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Exploring Diet in the Middle Ages in Northeastern Portugal (Bragança) Through Dental Calculus: The Cases of Torre Velha (Castro De Avelãs) and Mós (Torre De Moncorvo)

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Abstract

Calculus deposits of individuals unearthed from Torre Velha (TVCA) and Mós (MOTM), Necropolis, were analyzed to obtain insights about diet, crop cultivation, and plant use. All samples (n = 11) revealed micro-remains, including starch grains, pollen grains, fungal spores, and sclerenchyma fibers. Starch grains were detected in all studied specimens, belonging mostly to wheat and rye, with fewer to barley and various pulses, with fava beans being the most relevant. Mós samples also showed evidence of millets and pollen grains. These include genera with known medicinal properties, suggesting their intentional use for medical purposes. Fungal spores were isolated from samples of both sites, with higher yield in Mós. A major diversity of micro-remains was obtained in Mós individuals, although any differences must be interpreted with caution. The present work is the first to provide insights into the medieval diet in the Northeast region of Portugal through dental calculus analysis and, when combined with written sources, it contributes to the knowledge of the cultural heritage of the Middle Age diets.

Keywords: heritage diet; starches; crop cultivation; food habits; medicinal plant use; Early and Late Middle Ages

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Academic Editor: Arlen F. Chase

Received: 6 July 2025
Revised: 27 August 2025
Accepted: 29 August 2025
Published: 14 September 2025

Citation: Coutinho, A.P.; Tereso, S.; Carvalho, P.C.; Neves, M.; Catarino, L.; Silva, A.M. Exploring Diet in the Middle Ages in Northeastern Portugal (Bragança) Through Dental Calculus: The Cases of Torre Velha (Castro De Avelãs) and Mós (Torre De Moncorvo). *Heritage* **2025**, *8*, 379. https://doi.org/10.3390/heritage8090379

1. Introduction

The study of diet is an essential component in the analysis of past human societies, since it plays a crucial role in well-being by influencing health throughout life as well as life expectancy. The diet of past populations can be inferred by different documentary sources and skeletal remains, specifically through oral pathology, dental wear, isotopic analysis, and calculus deposits.

Dental calculus results from the mineralization of dental plaque, produced by a complex interaction between saliva and bacteria, and is essentially composed of calcium phosphate mineral salts [1–3]. It is very common in human dentition, and its development and quantity depend on various factors like oral hygiene, genetics, and diet [4–6]. Different types of material can be trapped inside the calculus, including plant food debris, and thus its analysis is an excellent opportunity to understand crop cultivation, plant use, and diets of past populations ([3,7–10], among others).

According to written sources from the region north of the Douro River (Portugal), more numerous after the 11th century, the most quoted human activities were agro-pastoral, forestry, and fishing. Bread was the main food, along with wine and meat, as was common in the rest of Western Europe [11]. The primary agricultural production was cereal, with the production of wheat, millet, barley, and rye, followed by wine, vegetable crops, strawberries, and fruit trees (most often apple and fig trees). Bread was preferentially produced with wheat, but this was not available for most of the population, so "second-class" bread was produced instead, mostly with millet or rye [11]. However, cereals were not only used to make bread. They were also known to be used in porridge, a simple preparation made from flour and water, sometimes with fat and vegetables, such as cabbage, or the tops of other vegetables, such as turnips or even pumpkin (*Lagenaria siceraria*) [6]. The most valued dried fruit was chestnut [12], but hazelnuts, pine nuts, plums, and figs were also consumed [11].

For the Portuguese region of Trás-os-Montes, which includes the two rural archaeological contexts under study, very few carpological analyses are known, and they have mostly focused on the Roman Period. The vast majority of studies have been carried out within the archeological work of the Baixo Sabor Hydroelectric Benefiting Project [13,14]. Among them, the site of Quinta de Crestelos has provided some data on the medieval period, where the presence of barley (*Hordeum vulgare* subsp. *vulgare*), rye (*Secale cereale*), and free-threshing wheat (*Triticum aestivum* L.) was observed. Traces of some ruderal plants, such as malva (*Malva* L.), henbane (*Hyoscyamus niger* L.), poppy (*Papaver somniferum* L.), and corn spurry (*Spergula arvensis* L.), as well as a small number of wild grasses and vegetables, were also found. Grapevine (*Vitis vinifera* L.) was identified in the assemblage, although it is unknown whether it was cultivated or wild [13]. A large amount of rye grains dating to the 6th-7th centuries AD was recovered at S. João das Arribas, a site overlooking the Douro river, east of our site and near the Sabor river [15]. This was accompanied by other crops, such as broomcorn millet (*Panicum miliaceum* L.), foxtail millet (*Setaria italica* (L.) P. Beauvois), barley, and flax (*Linum usitatissimum* L.).

Further south, published carpological data of archaeological work carried out at the sites of Soida, São Gens, Penedo dos Mouros, and Senhora do Barrocal, concluding that the communities of the 10th century practiced diversified agriculture and food consumption. The cereals found were mostly made up of oats and rye, given the environmental conditions of the sites. However, seeds of millet, barley, and wheat were recognized. The vegetables identified were broad beans, peas, red peas, and lentils (in small quantities). In addition, chestnuts and grapes were also cultivated, and flax has been documented. The presence of harvested wild species, such as pinions, strawberries, and blackberries, has been recorded [16–18]. Therefore, the archaeobotanical studies are consistent with the documentary information, especially regarding the cultivation of cereals.

In this work, we aimed to shed light on the food habits and crop cultivation of Portuguese medieval populations. To achieve this, we analyzed the plant debris trapped in the dental calculus of eleven individuals of both sexes, including a non-adult, exhumed from two Middle Age sites in northeastern Portugal. Although our main focus was the identification of starch grains, we also documented other micro-remains, such as pollen grains and fungal spores.

Archaeological Background

The Early Middle Age Torre Velha necropolis (TVCA), located in northeastern Portugal (Figure 1), was excavated between the years of 2012 and 2015. From the 59 graves directly excavated in the schist rock, we unearthed a minimum of 57 individuals, 39 from individual graves (33 adults of both sexes; 6 non-adults) and 18 from ossuaries (17 adults; 1 non-adult). Radiocarbon dating on 16 of these individuals confirmed their burial between the 6th and 13th centuries. Seven adults (of both sexes) with deposits of calculus were sampled. In the Suevic period, Torre Velha may have been the place of the Suevic *Pagus* of Brigantia, mentioned in the Parochiale Suevum (585 AD), while remaining as a parish (of the Astur-Leonese kingdom) during the Early Medieval period and benefiting from its location at the cross of ancient and important Roman roads [19].

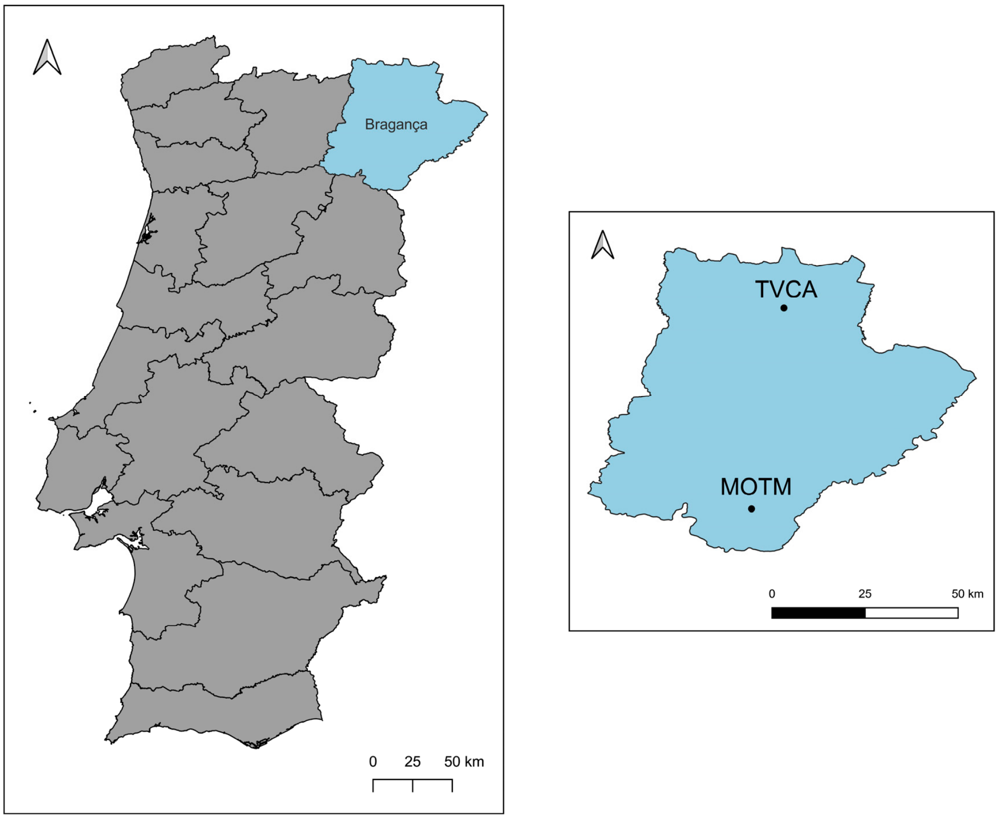

Figure 1. Geographic location of Torre Velha (TVCA) and Mós (MOTM) in Northeast region of Portugal.

The Late Middle Age necropolis of Mós (Figure 1) is located in the churchyard of Santa Maria de Mós church (16th century) in the village of Mós, in the region of Trás-os-Montes (Torre de Moncorvo, Bragança). During the construction of a retaining wall for the churchyard in 2007, several graves dug into the rock were exposed. The archaeological work focused only on the area affected by the construction of the wall, although the necropolis was much more extensive. Some of the graves identified were partially covered by the church, meaning that they are older and likely to be associated with a possible primitive church. The foundation of the Castle of Mós possibly dates to the end of the 9th or the beginning of the 10th Century, following the campaigns promoted by King Afonso III of Asturias to advance the borderline to the Douro River. Radiocarbon dating of Individual 2 (MOTM2) of this necropolis confirmed that the necropolis was used until at least the 14th Century (BETA-496536: 600+/-30 BP; 1296-1409 Cal AD), precisely when Mós seems to have entered decline and the depopulation of the village occurred [20].

The Mós sample is composed of 15 individuals unearthed from primary burials and 5 associated ossuaries, which correspond to a minimum of 38 individuals, where 23 were adults of both sexes and 15 were non-adults, buried over time. From this necropolis, deposits of calculus were obtained from four individuals: three adults (one male and two female) and one non-adult.

As is typical in this region, no archaeological remains have been found associated with the tombs of these two necropolises. A detailed analysis of the anthropological sample is ongoing (Tereso, in preparation).

2. Materials and Methods

A dental calculus sample from 11 individuals (7 from TVCA and 4 from MOTM; Tables S2 and S3) was extracted using sterile disposable scalpels. These represent all the individuals with calculus deposits, and samples were collected from the buccal surface of posterior teeth. Disposable vinyl powder-free gloves, recently cleaned laboratory overcoats and Erlenmeyer flasks, and new microscope slides, coverslips, and laboratory masks were used to limit contamination.

The material was demineralized with 1N hydrochloric acid [21,22] on a new steel filter (mesh size = 1/10th mm). It was then placed in sterile Eppendorf tubes and kept at 2 °C for 48 h [21,22]. Finally, it was washed twice with sterilized water and once with 50% glycerol. The material was then transferred to a microscope slide, covered with a coverslip, and sealed with a double layer of nail varnish. The chemical test of Lugol's iodine staining was employed to verify the presence of starch.

Starch granules and other relevant microstructures (sclerenchyma fibers, pollen grains, and fungal spores) were photographed at 600 magnification in a Motic BA-310 light, bright-field microscope equipped with a digital camera. A light, polarizing microscope Model Eclipse, CiPOL, also fitted with a digital camera, was used to detect and photograph (400 magnification) the starch grains.

To identify the different granules, several articles [8–10,23–29], dichotomous keys [9,25,27,28], and specialized websites [30] were used. The starch collection of the Department of Life Sciences of the University of Coimbra was also considered in the evaluation. The terminology follows the International Code for Starch Nomenclature [31].

Wheat, barley, and many of their wild relatives, usually show starch grains of two size classes, major (Type 1) and small (Type 2) starch granules (<10 µm diameter) (bimodal distribution; see Table S1 in Supplementary Materials). In most other species, however, there is only one size class (monomodal distribution) [32]. Of note, processing methods, such as baking, parching, boiling, pounding, and grinding, may alter many grain traits, such as the integrity of the margin and surface, the definition of lamellae and hilum, size (it increases with cooking), and shape. Another trait that gradually loses definition with the degradation of the starch crystalline structure is the Maltese cross [10,33,34]. For these reasons, only medium-sized Type 1 granules with an intact margin were considered for measurement and general description.

3. Results

All analyzed dental calculus samples (n = 11) revealed several micro-remains, such as starches, pollen grains, fungal spores, and sclerenchyma fibers (Figures 2–5; Tables 1, S2 and S3).

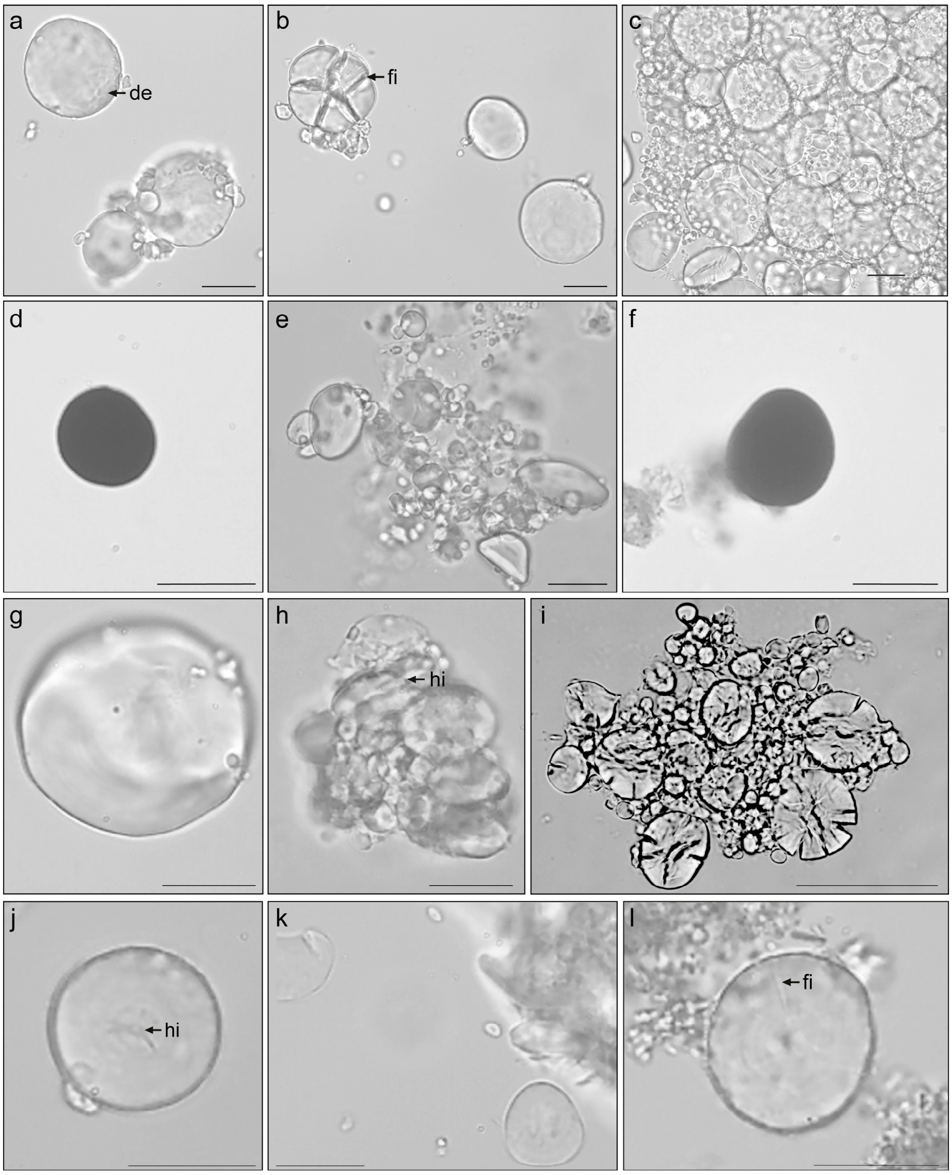

Figure 2. Triticeae starch grains retrieved from dental calculus of individuals of Torre Velha (TVCA) and Mós (MOTM), and photographed with bright-field light microscopy. Bars = 20 µm. Legend: TVCA 2: (**a**) three Type 1 grains in frontal view (one showing a reticulate pattern of depressions) and several Type 2 grains; (**b**) three Type 1 grains in frontal view, exhibiting an increase in size and damage (probably parallel to the increase in cooking time) and some Type 2 grains; (**c**) several Type 1 grains in frontal and lateral view (showing variations in size and definition of the lamellae and hilum) and many Type 2 grains; (**d**) one medium-sized Type 1 grain exhibiting a strong reaction to Lugol's iodine staining. TVCA 3: (**e**) several Type 1 (in frontal and lateral view) and Type 2 grains; (**f**) one medium-sized Type 1 grain exhibiting a strong reaction to Lugol's iodine staining. TVCA 5: (**g**) one large (probably dilated by cooking) Type 1 grain, showing indistinct lamellae and a somewhat bulged center. TVCA 6: (**h**) a cluster of Type 1 (mainly in lateral view) and Type 2 grains. TVCA 7: (**i**) a cluster of Type 1 (more or less degraded by cooking) and Type 2 grains. MOTM 1: (**j**) one Type 1 grain, showing a centric, punctiform–stellate hilum and very indistinct lamellae; (**k**) two abnormally shaped (ovoid and concave–convex), medium-sized Type 1 grains. MOTM 2: (**l**) one medium-sized Type 1 grain, exhibiting a centric, punctiform hilum, a fissure, and indistinct lamellae. de—depressions; fi—fissures; hi—hilum; la—lamellae.

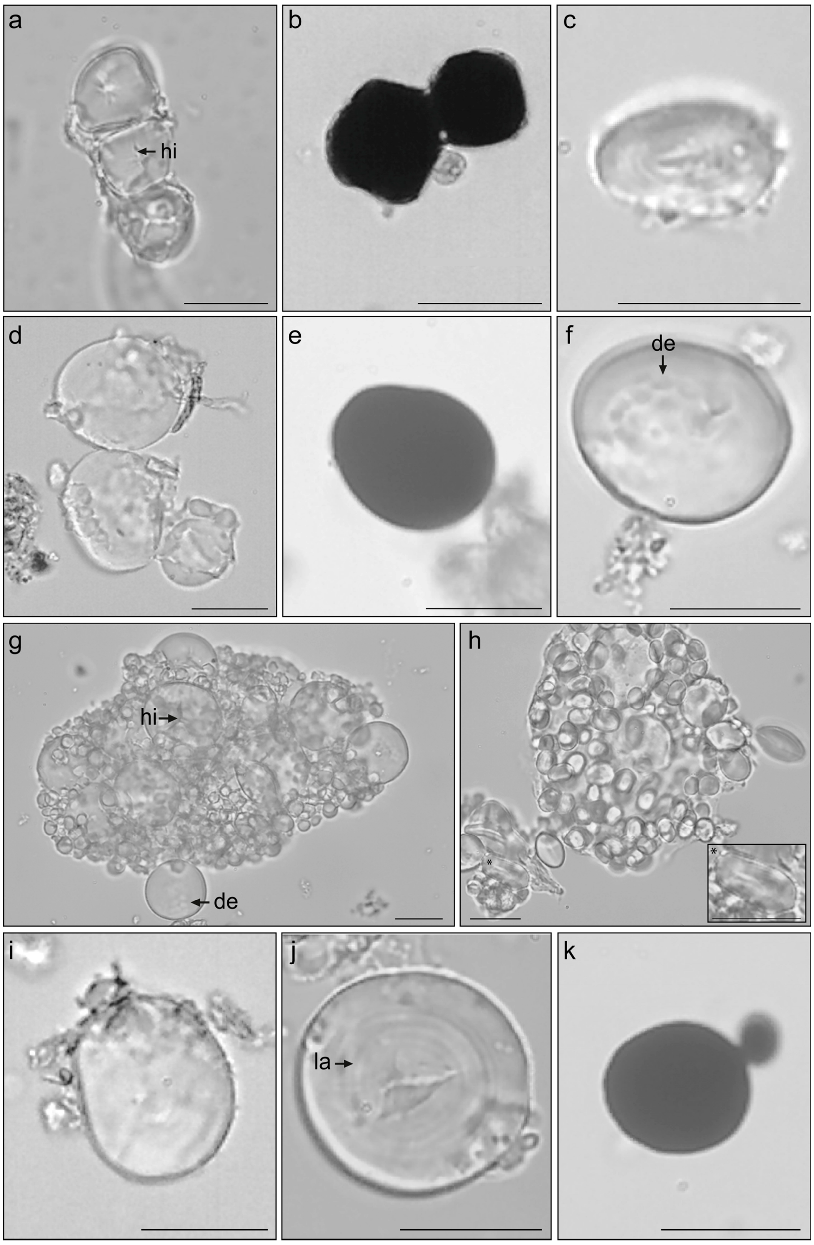

Figure 3. Starch grains retrieved from dental calculus of individuals of Torre Velha (TVCA) and Mós (MOTM), and photographed with bright-field light microscopy. Legend: MOTM 2: (**a**) grains of *Setaria* sp. *Panicum* (Paniceae) with a centric, slightly radiate hilum; (**b**) grains of *Setaria* sp. or *Panicum* (Paniceae), showing a strong reaction to Lugol's iodine staining; (**c**) Fabaceae: ovoid-ellipsoid grain, exhibiting well-defined lamellae and a centric, slightly elongated hilum; (**d**) three Triticeae Type 1 grains; (**e**) one Triticeae medium-sized Type 1 grain showing a strong reaction to Lugol's iodine staining. MOTM 3: Triticeae: (**f**) one medium-sized Type 1 grain exhibiting a reticulate pattern of depressions; (**g**) a cluster of medium- and large-sized Type 1 grains and Type 2 grains; (**h**) a cluster of medium- and large-sized Type 1 grains (seen in frontal and lateral views) and Type 2 grains and an ellipsoid–ovoid, lamellated (lamellae distinct, concentric, fine). MOTM 4: Triticeae: (**i**) one medium-sized Type 1 grain with indistinct lamellae; (**j**) one large (probably enlarged by preparation) Type 1 grain, showing the distinct, concentric, thin lamellae; (**k**) two grains (one medium-sized Type 1 and one Type 2), exhibiting a strong reaction to Lugol's iodine staining. Bars = 20 µm.

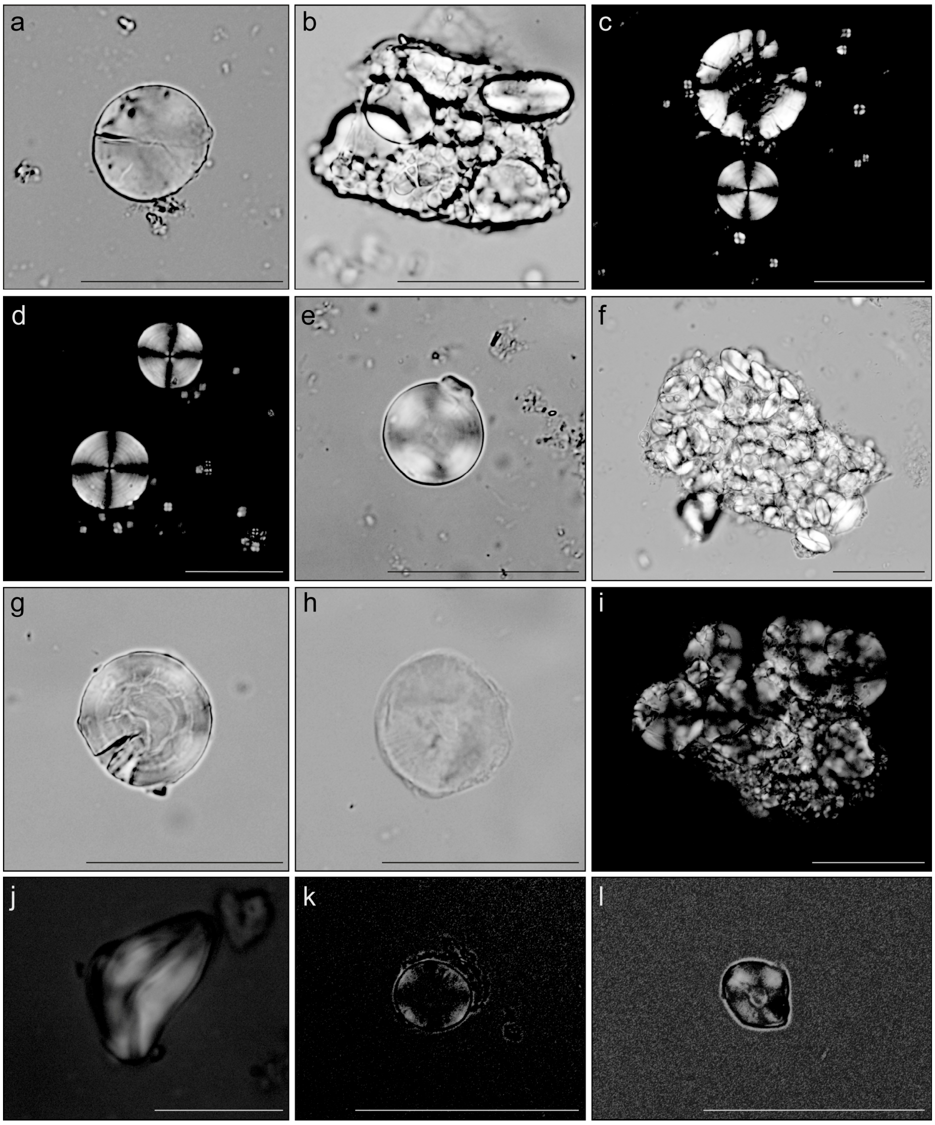

Figure 4. Starch grains retrieved from dental calculus of individuals of Torre Velha (TVCA) and Mós (MOTM), and photographed with polarized light microscopy. Bars = 50 µm. Legend: TVCA 1: (**a**) Triticeae Type 1 granule, with fissures and a centric, indistinct, blurred Maltese cross; (**b**) cluster of Triticeae Type 1 (in frontal and lateral view) and Type 2 granules without Maltese cross.TVCA 2: (**c**) two Triticeae Type 1 granules (one medium-sized, whole, with a centric, distinct Maltese cross; and the other large-sized, fissured–fragmented, with a centric, indistinct, blurred Maltese cross) and several Type 2 grains; (**d**) two Triticeae Type 1 (medium-sized, with a centric, distinct Maltese cross) and several Type 2 granules (with a centric, distinct Maltese cross). TVCA 7: (**e**) Triticeae Type 1 granule, with a centric, relatively distinct Maltese cross; (**f**) cluster of predominantly Triticeae Type 1 grains (in lateral and frontal view) with centric, distinct, thin Maltese cross. MOTM 1: (**g**) Triticeae Type 1 granule with a centric, indistinct, blurred Maltese cross; (**h**) Triticeae Type 1 granule without Maltese cross. MOTM 2: (**i**) cluster of Triticeae Type 1 granules (with a centric, predominantly distinct Maltese cross) and Type 2 granules; (**j**) Fabaceae or Triticeae curved–ellipsoid grain, dilated by cooking, Maltese cross indistinct, confused, with lines thick; (**k**) Triticeae Type 1e granule with a centric, indistinct, blurred Maltese cross. MOTM 4: (**l**) Paniceae grain with a centric, indistinct, blurred Maltese cross.

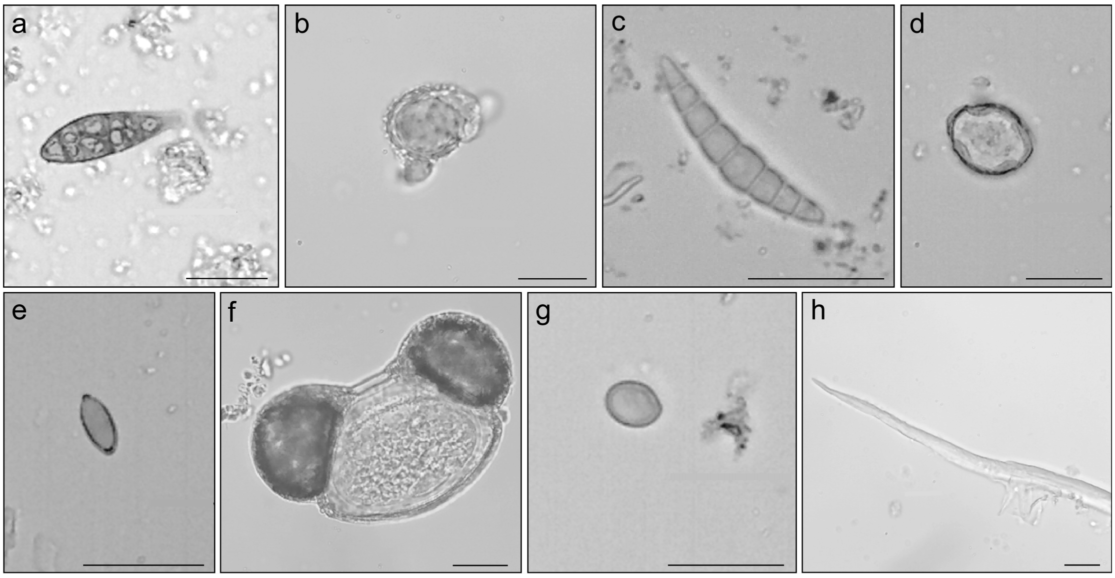

Figure 5. Pollen grains, fungal spores, and sclerenchyma fibers retrieved from dental calculus of individuals of Torre Velha (TVCA) and Mós (MOTM), and photographed with bright-field light microscopy. Bars = 20 µm. Legend: TVCA 4: (**a**) Fungal spore of the dyctiosporae-phaeodictyae type of an *Alternaria* spp. (Ascomycota-Pleosporaceae). MOTM 1: (**b**) Pollen grain of Gnaphalieae (Asteraceae); (**c**) fungal spore: ascospore of the phragmosporae-phaerophragmiae type of an Ascomycota (probably *Leptosphaeria*, *Massariosphaeria* or *Phaeosphaeria*). MOTM 2: (**d**) Pollen grain of *Fumaria* spp. (Papaveraceae); (**e**) conidiospore of *Cladosporium* spp. (Davidiellaceae-Ascomycota) or, less probably, phialid of *Aspergillus* spp. or *Penicillium* spp. (Trichocomaceae-Deuteromycota). MOTM 4: (**f**) pollen grain of *Pinus* spp. (Pinaceae); (**g**) basidiospore of a Basidiomycota. TVCA 7: (**h**) sclerenchyma fiber.

Table 1. Synthesis of the recovered micro-remains by individual.

Individual/ Micro-Remains	TVCA1 F	TVCA2 M	TVCA3 Adult	TVCA4 M	TVCA5 M	TVCA6 F	TVCA7 F	MOTM1 M	MOTM2 F	MOTM3 F	MOTM4 Child
Triticeae Type 1	X	X	X	X	X	X	X	X	X	X	X
Paniceae tribe									X		X
Fabaceae									X	X	
Pollen grains								X (*Gnaphalieae*)	X (*Fumaria*)		X (*Pinus*)
Fungal spores				X (*Alternaria*)				X (*Leptosphaeria*)	X (*Cladosporium*)		X (*Basidiomycota*)
Fibers of sclerenchyma	X	X	X	X	X	X	X	X	X	X	X

Legend: F—female; M—male.

We obtained starch grains from all samples (Figures 2–4). Their observation, both under light field and polarizing optical microscopy, allowed the identification of four different morphometric types (described in the Supplementary Materials (Table S1)). The quantity of starch granules found varied significantly between individuals (Tables S2 and S3) and allowed for the identification of Triticeae, Paniceae/Andropogoneae, and Fabaceae grains.

We also found Poaceae–Triticeae starches in the dental calculus of all individuals of both Torre Velha (n = 7) (Figure 2a–i) and Mós (n = 4) (Figure 2j,k), including the non-adult individual (Figure 3i–k). The existence of significant morphometric overlap between Triticeae and Fabeae starches [35] and, even more importantly, the occurrence of changes due to food preparation [10,34], makes the identification of genera and species of these grains problematic. Considering the low number of medium-sized granules with abnormal shapes (e.g., concave–convex, bell-shaped, and plane–convex) and their metrics, we believe it is more likely that they belong to *Triticum* or *Secale* than to *Hordeum*.

We identified several starch granules of the Paniceae tribe in adult female MOTM2 (Figure 3a,b). These structures are compound-linear [27] or compound-irregular [35] but can easily be separated into individual units [35,36]. Their morphology corresponds to *Panicum miliaceum* L. (Proso millet, broomcorn millet—Andropogoneae) and, if we consider morphometrics, to *Setaria italica* (L.) P. Beauv.

The variation in the definition of the Maltese cross in the individuals TVCA2 (Figure 4c) and MOTM2 (Figure 4i) may have two explanations. First, the starch granules came from different parts of the same bread and, naturally, those closer to the periphery of the dough were subjected to higher temperatures, which altered the crystalline structure of the starch more profoundly, with a concomitant loss of Maltese cross definition. Second, they came from different breads, where one was pounded for longer and/or baked at a higher temperature. It is important to note that, in both cases, the most damaged granules had the largest dimensions and the least well-defined Maltese cross.

In addition to starches, we found other structures in the calculus samples, such as pollen grains, fungal spores, and sclerenchyma fibers.

Some fungal spores were found in the dental calculus of individuals from both sites. In TVCA individuals, we identified only one spore of *Alternaria* (Ascomycota-Pleosporaceae) [37–39] (Figure 5a). From the MOTM samples, we detected three different types of fungal spores: two related to fungal pests of wheat, barley, and rye: *Cladosporium* (Figure 5e), and *Leptosphaeria* (s. l.)/*Massariosphaeria* (Figure 5c) and *Basidiomycota* (Figure 5g) [39,40].

We detected only pollen grains in the samples from Mós: in the adult male MOTM1, we observed grains from the Gnaphalieae tribe (Figure 5b); *Fumaria* grains were found in adult female MOTM2 (Figure 5d); and finally, *Pinus* grains (Figure 5f) were found in the dental calculus of child MOTM4.

4. Discussion

4.1. Starch Grains and Their Significance

Starch grains from the Triticeae tribe were identified in the dental calculus of all individuals (n = 11). This tribe includes useful species, such as wheat, maize, rye, and barley, and represents the most important group of plants in human diet. Among these, wheat and barley have been cultivated in the Iberian Peninsula since around 5500 BC [41–43].

In medieval Portuguese society, as in the rest of Western Europe, the human diet was based on the consumption of bread, wine, and meat [11,44]. For bread production, wheat has always been the most appreciated cereal, providing a whiter, tastier, and more nutritious bread. Consequently, it was cultivated widely, even on unsuitable lands. At that time, rye closely shared with wheat the role of feeding. After wheat, rye is the most nutritious and suitable cereal for breadmaking, and some of its phenological and ecological traits made it preferable. It is a plant that tolerates cold well, and is not demanding in terms of soil quality, generally following the colonization of highlands. Furthermore, this cereal generally yields higher productivity than wheat and, for the same weight, rye produces a great amount of flour. Additionally, rye has a shorter vegetative cycle; it ripens earlier and thus helps to fill the food shortages that occur seasonally in the period immediately before harvesting. It is therefore likely that rye was cultivated in the more inhospitable, cold, and humid mountain regions of Trás-os-Montes, which were more averse to the production of the demanding noble cereal, wheat. In contrast, wheat grew in the deeper, more sheltered or warmer lands [44]. Consequently, it is not unexpected to find starches from both genera in the dental calculus of these individuals.

In two individuals of Mós, an adult female and the child, the presence of millet is suggested. Millet has long been used in the human diet (as a secondary resource) and for animal fodder. Their introduction in the Iberian Peninsula dates back to the Late Bronze Age [45], and two millet species have been traditionally cultivated in Europe, *Panicum miliaceum* (broomcorn millet) and *Setaria italica* (foxtail millet). It is important to note that both species have a short life cycle, which allows annual crop rotation with other grain crops such as wheat, barley, or rye [45]. Another advantage of this crop is its great ecological adaptability to different altitudes, soils, and climates, making it easier to cultivate in inhospitable lands, such as the two sites under study. Although traditionally seen as a minor crop with a secondary role in past human economies, this cereal has a rich nutritional value. Several authors have therefore considered that it was more relevant in the human diet than written sources imply. These studies have also documented that cereals were not used exclusively for breadmaking. Broths were thickened with wheat, millet, or rye flour, turning into porridge that "*warmed the stomachs on winter days and gave energy to those who had to use a lot of physical strength at work*" [46].

After Poaceae, Fabaceae (Leguminosae) represent the most significant botanical family in the human diet. Their presence in the Iberian Peninsula is as old as that of cereals [41,47,48], and they were commonly cultivated together [42,47,49]. From a dietary perspective, pulses are a healthy complement to the consumption of Triticeae, as they are very rich in proteins and essential amino acids, and other nutrients, such as potassium, iron, and fibers [48]. For this reason, they were— and still are—used as a meat substitute. Furthermore, by sequestering nitrogen, they fertilize the soils in which they are cultivated [41].

The lower presence of these starches may suggest a reduced consumption of these pulses compared to Triticeae. Yet, besides factors related to calculus formation, it should be noted that, unlike Triticeae, Fabaceae seeds are generally eaten without being ground into flour. They also have contained a higher water content (e.g., 14–14.2% in chickpeas and lentils and 15% in peas vs. 12% in wheat and 11% in rye), which, if milled, would reduce the amount of pulverized (and then, of mouth inhaled and involuntarily manipulated and ingested) starch [50]. Moreover, the starch of Fabaceae may be more susceptible to the action of salivary enzymes, such as ptyalin, which breaks it down into dextrin and maltose [51], and/or to treatment with dilute hydrochloric acid [7], than those of Triticeae.

4.2. Other Vegetal and Fungal Structures

Pollen grains and fungal spores were other types of recovered micro-remains. In all cases, their presence due to soil contamination cannot be ruled out. Yet, their consumption, whether intentional or not, is very plausible, as they are often associated with the main diet of Triticeae.

Pollen grains were only detected in Mós samples. A significant number of species of *Fumaria* (Papaveraceae: e.g., *F. capreolata* L., *F. officinalis* L., *F. parviflora* Lam., *F. reuteri* Boiss.) and of tribe Gnaphalieae [Asteraceae: *Bombycilaena* (DC.) Smolj., *Filago* L., *Gnaphalium* L., and *Logfia* Cass.] can be associated with cultivated fields [52–62]. Thus, their presence in the dental calculus can reflect the involuntary contamination of cereals with these plants. An alternative hypothesis is the intentional consumption of *Fumaria* and *Gnaphalium* for medicinal purposes. Indeed, *F. officinalis* (earth smoke, common fumitory), a relatively common plant in Trás-os-Montes, is used in folk medicine, with applications in the treatment of liver, gallbladder, and kidney problems [63,64]. Similarly, some species of *Gnaphalium* (cudweeds), also present in this region, are known for their expectorant, cough-suppressing and anti-inflammatory properties [65].

The presence of pine pollen grains in the dental calculus of the child from Mós raises some questions. Contrary to *Fumaria* (which has entomophilous pollination) and Gnaphalieae (which have either entomophilous or autogamous pollination), all *Pinus* species are anemophilous, i.e., their pollen grains are dispersed by the wind. Therefore, their presence can be explained by airborne contamination of crops. However, the hypothesis of pine nut consumption for medical purposes, specifically from *Pinus pinaster* Ait., native to the considered area [66,67], should not be discarded. According to *Livro de Naturas*, a manuscript attributed to Frei Gil de Santarém, a Portuguese physicist and Dominican friar who lived in the 12th/13th centuries, *Pinus* can be used for the treatment of asthma, bronchitis, cough, and other lung diseases [68].

Fungal spores were found in individuals from both sites. In male individual TVCA4, only one spore of *Alternaria* (Ascomycota-Pleosporaceae) [38,39] was isolated and identified. This genus commonly infects various Poaceae-Triticeae, such as wheat, barley, and rye [69–71], and several edible Fabaceae [70], which easily could explain its presence.

From Mós, three different types of fungal spores were identified: two are associated with fungal pests of wheat, barley, and rye: *Cladosporium* and *Leptosphaeria* (s. l.)/*Massariosphaeria* [39,40]. The former can also attack pulses, like peas [72–74], broad beans, chickpeas, and lentils [73]. Therefore, the presence of their spores in the dental calculus is perfectly plausible and indirectly supports the identification of starch grains of the crops present in MOTM. The third type of fungal spore belongs to the Basidiomycota phylum, and no ecological inferences are achievable.

Sclerenchyma fibers were present in all samples. They consistently displayed thick walls, a narrow lumen, and (whenever observable) acute apices (Figure 4h). Not infrequently, the pits of the wall are also noticeable. As is well known, in many Poaceae, including the edible Triticeae [e.g., wheat [74] and rye [75], the vascular bundles present prominent sheaths of numerous sclerenchyma fibers, which are released during cereal grinding.

4.3. Insights into Diet in the Middle Ages in Northeastern Portugal

These results suggest that during the Middle Ages in northeastern Portugal, populations cultivated fields of diverse cereals, probably wheat and rye, surrounded by small plots of pulses, likely more than one species, with *Vicia faba* being the most important. This condition was previously reported for the Iberian Peninsula [41,47]. For Mós, the presence of millet is also suggested. According to written sources, millet seemed to be of less importance in the human diet, being cultivated mainly for animal fodder and straw. However, these sources also highlight the importance of millet consumption during periods of shortage of remaining cereals and/or among individuals with fewer resources. Therefore, flour or bread could be prepared with one or several cereals, as still occurs today. Moreover, cereals were also used to prepare diverse types of porridges. Regarding the number of starch grains relative to consumption, although this may indicate the presence or absence of specific plants in the diet, it does not reflect the intensity of their consumption [7]. Indeed, the formation of dental calculus—closely related to the capture of starch—varies between individuals, according to factors not yet fully clarified [4,5]. Also, most plant foods common during the occupation of the two archaeological stations (e.g., apples, pears, plums, and grapes) do not produce polysaccharides.

Sex differences in diet were not possible to explore due to the low number of samples. Yet, female individuals of MOS revealed a greater diversity of micro-remains in their dental calculus than MOS male and both sexes from TVCA.

5. Conclusions

The starch grain profile obtained suggests that the populations of the archaeological sites of Torre Velha and Mós consumed different cereals, such as wheat and/or rye (less probably, barley). Evidence of the use of millet in the human diet was also attested for Mós.

Although the possibility of soil contamination cannot be ruled out, the presence of spores of fungi associated with cereals and pulses diseases, along with sclerenchyma fibers (abundant in all identified taxa of Poaceae), may reinforce the above conclusions. The pollen grains discovered in Mós samples, although belonging to plants commonly associated with cultivated fields, also suggests their intentional consumption as medicinal plants, as attested by ancient written sources.

In summary, this research, based on dental calculus analysis and complemented with historical sources, strengthens our knowledge about diet, crop cultivation, and the potential medicinal use of plants among medieval populations of northeastern Portugal.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/heritage8090379/s1, Table S1: Starch types descriptions; Table S2: Morphometric traits of the type 1 (medium-sized) non-degraded starch granules found in the dental calculus of the studied individuals of Torre Velha- (TVCA); Table S3: Morphometric traits of the type 1 (medium-sized) non-degraded starch granules found in the dental calculus of the studied individuals of Mós (MOTM); Figure S1: Starch grains of Fabaceae from the reference collection of the Department of Life Sciences of the University of Coimbra.

Author Contributions: Conceptualization, A.M.S. and S.T.; Formal analysis, A.P.C., M.N., L.C. and A.M.S.; Funding acquisition, A.M.S. and A.P.C.; Investigation, A.M.S., A.P.C., S.T. and P.C.C.; Project administration, A.M.S. and P.C.C.; Resources, S.T. and A.M.S.; Validation, A.M.S.; Writing—original draft, A.M.S., A.P.C. and P.C.C.; Writing—review and editing, A.M.S., A.P.C., S.T., P.C.C., M.N. and L.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Presented within the manuscript.

Acknowledgments: Research Centre for Anthropology and Health (PEst-OE/SADG/UI0283/2021). The authors are grateful to the reviewers for their insightful comments, which led to significant improvements of the manuscript.

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

Abbreviations

The following abbreviations are used in this manuscript:

TVCA	Torre Velha
MOTM	Mós

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