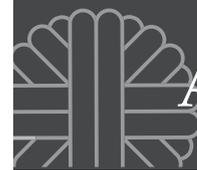
Through the study of spinning and weaving implements – particularly spindle whorls, spindle tips, and other tools preserved in archaeological contexts – this work has proposed a material reading of the structural changes that al-Andalus underwent from the ninth century onwards, a period in which processes of technical specialisation and typological standardisation intensified. The lack of solid data for earlier centuries – with a few exceptions – still prevents us from tracing a clear line of evolution from the Visigothic or Late Antique periods. Nevertheless, from the ninth and tenth centuries, signs of a reorganisation of textile production begin to emerge, in which the introduction of new raw materials, such as cotton, coincides with the intensification and diversification of traditional fibres like flax and wool.

Comparative analysis with other Mediterranean contexts has made it possible to situate the Andalusí phenomenon within a broader horizon of change,

without losing sight of its regional specificities. Within this framework, the extremely lightweight spindle whorls documented from the twelfth century onwards may be linked to the expansion of cotton – mentioned in agronomic treatises such as those by Ibn al-‘Awwām (2003) – although direct archaeobotanical evidence is still lacking. This line of interpretation remains open, but it is reinforced by the consistent similarities in shape and function observed in the tools, as well as by the repeated finding of lightweight spindle whorls across both urban and rural contexts.

Despite these advances, there remains a wide field of study to explore, particularly regarding rural contexts and well-stratified assemblages from the ninth and tenth centuries, during the Umayyad emirate and caliphate. It is precisely in these centuries that a territorially articulated model of textile production appears to consolidate, already showing signs of technological standardisation – as has also been documented for the horizontal loom in various *qura* (villages or rural settlements) from the ninth century onwards, and more clearly from the 11th century (Moreno-Narganes 2024, 377–384). From a critical analysis, it is essential to emphasise that the hypotheses proposed in this study – particularly those concerning the technical improvement of spinning, evidenced by the progressive lightening of spindle whorls, and the diffusion of horizontal looms as tools of productive rationalisation – should be tested in future research through the systematic analysis of preserved textiles from well-dated archaeological contexts. Although scarce, the extant textile fragments from al-Andalus provide valuable insights into thread fineness, twist direction, and fabric density, which would allow scholars to establish empirical correlations between specific tool typologies and the technical qualities of the final product. This dialogue between tool and thread, between production and finished cloth, represents a crucial line of inquiry for advancing a comparative technological history of medieval textile production that integrates archaeological, analytical, and experimental data within a rigorous interpretive framework. The future documentation of textiles from stratigraphically secure contexts – particularly in *maqābir*, domestic spaces, and workshop areas – will make it possible to assess the extent to which tool standardisation was driven by emerging demands for quality, specialisation, and volume within regional production circuits.

These transformations must be read in direct connection with the economic development of al-Andalus, which is amply attested in fiscal records from the ninth century onwards (Chalmeta 2021, 577). The taxation



system, organised by administrative districts (*kūra*) and centrally controlled from Córdoba, included levies on textile goods, particularly concerning caliph silk (Dozy 1961, 90, 132). This institutional framework facilitated the consolidation of internal commercial networks, articulated through local and regional markets – documented through the figure of the *sāhib al-sūq* (“market inspector”) (Chalmeta 2010) – which animated the circulation of goods across all territorial scales. Economic growth, therefore, relied not only on long-distance Mediterranean trade circuits but also – and fundamentally – on a dense network of internal exchanges between countryside and city. Within this interpretation, the expansion and increasing sophistication of spinning tools should be understood as a direct consequence of the rise in textile production centres, both urban and rural, in response to the growing demand of an expanding population. Urban growth, agricultural intensification, and the foundation of new villages from the tenth century onwards – a process that can be interpreted as a form of internal colonisation (Jiménez-Castillo et al. 2023) – created a setting in which textiles assumed a central role.

In sum, the available evidence demonstrates that spinning – far from being a minor activity relegated to the domestic sphere – formed a structural component of the Andalusí productive system. Material analysis enables the reconstruction of the techniques and knowledge of those who produced thread, while also providing access to the fiscal, specialised, commercial, and social processes that shaped the economic landscape of al-Andalus between the ninth and 13th centuries. In this sense, textiles are not an isolated sector but offer a privileged lens through which to understand the overall functioning of a highly connected, complex, and continuously evolving western Islamic society.

Acknowledgments

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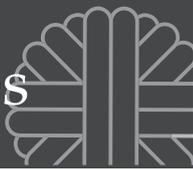
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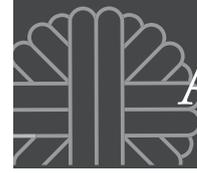
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