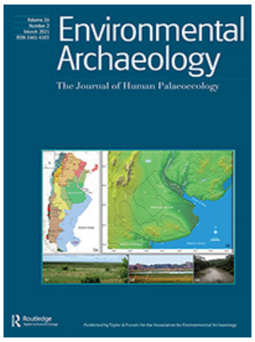

Environmental Archaeology

The Journal of Human Palaeoecology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/yenv20

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ENVIRONMENTAL ARCHAEOLOGY
https://doi.org/10.1080/14614103.2020.1867291

Production and Transport of Goods in the Roman Period: Residue Analysis and Wine Derivatives in Late Republican Baetican Ovoid Amphorae

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ABSTRACT
Amphorae are key materials in the investigation of the production and transport of goods in ancient times. For the Roman period, many typologies of amphorae are standardised and there are hypotheses concerning their uses and contents mainly based on the shape, provenance, *tituli picti* and, when preserved, the solid contents. However, there are still many amphora types that have to be investigated in order to better understand the economy of the regions where they were produced and filled. This is the case of the amphorae object of this paper: the so-called ovoid amphorae of *Hispania Ulterior/Baetica*.

This paper presents new results of an interdisciplinary investigation aimed to discover the commodities contained in ovoid amphorae. This amphora type and its specific use have never been investigated, except for a preliminary test. Here, organic residues analysis of twenty-four amphorae produced in two different locations in *Hispania Ulterior/Baetica* (Bay of Cadiz and the Guadalquivir Valley) and excavated at the site of El Olivillo in Cadiz (Spain), are presented. The findings suggest that the majority of the amphorae were coated with abundant pitch derived from Pinaceae trees and that most of them contained grape derivatives, although other products were also identified. Not only is this documentation of *Hispania Ulterior/Baetican* wine production in the late Republican period important, but the use of ovoid amphorae for carrying wine is somewhat unexpected because it is usually thought that amphorae of this type in southern Italy and in the Corinthia probably carried olive oil.

ARTICLE HISTORY
Received 9 April 2020
Revised 12 October 2020
Accepted 26 October 2020

KEYWORDS
Ovoid amphorae; organic residues analysis; Roman period; *Baetica*; Cadiz; wine derivatives

Introduction

The study of the contents of Roman amphorae is especially important, as it offers information about the production and transportation of key goods from specific regions of the Roman Mediterranean (Bernal-Casasola 2015; Woodworth et al. 2015). Traditional analyses applied to amphorae in order to reconstruct their uses and the commodities carried in them are based primarily on the study of (i) the amphora shape, (ii) the *tituli picti* sometimes written in ink on them, (iii) the provenance area of the vessels, or, in the rare casesin which it is preserved (iv) the solid contents of the amphorae – for example grape seeds, fish bones (e.g. Peacock and Williams 1986). However, the latter evidence, apart from occurring rarely, has not always offered reliable information about the commodities contained in specific amphorae; moreover, it represents the last use of the container, and possibly a re-use. Therefore, much work is still needed to characterise the content of the vast majority of amphora types.

During the last decades, organic residues analysis has been successfully applied to investigate the use of amphorae and, in this way, to provide key information for the documentation and study of the production and trade of foodstuffs and other goods (e.g. oil for lighting, mastic, etc.) carried in them (Bernal-Casasola, Pecci, and Sáez 2019; Camporeale et al. 2008; Cau Ontiveros et al. 2018; Garnier 2007; Garnier, Silvino, and Bernal-Casasola 2011; Pecci et al. 2010, 2017; Pecci and Cau Ontiveros 2010, 2014; Romanus et al. 2009; Woodworth 2017). Often the information obtained from the organic residues analysis is consistent with the hypothesis suggested by the archaeological context. However, sometimes it has provided data that were not expected, strengthening the need of performing such analyses in order to better reconstruct the reliable content of specific vessels. In addition, organic residues analysis has shed light on the presence of organic coatings in amphorae (e.g. resin or pitch) that not always are visible to the naked eye (Garnier, Silvino, and Bernal-Casasola 2011; Pecci and Cau Ontiveros 2010).

Among the amphorae whose use is still unknown are the so-called ovoid amphorae from *Hispania Ulterior/Baetica*, a complex class of late Republican forms with an ovoid-shaped body, with many regional typological variants (García Vargas, de Almeida, and González Cesteros 2011, 2019). Here we present the results of organic residues analysis carried out by gas chromatography coupled with mass spectrometry on

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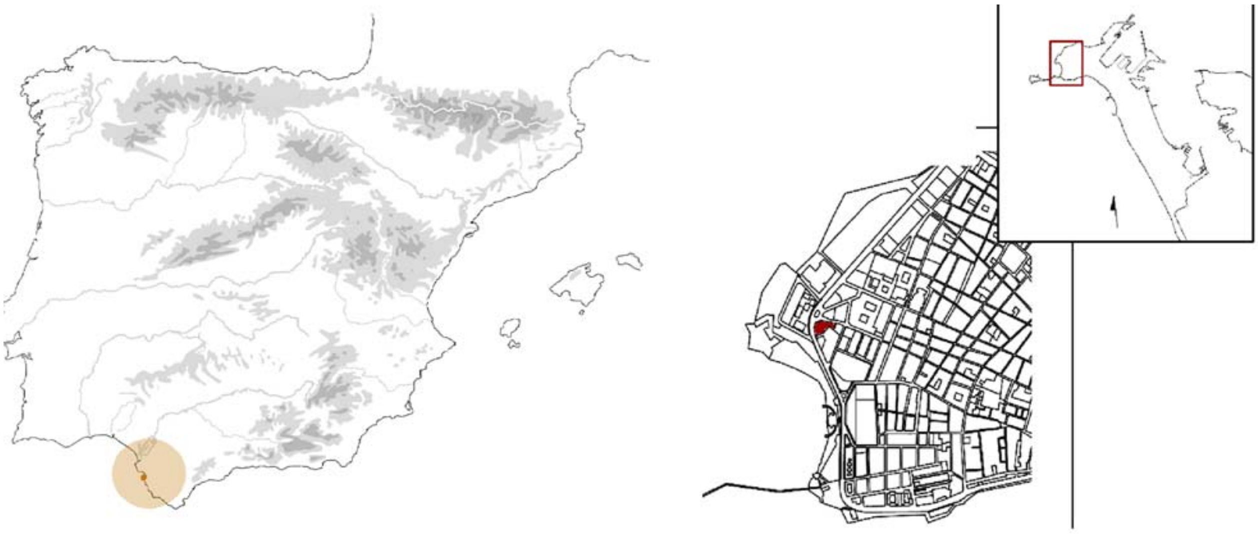

Figure 1. Location of Cadiz and the site of El Olivillo in Cadiz.

twenty-four examples of this type. These were excavated in the site of El Olivillo in Cadiz (Figures 1 and 2) and were produced in the area of Cadiz and the Guadalquivir Valley. In particular, we concentrated our attention on ovoid amphora types 1 and 5 and others which can probably be attributed to these types (Figures 3 and 4).

Previous archaeological studies had suggested that ovoid amphorae were connected to the 'Lomba do Canho 67' group and that the ovoid type 1 amphora from the Guadalquivir valley may have carried olive oil (like the later Dressel 20 from this region) – although without rejecting wine and its derivatives; while for the Ovoid type 5, a possible oil content, or perhaps a content related to grape by-products had been suggested (Bernal-Casasola, Pecci, and Sáez 2019; Bernal-Casasola et al., 2019a; García Vargas, de Almeida, and González Cesteros 2016).

However, as previously mentioned, the contents of this amphora class have not been previously studied through organic residues analysis, except for a preliminary study on few ceramic samples (Bernal-Casasola, Pecci, and Sáez 2019). The latter work resulted in the identification of wine residues (or its derivatives) in three different amphora types: one Ovoid 5 amphora, from a site on the coast of Cadiz (present-day San Fernando, Cadiz, Spain); one Ovoid 1 amphora, from Benzú near Ceuta (Spain); and one Haltern 70, of later date, also recovered on the latter site (Bernal-Casasola, Pecci, and Sáez 2019). But more analyses are needed to better understand what was carried in ovoid amphorae and, in particular, to verify whether this area of *Hispania Ulterior/Baetica*, the Guadalquivir Valley, known for the production of oil from the 1st century AD onwards (carried in the Oberaden 83, Haltern 71 and Dressel 20 amphora types) and fish sauce (produced in the coastal fish processing vats in the Bay of Cádiz associated with other amphorae) during late Republican period, also produced wine or derivatives, as has been suggested (Berni Millet 1998; de Almeida 2008; Lagóstena Barrios 2001).

The Site of El Olivillo

The site of El Olivillo in Cadiz, located next to the outer port of Roman *Gades*, was excavated in 2016–2017 by the University of Cadiz in the plot occupied by the modern building of the same name (Bernal-Casasola and Vargas 2017; Bernal-Casasola and Vargas Girón 2019) (Figure 1).

The stratigraphy of the investigated area (400 m^2) ranges from the Bronze Age to the Modern Age. In the central part of the site, a large artificial mound of dumped rubbish of the Roman period was discovered. As the small hill is formed mostly of amphorae and has walls to contain the waste also made of amphorae, it recalls the much larger 'Monte Testaccio' mound of amphorae outside the walls of Rome, where imported amphorae, especially olive oil amphorae from southern Spain, were emptied and systematically discarded (Blázquez Martínez and Remesal Rodríguez 2014) (Figure 2). Therefore, it was named by the archaeologists the halieutic 'Testaccio of Gades', as most of the remains are connected with the exploitation of marine resources (Bernal-Casasola et al. 2017). In this case, the small hill possibly resulted after the accumulation of waste from nearby Roman fish factories of the same period and harbour activities, given that there is evidence for the additional contemporary deposition at the dump of large quantities of fish remains and murex shells, as well as evidence of burning, perhaps to minimise health risks. The special context of these amphorae suggests that they were used once, and then discarded, but this has to be

Figure 2 Photograph of the excavations at El Olivillo, with the strata of the mound clearly visible.

verified through the organic residues analysis of the materials.

The amphorae recovered are in some cases long distance imports, but most are local or regional forms. In the lower levels there are Augustan Haltern 70, Ramon T-7433, local imitations of Dressel 1, Punic-style amphorae, and ovoid amphorae (García Vargas and Bernal-Casasola 2008). In the upper levels, the presence of imported amphorae, *sigillata* table wares and coins provide good dating evidence for the context, which ranges from the later 1st century BC to the mid-1st century AD (Bernal-Casasola et al. 2019b; Bernal-Casasola and Vargas Girón 2019).

For this first study of the material we decided to focus on the analysis of ovoid amphorae recovered in the lower levels, because the contents of this amphora class have not yet been investigated (García Vargas et al. 2019). This complex class of late Republican *Hispania Ulterior/Baetican* amphorae have many regional typological variants, some associated with known production sites (Bernal-Casasola, Pecci, and Sáez 2019; Bernal-Casasola et al. 2019a; García Vargas et al. 2019; García Vargas, de Almeida, and González Cesteros 2011; see also the Amphorae ex Hispania website http://amphorae.icac.cat/).

Materials and Methods

Ceramic Samples

Twenty-four sherds from ovoid amphorae have been analysed; two are Ovoid 5, seven are Ovoid 1, and fifteen are indeterminate (including one possible Ovoid 5 – sample OL14 – and one ovoid which appears to be different from both Ovoid 1 and 5 – sample OL24) (Table 1, Figures 3 and 4). Based on macroscopic analyses that have proven to be consistent with petrographic and chemical analyses, the sherds have two main provenances, i.e. the Guadalquivir Valley and the Bay of Cadiz. These latter fabrics are very easy to recognise by macroscopical analysis, as demonstrated long ago (Martin Kilcher 1987) and since then accepted by the academic community. Table 1 displays the main details regarding this group of samples.

Methodology

Sherd samples were mechanically cleaned to remove post-depositional contamination, then sub-sampled in the laboratory and pulverised. The powders were extracted by using two different extraction methods (see below) and the extracts were analysed by gas chromatography-mass spectrometry (GC-MS). A blank sample was analysed using the same solvents employed for the analysis of the archaeological samples. An internal standard (20 µg of *n*-hexatriacontane, C_{36}) was added to the powdered sherds to enable the quantification of lipid extract. The ceramic samples were extracted using two different extraction methods:

(i) Chloroform/Methanol extraction was performed by adding 10 ml $CHCL_3$/MeOH and sonicating. After centrifugation in a test tube, the lipid extract (usually called TLE) was transferred to a 2 mL vial and the solvent evaporated under a gentle stream of nitrogen. An aliquot of the TLE (1/4) was hydrolysed and trimethylsilylated for analysis by GC-MS, following Evershed et al. (1990, 1994) and Charters et al. (1997, 1993).

(ii) The alkaline extraction with KOH in distilled water proposed by Pecci et al. (2013) to identify wine biomarkers was applied on approximately 1 g of the sample. The extract was trimethylsilylated for analysis by GC-MS. This method has

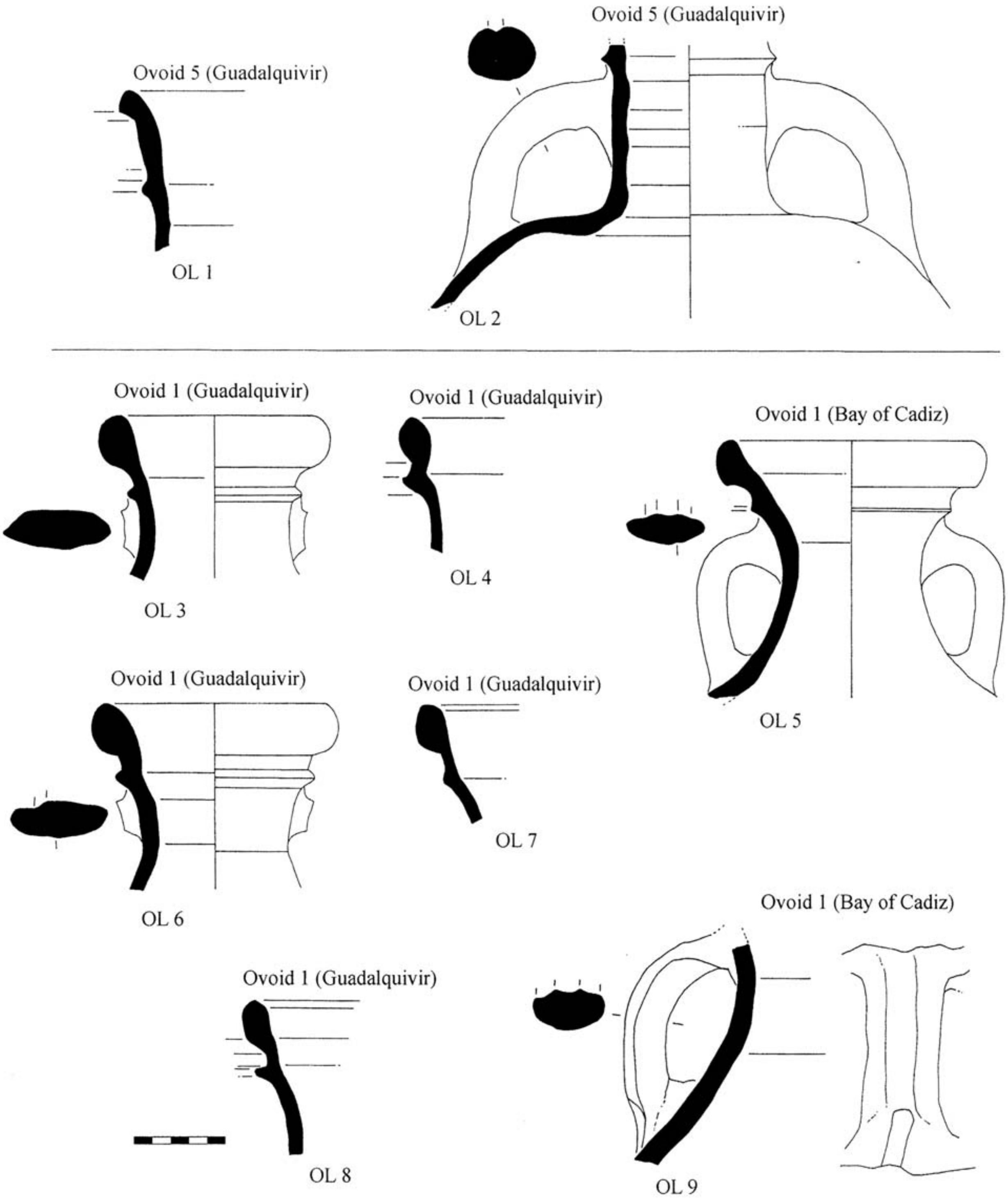

Figure 3. El Olivillo (Cadiz). Amphora samples OL 1 to OL 9.

reliably allowed to identify tartaric acid and other acids present in wine in experimental, archaeological and ethnoarchaeological contexts (Pecci, Cau Ontiveros, and Garnier 2013; Pecci et al. 2013, 2017, 2020).

Analyses were carried out with a chromatographer Thermo Scientific TS GC ultra, with a silica capillary column of 30 m, 0.25 μm thickness and a mass spectrometer Thermo Scientific ITQ 900 operated in electronic ionisation (70 eV). The mass range is *m/z* 40–900.

Results

The general preservation of the residues was low; nevertheless, it was possible to identify a number of biomarkers indicating the presence of organic coatings and providing evidence for the possible amphora contents.

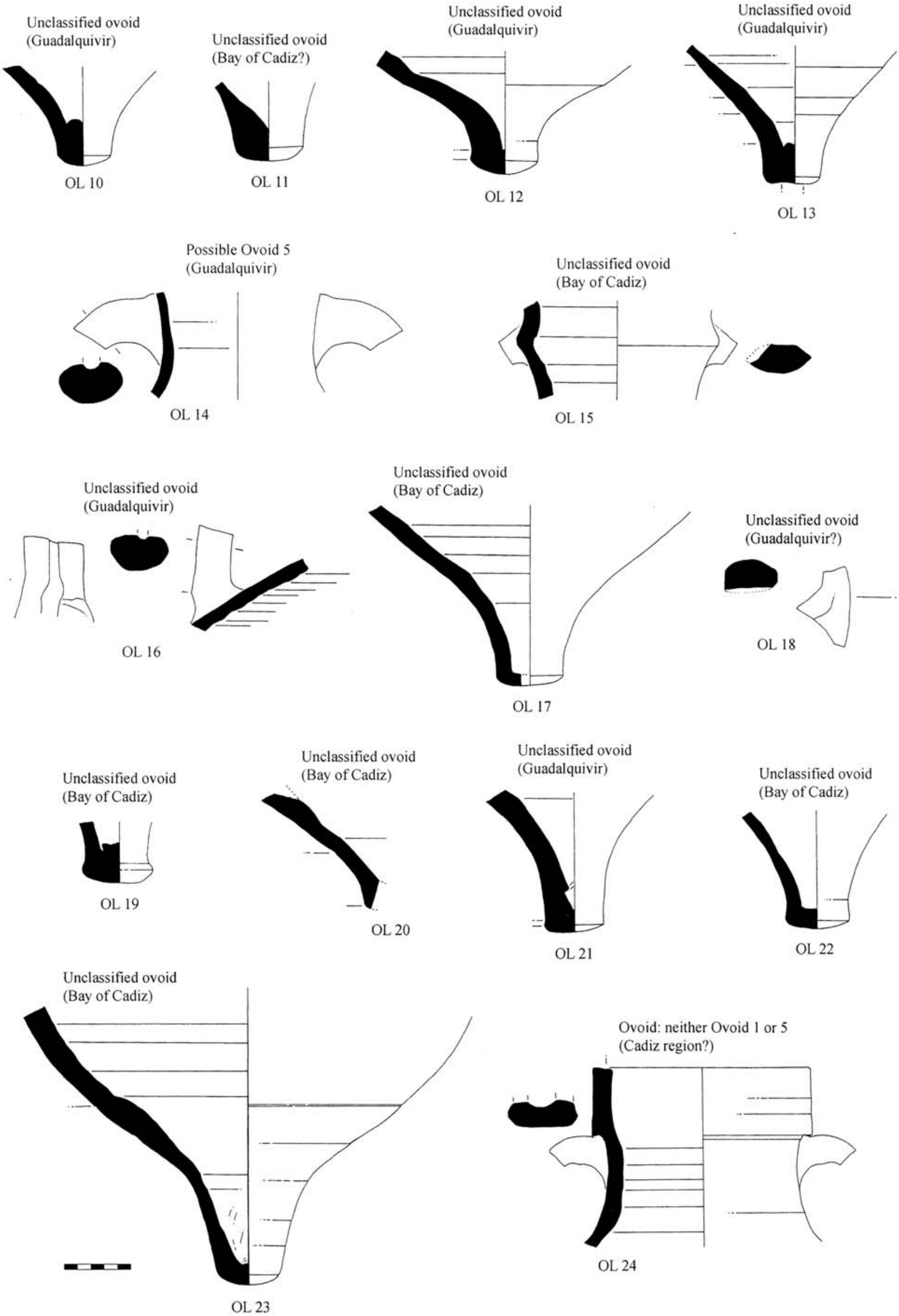

Figure 4. El Olivillo (Cadiz). Amphora samples OL 10 to OL 24.

Table 1. List of ceramic samples analysed.

Sample ID	Typology	Production area
OL1	Ovoid 5	Guadalquivir Valley
OL2	Ovoid 5	Guadalquivir Valley
OL3	Ovoid 1	Guadalquivir Valley
OL4	Ovoid 1	Guadalquivir Valley
OL5	Ovoid 1	Bay of Cadiz
OL6	Ovoid 1	Guadalquivir Valley
OL7	Ovoid 1	Guadalquivir Valley
OL8	Ovoid 1	Guadalquivir Valley
OL9	Ovoid 1	Bay of Cadiz
OL10	Unclassified Ovoid	Guadalquivir Valley
OL11	Unclassified Ovoid	Bay of Cadiz?
OL12	Unclassified Ovoid	Guadalquivir Valley
OL13	Unclassified Ovoid	Guadalquivir Valley
OL14	Possible Ovoid 5	Guadalquivir Valley
OL15	Unclassified Ovoid	Bay of Cadiz
OL16	Unclassified Ovoid	Guadalquivir Valley
OL17	Unclassified Ovoid	Bay of Cadiz
OL18	Unclassified Ovoid	Guadalquivir (fine fabric)?
OL19	Unclassified Ovoid	Bay of Cadiz
OL20	Unclassified Ovoid	Bay of Cadiz
OL21	Unclassified Ovoid	Guadalquivir
OL22	Unclassified Ovoid	Bay of Cadiz
OL23	Unclassified Ovoid	Bay of Cadiz
OL24	Ovoid: neither Ovoid 1or 5	Cadiz region?

Pitch biomarkers were identified in the majority of the extracts (nineteen), which displayed an abundance of dehydroabietic acid, 7 - oxodehydroabietic acid and methyldehydroabietate (Table 2, Figures 5 and 6). While dehydroabietic acid is a typical marker of *Pinaceae* products (mainly resin), and and 7 - oxodehydroabietic acid is a degradation marker of dehydroabietic acid, the methyl-dehydroabietate is considered the marker of the pitch extracted directly from the wood (Colombini et al. 2005), suggesting that all the analysed amphorae were coated with pitch. In some cases, pitch is evident to the naked eye, while in others it is not.

The majority of the extracts (i.e. eighteen, which correspond to 75% of the samples analysed), obtained following extraction method ii., displayed the presence of tartaric and succinic acids. Tartaric, succinic together with malic acid, are present in three of these samples (OL5, 6 and 10), suggesting that these amphorae were used to contain grape derivatives (Table 2). In fact, while other fruits may also contain tartaric acid (Barnard et al. 2011), this acid is particularly abundant in grape, and it is usually considered the marker of grape derivatives (Barnard et al. 2011; Drieu et al. 2020; Garnier and Valamoti 2016; Guash-Jané et al. 2004; Pecci 2018; Pecci, Cau Ontiveros, and Garnier 2013; Pecci et al. 2013, 2017, 2020; Rageot et al. 2019). In particular, for the investigated period and region, it is possible to hypothesise that these amphorae contained wine – or its derivatives. Figure 5 displays two chromatograms as example for this group of amphorae.

Among the eighteen extracts characterised by grape products, seven residues, derived from extraction method i. (i.e. OL1, OL2, OL3, OL5, OL7, OL8, OL15), displayed other compounds (Figure 6). OL1 and OL2 displayed an appreciable concentration of oleic acid ($C_{18:1}$), followed by palmitic ($C_{16:0}$) and stearic ($C_{18:0}$) acids. β-sitosterol was also identified. This distribution is compatible with the possible presence of plant oil products in the amphorae.

Extract OL3 displayed a lipid distribution with a high concentration of palmitic and stearic acids, followed by oleic acid. This residue might have an animal origin. However, the presence of azelaic acid (usually deriving from the degradation of oleic acid) and β-sitosterol, suggests a mixed content or a re-use of the amphora. Figure 6 displays two chromatograms as examples for this group.

Cholesterol is present in all the extracts; this compound is present in animal products, however, recently, Hammann et al. (2018) have suggested that it often derives from post-depositional contamination. Therefore, the presence of this compound is not taken into account in the interpretation of the possible contents of the amphorae.

Finally, six samples did not show tartaric acids. Among them, the total lipid extract (TLE, extract i.) of OL20 displayed oleic acid ($C_{18:1}$) and traces of β-sitosterol, suggesting possible plant oil products. OL16, OL17 and OL19 displayed pitch biomarkers (indicating the presence of an organic coating) and traces of succinic acid, but no other compound that can be considered a biomarker of specific substances. Samples OL11 and OL12 displayed non-specific compounds, neither traces of resin and/or pitch. The latter amphorae might have been used to contain products that cannot be identified by the analyses carried out (e.g. solids).

Discussion

The information obtained from the organic residues analysis allowed hypothesising the possible use of the ovoid amphorae analysed. The majority of the amphorae were coated with pitch; the latter result is consistent with the literature suggesting that resin or pitch were common products used during the Roman period to waterproof ceramic vessels, and amphorae and *dolia* in particular (Bernal-Casasola and Petit 1999; Allevato et al. 2012; Colombini et al. 2005; Garnier 2007; Garnier, Silvino, and Bernal-Casasola 2011; Pecci and Cau Ontiveros 2010; Pecci et al. 2017; Pecci et al. 2018; Romanus et al. 2009).

The presence of methyldehydroabietate, which is a biomarker typical of pitch that is extracted burning the wood of *Pinaceae* trees, allows us to obtain information on the production process of this product (Colombini et al. 2005). It is worth highlighting the absence of resin biomarkers in five out of twenty-four amphorae. In fact, even though the use of *Pinaceae* products to seal the inner surfaces of amphorae is well known for the Roman period, the absence of *Pinaceae* products biomarkers in some of the amphorae suggests

Table 2. List of identified compounds in each ceramic samples.

Sample ID	Shape	Production area	Main FAs in order of decreasing concentration	TA	Other acids present in wine	DHA	MDHA	Azelaic acid	ß sitosterol
OL1	Ovoid 5	Guadalquivir Valley	$C_{16:0}$ $C_{18:1}$ $C_{18:0}$ *	Yes	SA	Yes	Yes	None	Yes
OL2	Ovoid 5	Guadalquivir Valley	$C_{16:0}$ $C_{18:1}$ $C_{18:0}$*	Yes	SA	None	None	None	Yes
OL3	Ovoid 1	Guadalquivir Valley	$C_{16:0}$ $C_{18:1}$ $C_{18:0}$ **	Yes	SA	Yes	Yes	Yes	Yes
OL4	Ovoid 1	Guadalquivir Valley	$C_{16:0}$ $C_{18:0}$ $C_{18:1}$	Yes	SA	Yes	Yes	Yes	None
OL5	Ovoid 1	Bay of Cadiz	$C_{16:0}$	Yes	SA + MA	Yes	Yes	None	Yes
OL6	Ovoid 1	Guadalquivir Valley	$C_{16:0}$	Yes	SA + MA	Yes	Yes	None	None
OL7	Ovoid 1	Guadalquivir Valley	$C_{16:0}$ $C_{18:0}$ $C_{18:1}$	Yes	None	Yes	Yes	None	Yes
OL8	Ovoid 1	Guadalquivir Valley	$C_{16:0}$ $C_{18:0}$ $C_{18:1}$	Yes	None	Yes	Yes	None	Yes
OL9	Ovoid 1	Bay of Cadiz	None	Yes	SA	Yes	Yes	None	None
OL10	Ind. Ovoid	Guadalquivir Valley	None	Yes	SA + MA	Yes	Yes	None	None
OL11	Ind. Ovoid	Bay of Cadiz?	None	None	None	None	None	None	None
OL12	Ind. Ovoid	Guadalquivir Valley	None	None	None	None	None	None	None
OL13	Ind. Ovoid	Guadalquivir Valley	None	Yes	SA	Yes	Yes	None	None
OL14	Ovoid 5?	Guadalquivir Valley	$C_{16:0}$ $C_{18:1}$ $C_{18:0}$	Yes	SA	None	None	None	None
OL15	Ind. Ovoid	Bay of Cadiz	None	Yes	SA	Yes	Yes	None	Yes
OL16	Ind. Ovoid	Guadalquivir Valley	None	None	SA	Yes	Yes	None	None
OL17	Ind. Ovoid	Bay of Cadiz	None	None	SA	Yes	Yes	None	None
OL18	Ind. Ovoid	Guadalquivir (fine fabric)?	None	Yes	SA	Yes	Yes	None	None
OL19	Ind. Ovoid	Bay of Cadiz	None	None	SA	Yes	Yes	None	None
OL20	Ind. Ovoid	Bay of Cadiz	$C_{16:0}$ $C_{18:1}$ $C_{18:0}$	None	SA	Yes	Yes	None	Yes
OL21	Ind. Ovoid	Guadalquivir	$C_{16:0}$	Yes	SA	Yes	Yes	None	None
OL22	Ind. Ovoid	Bay of Cadiz	$C_{16:0}$	Yes	None	Yes	Yes	None	None
OL23	Ind. Ovoid	Bay of Cadiz	$C_{16:0}$	Yes	None	Yes	Yes	None	None
OL24	Ind. Ovoid (neither 1 or 5)	Cadiz region?	$C_{16:0}$	Yes	None	None	None	None	None

Note: In the table the symbol * indicates the high concentration of fatty acids (FAs); DHA and MDHA are respectively dehydroabietic acid and methyldehydroabietate; TA, SA and MA are respectively tartaric, succinic and malic acids.

that, during the investigated period, this technological practice was not universally applied. In particular, it is interesting to observe that there is no correspondence between the presence/absence of an organic coating and the specific content of the amphorae. In fact, in contrast to other cases, no pitch is present in three amphorae which contained wine or derivatives (OL2, OL14, and OL24), while it is present in OL20, which possibly contained a plant oil. If the latter result is confirmed, it would indicate the contemporaneous presence of both pitch and plant oil in the same amphora. A similar result has been detected in other cases, such as the studies carried out at Arles, Classe (Ravenna), and the Testaccio in Rome (Garnier, Silvino, and Bernal-Casasola 2011; Pecci et al. 2010; Pecci and Cau Ontiveros 2010). In some cases the amphorae carried non-olive oil (i.e. castor oil in those from Classe and moringa oil in the one from Arles, as suggested by Pecci et al. 2010 and Garnier, Silvino, and Bernal-Casasola 2011), while in others the residues are compatible with olive oil.

Concerning the content, most of the analysed amphorae contained grape juice or derivatives. Among them, fourteen amphorae were probably used only to contain wine or derivatives. This content is characteristic of Ovoid 5 type from the Guadalquivir Valley and Ovoid 1 types from the Guadalquivir Valley and the Bay of Cadiz. The same can be said for the unclassified amphorae from both production regions, and the unclassified ovoid which is neither Type 1 nor 5 (sample OL 24). These data are in agreement with the second hypothesis suggested by García Vargas, de Almeida, and González Cesteros (2016) for a grape by-product content for the Ovoid 1 and 5 types. Moreover, they are in agreement with the data obtained by G. Chic García (1978) who found some grape seeds in a possible Ovoid 1, recovered from the coast at Punta del Nao (Cadiz), suggesting that grape juice or must could have been the content of the amphora. All these data confirm the importance of the production of wine in the region, and begin to solve a major problem: the scarce number of amphorae apparently devoted to the transport of wine of *Hispania Ulterior*/Baetican origin, known for this late Republican period. In fact, so far, only the Haltern 70 type, which emerges as the successor to ovoid forms in the Augustan period, and other minority types, such as the Dressel 28, were known.

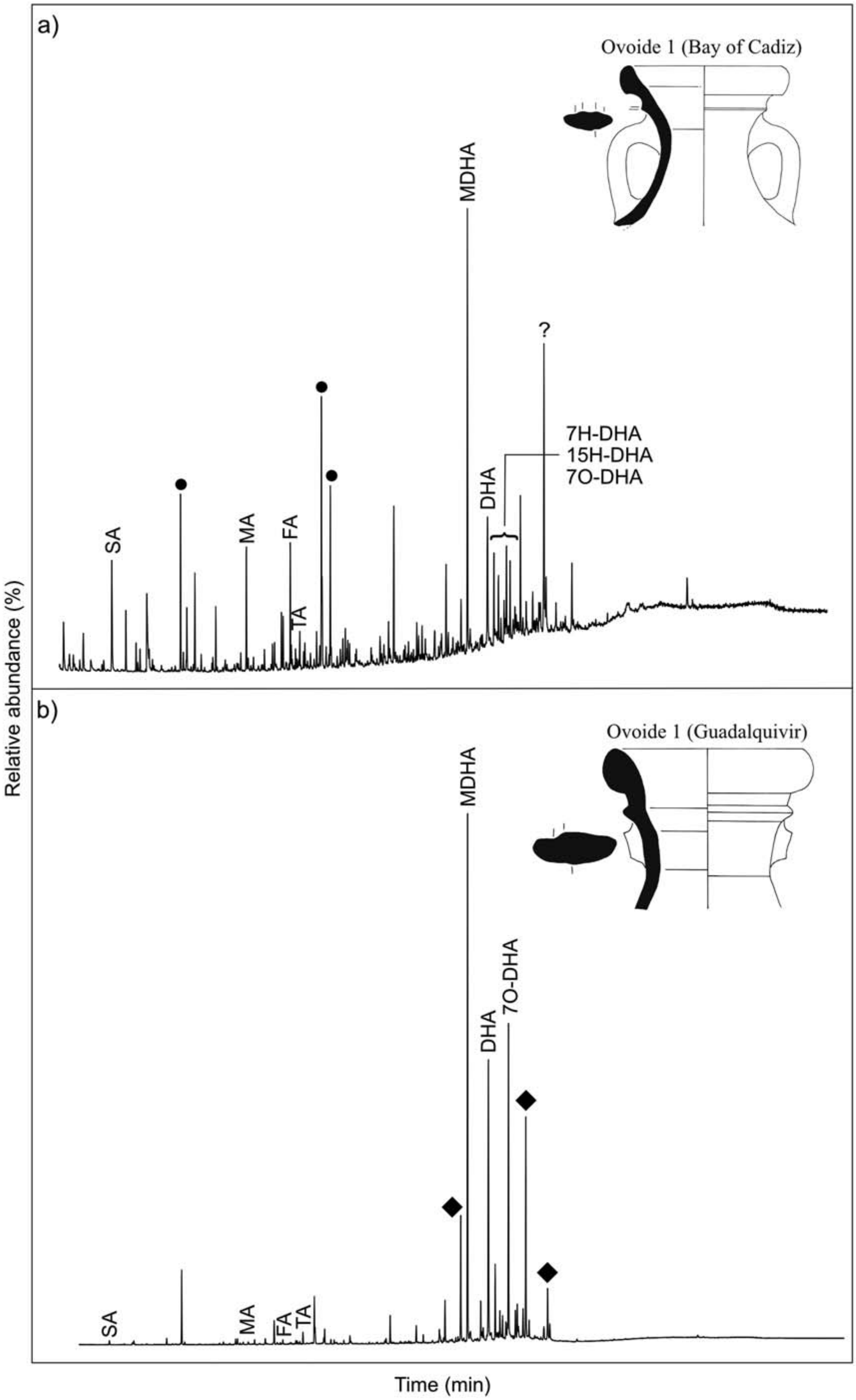

Figure 5. Partial gas chromatogram from sherds (a) OL5 and (b) OL6, both from the extraction method ii., showing succinic acid (SA), malic acid (MA), fumaric acid (FA), tartaric acid (TA), methyl-dehydroabietate acid (MDHA), dehydroabietic acid (DHA), 15-Hydroxy DHA (15H-DHA) and 7-oxo dehydroabietic acid (7O-DHA). Dots identify contamination (mainly phthalates) and rhombuses identify other resin compounds.

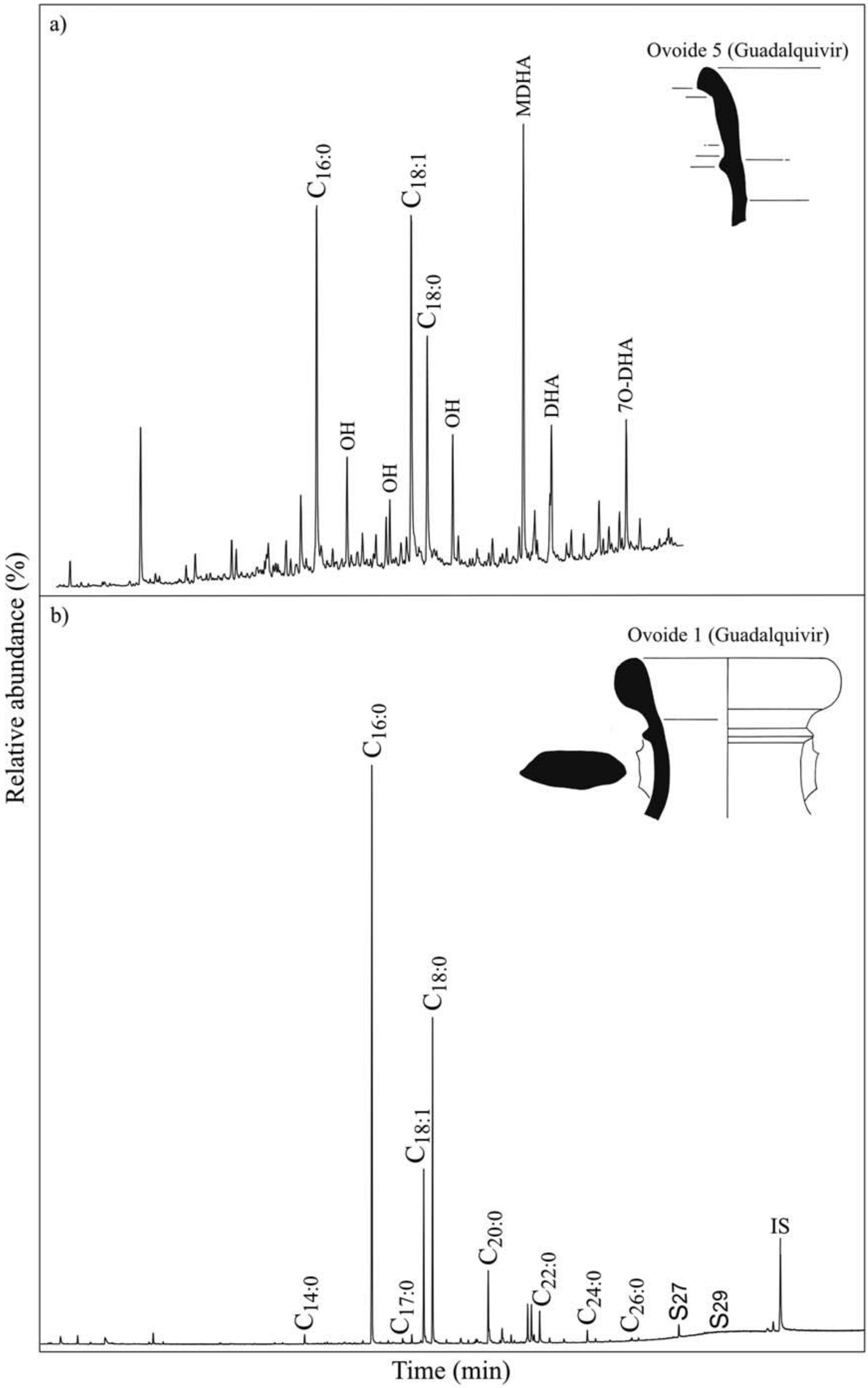

Figure 6. Partial gas chromatogram of the total lipid extract (TLE) from sherds (a) OL1 and (b) OL3 (extraction i.), showing mystiric, palmitoleic, palmitic, oleic and stearic acids ($C_{14:0}$, $C_{16:1}$, $C_{16:0}$, $C_{18:1}$ and $C_{18:0}$), ß-sitostetol (S_{29}), and cholesterol (S_{27}), dehydroabietic acid (DHA), methyldehydroabietate (MDHA), and 7-oxodehydroabietic acid (7O-DHA). A distribution of alcohols (OH) probably coming from the soil is also present in OL1.

Only one sample might have contained only plant oil products, while three amphorae might have been used to contain both grape derivatives and plant oil products. As oil and wine cannot be stored in the same vessel at the same time, the latter result suggests a re-use of the amphorae. Unfortunately, the analyses are not able to establish which were the original content and the re-use content.

The presence of possible plant oil in these ovoid amphorae is in agreement with what has been suggested previously by González Cesteros, de Almeida, and García Vargas (2016), regarding a possible oil content for ovoid amphorae of types 1 and 5. It is interesting to observe that these ovoid amphorae are closely related to the 1st century BC 'Brindisi amphora' type and forms produced in the region of Corinth (Greece) that are generally believed to have contained primarily olive oil. For instance, amphora Type 22 published by Bezeczky (2013, 91–93), equivalent to Dressel 25, is similar to Ovoid 1; and another version of amphorae produced in the region of Corinth (Greece), with a vertical rim and small ridge on the neck, no. 177 in Bezeczky (2013), is similar to Ovoid 5. However, this was not the main content of the ovoid amphorae we have analysed here.

One amphora might have been used to contain wine/derivatives and animal products at the same time (i.e. animal products in wine or vinegar) or in different moments. Finally, five amphorae did not display specific compounds ascribable to any substance that can be identified with the performed analyses. In general, although compatible with the data obtained, it is difficult to think that the amphorae were not used, as the archaeological context is a rubbish dump; therefore we can suggest that these amphorae may have contained solid products.

Conclusions

This preliminary research provided very interesting insights into the contents of ovoid amphorae produced in the Bay of Cadiz and the Guadalquivir Valley recovered in Cadiz, and confirms the importance of performing organic residues analysis of amphorae. In particular, as Bernal-Casasola, Pecci, and Sáez (2019) pointed out, studies on the contents of Roman amphorae are a critical research line in Hispano-Roman archaeology and that of the Ancient World in general. Despite decades of amphora studies since the pioneering works of Dressel (1879), the contents carried by the majority of amphorae forms remain unclear.

According to the results obtained, a few (five) amphorae could have been used to contain solid products and/or other commodities that cannot be identified, as it is unlikely that unused amphorae were discarded far from their production centres, and animal products (if cholesterol cannot be used as a marker for an animal products content) were present in just one of the analysed amphorae.

Plant oil could have been contained in a few of the analysed amphorae, and in some cases, in re-used amphorae. This product (oil and in particular olive oil) will become one of the main exports of *Baetica* in later periods (in the famous Dressel 20 amphorae) and it was possibly already produced in this period and bottled in Oberaden 83-Haltern 71 amphorae (archaic forms of Dressel 20) that are found in the same stratigraphic units at El Olivillo. However, the data obtained from these first analysed samples indicate that grape derivatives were also produced and exported from this region. In fact, the main discovery of this research it is that most of the analysed amphorae were used to contain grape derivatives, possibly wine, which finally emerges as an important product of late Republican *Hispania Ulterior/Baetica*, thanks to the organic residues analysis of these ceramic samples. Finally, the analyses have signalled the possibility that amphorae were re-used to carry different products, another important issue in the study of amphora contents (e.g. Garnier, Pecci accepted; Cau Ontiveros et al. 2018).

Acknowledgements

The study is part of the projects I+D RACAMed (HAR2017-84242-P) and GARVM III (PID2019-108948RB-I00) of the Ministry of Economy and Competitiveness of the Spanish Government, and ARQUEOSTRA of the Programa Operativo FEDER Andalucía 2014-2020. It is also part of the activities of the ERAAUB, Consolidated Group (2017 SGR 1043) of the Universitat de Barcelona, ICREA, the Universidad de Cádiz and the contract RYC 2013–13369 of A. Pecci, funded by the MINECO Spanish Ministry. Analyses were performed by the authors using the facilities of the Archaeology Laboratory and the CCiTUB Laboratory of the University of Barcelona.

Disclosure Statement

No potential conflict of interest was reported by the author (s).

Funding details

This work was supported by the Ministry of Economy and Competitiveness of the Spanish Government with the projects I+D RACAMed (HAR2017-84242-P) and GARVM III (PID2019-108948RB-I00), the contract RYC 2013–13369 and the 2014–2020 ERDF Operational Programme and by the Department of Economy, Knowledge, Business and University of the Regional Government of Andalusia. Project reference: ARQUEOSTRA, (FEDER-UCA18-104415) and ARQUEOFISH (P18-FR-1483, PAIDI 2020).

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