Journal of Archaeological Science 96 (2018) 124–130

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: www.elsevier.com/locate/jas

Direct evidence from lipid residue analysis for the routine consumption of millet in Early Medieval Italy

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ARTICLE INFO

Keywords:
Millet
Miliacin
Organic residue analysis
Lipids
Ceramic
Cooking wares
Pottery
Early medieval

ABSTRACT

Millets have been cultivated in Europe since the Late Neolithic but, beyond recording their presence, little is known about their use and context of consumption. As a C_4 plant, the contribution of millet on diet can be readily identified through stable isotope analysis of human bones. Using this approach, however, previous studies have been unable to distinguish direct consumption of the cereal from the consumption of millet fed animals. Historical evidence suggests that the latter was common practice. To address this issue, we present the first direct evidence for millet consumption in Medieval period using organic residue analysis. Lipid were extracted from 45 pottery vessels from the Episcopal centre in Padua, Northern Italy dating from the 6th to 10th centuries AD. Miliacin, a biomarker for broomcorn millet, was present in many of the cooking vessels tested. Based on the co-occurrence of miliacin with other food derived lipids and the vessel typologies, we suggest that millet was a common culinary ingredient during the Early Medieval period in this region. The earliest evidence dates to the 6th c. AD and notably derives from deposits associated with high status occupation of the site, a surprising result given the common association of these crops as low-status or starvation foods in the historic periods. It is likely that millet was a common cereal staple in human diet during this period in North-eastern Italy and that its use was far less restricted than previously thought. More broadly, our study highlights the efficacy of combining organic residue analysis and stable isotope analysis of bone to relate culinary and dietary information of ancient populations.

1. Introduction

The cultivation of millet in Europe has a long history but its significance in ancient economies is far from clear. In Northern Italy, the botanical evidence for the appearance of millets (Broomcorn millet, *Panicum miliaceum* and Foxtail millet, *Setaria italica*) from the Late Neolithic period is debated, however there is clear evidence for widespread cultivation during the Bronze and Iron Ages (Castiglioni and Rottoli, 2013; Motuzaite-Matuzeviciute et al., 2013). Millet has also been identified chemically in alpine sediments dating to the Bronze Age (Jacob et al., 2008). Millet is a C_4 plant and its contribution to human diet can also be assessed through stable isotope analysis of human bone collagen since it is relatively enriched in ^{13}C compared to C_3 cereal crops such as wheat, barley and oats. Stable isotope evidence broadly supports the botanical evidence, although the evidence is sporadic with only a few studies indicating that millets made a major contribution to prehistoric European human diets (e.g. Lightfoot et al., 2013; Lightfoot et al., 2015; Knipper et al., 2016; Goude et al., 2017), including humans from Bronze Age Northern Italy (Tafuri et al., 2009; Laffranchi et al., 2016). However, it is unclear from this evidence whether millet was directly consumed or became indirectly incorporated into the human tissues through the consumption of the meat and milk of millet-foddered animals.

In the Roman period, there is little evidence that millet was any more than a minor crop. Most historical accounts suggest that apart from animal feed it was deemed suitable only for the poor, although socio-cultural influences would have played a part in their use in the diet (Spurr, 1983; Murphy, 2016). Archaeobotanical evidence attests to the presence of millet on Roman sites, usually in small proportions in comparison to other major cereal crops (Murphy, 2016) and C_4 signals rarely register in the stable isotope values of humans from this period. Only one individual buried in periurban Rome has clearly enriched carbon stable isotopes values indicative of C_4 plant (millet) consumption (Killgrove and Tykot, 2013). However, stable isotope investigations are still quite limited for the Roman period in general and there have been no dietary isotopic studies of Roman and Late Antique diet in

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https://doi.org/10.1016/j.jas.2018.06.007
Received 7 September 2017; Received in revised form 13 June 2018; Accepted 17 June 2018

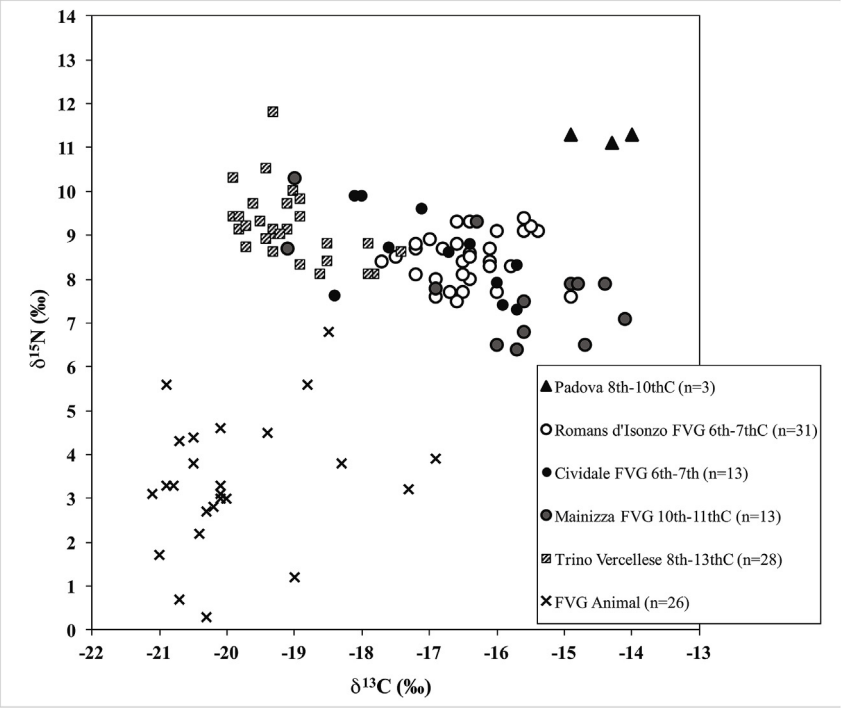

Fig. 1. Stable carbon and nitrogen isotope data from fauna and adult humans from Northern Italy (6th - 13th centuries) deriving from published sources.

Northern Italy. A recent survey of the botanical evidence has shown that millets as well as another C_4 crop, sorghum, made a resurgence in the Early Medieval period of Northern Italy as part of a mixed agrarian economy (Castiglioni and Rottoli, 2013; Rottoli, 2014). However, written accounts consider millets and sorghums to be a minor crop, inferior to the major grains, such as spelt that were important in the Roman period. The term "*grano minuto*" is commonly used in historical texts to describe millet (Montanari, 1979), although it is not clear whether this refers to its short growing season, sowed in spring and harvested in August, or its low status as a food for the poor. In areas of Northern Spain, unlike wheat and barley, millets were tax exempt in the Medieval period and so peasants did not need to use part of the harvest to pay rents (Zapata and Ruiz-Alonso, 2013), thus reinforcing the idea that it was grown and consumed by the poor.

The current stable isotope evidence shows widespread consumption of C_4 foodstuffs during the Early Medieval period of North East Italy (Fig. 1): Padova (Marinato, 2017), Friuli-Venezia Giulia (FVG: Romans d'Isonzo, Cividale and Mainizza, Iacumin et al., 2014) and Trino Vercellese (Reitsema and Vercellotti, 2012). Given the absence of any C_4 wild plants in this area, the observed high $\delta^{13}C$ are most easily explained by consumption of millet and/or sorghum directly or through animals foddering on millet. Limited analysis of animal bones, many unidentified, is consistent with the use of millet or sorghum as a fodder, as shown by collagen $\delta^{13}C$ values above ca. −18‰ (Fig. 1; Iacumin et al., 2014).

Overall, whilst changes in the production of millets have been well documented there is little evidence regarding their use or the social context of their consumption. Recently, a chemical marker for broomcorn millet (miliacin) has been identified in European and East Asian Bronze Age pottery (Heron et al., 2016), providing compelling evidence of its direct consumption at this time. Miliacin (olean-18-en-3β-ol methyl ether) is a pentacyclic triterpene methyl ether (PTME) that is enriched in seeds of *Panicum miliaceum* miliaceum (Bossard et al., 2013). It is readily absorbed in the walls of pottery during cooking and is highly resistant to degradation. This approach allows the crop itself to be directly linked with material culture, i.e. ceramic containers, to potentially understand the mode of use, through association with vessels associated with cooking, storage, serving or even drinking, the context of vessel deposition and the other types of foods millet was combined with. The association of millet with pottery vessels therefore opens up a new opportunity to examine the role of millet in Early Medieval society; both its culinary role and its association with contexts attributable to different sectors of society.

Here, we examine organic residues associated with an assemblage of ceramics dating from Late Antique and Early Medieval Age (6th - 10th century) at the episcopal centre of Padova (Brogiolo et al., 2017). The site offers an opportunity to study the economic changes in the city over this period and particularly with Lombard occupation in the 7th century. The presence of a large number of jars (olla) throughout the sequence provides an ideal target for comparative residue analysis, especially as the forms show minor variation throughout the sequence. The jars are wide bellied and unglazed, and were clearly used for cooking as shown by a boiling line on the interior and sooting on the external surfaces.

2. The site and its setting

Excavations of the episcopal centre of Padova between 2011 and 2012 revealed a rich archaeological sequence dating from Late Antiquity to the Modern Period (Fig. 2). The first structure detected is Building 1 (Phase 1), dated to before the 4th century, however this remains unexcavated. Amoung the next series of structures (Phase 2) was a high status building (Building 2) with mosaic floors which was AMS dated by its rudus mortar to the second half of the 4th century (Addis et al., 2017). At the beginning of 7th c. (Phase 3) the building was destroyed by fire, as shown by burning on the mosaic floors and the presence of large pieces of charred wood. This event was most likely perpetrated by the Lombards who occupied the city from 602 AD (Brogiolo et al., 2017). The pottery from the destruction layers (layer 222, inside the building, and 340–344, outside the building) includes many domestic cooking vessels but also amphora and red slipwares from different Mediterranean regions. In the destruction layers, a huge quantity of architectonic material, roof elements and a number of marble fragments were recovered that can be linked to liturgical