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Understanding residues of oil production: chemical analyses of floors in traditional mills

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ABSTRACT

Oil production is an important aspect of ancient Mediterranean economy; therefore, archaeological studies on oil-producing installations using archaeometry and in particular the chemical analysis of absorbed residues is valuable in identifying the substances actually produced and to understand the spatial distribution of the activities carried out at oil mills.

Modern contexts may provide a good reference for interpreting the archaeological chemical traces.

This study examines the chemical traces in three abandoned oil mills in the Mediterranean: Polveraia (Tuscany, Italy), Martina Franca (Puglia, Italy) and Binibassi (Mallorca, Balearic Islands). To identify the residues released by the production of oil and absorbed by the floors, samples were taken from the floors of these installations and analysed using spot tests aimed at identifying the presence of fatty acids and phosphates. Some of the samples were analysed also with gas chromatography–mass spectrometry. The results of the analyses were plotted in the Geographic Information System (GIS) platform and interpolated with Inverse Distance Weighting (IDW) to determine the spatial distribution of the residues. Overall, the results show a large presence of fats in the analysed floors in all of the installations.

1. Introduction

Oil was a vital ingredient in the lives of Mediterranean people for thousands of years. It was used for food, medicine, lighting, body care, and to make colours, among other things. Ceramic materials provide key evidence of the trade and use of oil in Antiquity, as vessels such as *amphorae* and *dolia* were used to trade and store oil, while lamps were used to burn it. Additionally, oil production installations (usually called oil mills) have been identified in the archaeological record and can be studied for the presence of oil.

Although also other oils were used, olive oil was without a doubt the most important oil used in Antiquity. Archaeological studies on the installations that were devoted to the production of oil exist (i.e., Brun, 2003, 2004; Peña Cervantes, 2010); however, it can be difficult to interpret the exact function of these installations, as wine and oil production structures are often similar (Brun, 1993). Archaeometry and in particular the chemical analysis of the organic residues left by the substances, offers a good instrument for the interpretation of the function of these installations. This method provides ways to identify the substance/substances actually produced and to understand the spatial distribution of the activities carried out in these installations (Brun, 1993, 2004; Pecci, 2007; Pecci et al., in press-b, in press-c).

Liquid or semi-liquid substances released by human activities are absorbed by the floors and can be studied to understand the activities that were performed in specific rooms and areas (Barba, 1986, 2007). Many investigations have been carried out in different parts of the World in order to identify the traces of human activities and to understand the use of space. These have involved the study of different contexts, from single rooms and buildings, to entire regions, using different samplings strategies (Wells, 2010). To do so, different analytical techniques, being the principal ones spot tests and multielemental analyses, have been applied, either to soils or to archaeological floors (most of which were plastered) (Barba, 1986, 2007; Ortiz and Barba, 1993; Ortiz et al., 1994; Linderholm and Lundberg, 1994; Middleton and Price, 1996; Middleton et al.,

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2010; Terry et al., 2004; Wells and Moreno Cortés, 2010; Wilson et al., 2005, 2009).

To ensure an accurate interpretation of the chemical traces of the activities carried out in archaeological sites and in particular of their distribution in space, it is important to consider modern contexts that prove methods, assumptions and interpretations for reading archaeological traces. Several studies have been carried out in this direction, nevertheless they focused mainly on the area corresponding to Ancient Mesoamerica (Barba and Ortiz, 1992; Barba et al., 1995; Fernández et al., 2002; López Varela et al., 2004; Middleton, 2004; Middleton and Price, 1996; Middleton et al., 2010; Pecci et al., 2011; Terry et al., 2004; Wells and Moreno Cortés, 2010), while very few studies have been carried out in the European and Mediterranean area and in the rest of the World (e. g. Knudson et al., 2004; Middleton, 2004; Pecci, 2007, 2009; Wilson et al., 2005, 2009). Moreover, most of the studies were related to domestic activities (Barba and Ortiz, 1992; Barba et al., 1995; Fernández et al., 2002; Middleton, 2004; Middleton et al., 2010; Pecci, 2009; Terry et al., 2004) although also other activities, such as the production of ceramics were explored (López Varela et al., 2004).

Here we show the results of the study of traditional oil mills in the Western Mediterranean, that provide good examples of the residues left by the production of oil combining spot tests and gas chromatography–mass spectrometry (GC–MS) analyses.

For this type of research involving archaeometric and ethno-archaeological work, the term 'ethnoarchaeometry', previously used for the study of traditional ceramic production processes (Buxeda Garrigos et al., 2003), can be applied.

For this study, three abandoned traditional oil mills were studied (Fig. 1). Two of them (Polveraia in Central Italy and Binibassi in Mallorca) are located inside buildings and are attached to private houses, while the third one (Martina Franca in Southern Italy) is located in a calcareous cave.

In the three installations, oil production involved crushing the olives in the mills, putting the olive "mash" in stacked baskets and pressing the mash in presses. The oil from the mash flowed out of the basket and was collected in the basins that were a fundamental feature of these installations. The waste of the mash, that Warnock (2007) calls "solid olive pressing waste", was usually re-used for fuel or for further extraction of lower quality oil.

The floors of the three installations were sampled and analysed to investigate the residues released by the production of oil. Furthermore, two samples from olives and oil storage areas at the agricultural firm La Casetta (Marrucheti, Tuscany, Central Italy) were also analysed. A total of one hundred fifty one samples were analysed with spot tests aimed at identifying fatty acids and phosphates. Some samples were also analysed with gas chromatography–mass spectrometry (GC–MS) to confirm that the fats that were identified with the spot tests correspond to the presence of oil.

2. Sites and materials

2.1. Polveraia (Scansano, Grosseto, Tuscany, Italy)

The first oil mill, located at Polveraia (Scansano, Grosseto) (Fig. 1), was used until 1963 and is characterised by the presence of a mill, two presses with two basins, and an area where the olives were stored before the milling (Fig. 2).

While presenting some 'modern' elements, such as the pumps used for the presses, the installation preserves the traditional characters of oil production. The mill (Fig. 3) has a metal exterior and twin millstones that are made of stone, as they used to be in ancient times. In the installation, there are two presses, which are connected to two basins where oil was kept to decant. Olives were stored to the left of the entrance before they were milled. Small walls, approximately 1.50 cm high, separate all activity areas. To the back of the structure there are different containers for the storage of oil: two large internally glazed ceramic vessels

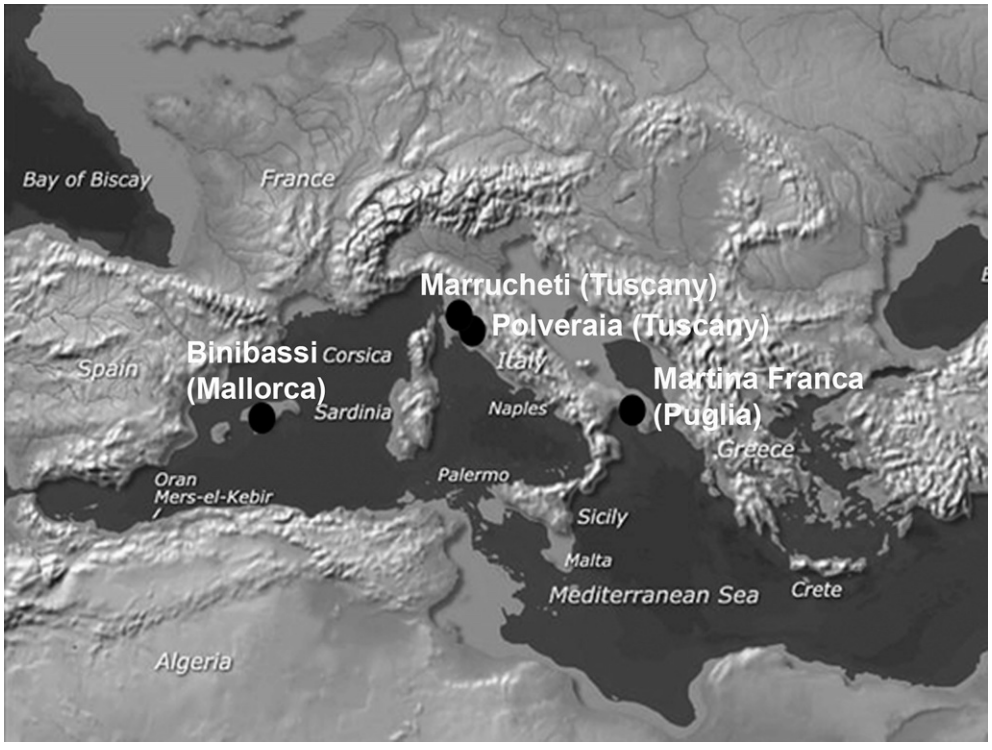

Fig. 1. Location of the installation analysed.