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Comparison of dry ashing and wet oxidation methods for recovering articulated husk phytoliths of foxtail millet and common millet from archaeological soil

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ABSTRACT

Phytolith research on foxtail and common millets represent one of the keys to explore early agricultural activities in the Yellow River basin in China. However, the phytoliths of these two millets easily disintegrate during burial and the extraction process. In this paper, both dry ashing and wet oxidation methods were applied to determine the effects on phytolith extraction from archaeological soil samples. The results indicated that the dry ashing method had two significant advantages over wet oxidation: (1) the morphology of husk phytoliths was retained to a greater extent; and (2) nearly all the charcoalified tissues were removed successfully. The dry ashing method proved to be a better method for phytolith extraction of both foxtail millet as well as common millet from archaeological samples.

1. Introduction

To date, foxtail millet (*Setaria italica*) and common millet (*Panicum miliaceum*) are regarded as staple foods in Northern China during the Neolithic period, and were initially domesticated in the Yellow River valley of China (Zhao, 2005; Crawford et al., 2006; Hunt et al., 2008; Barton et al., 2009). Foxtail millet and common millet can be identified by their morphological characters, which rely on exceptional conditions of burial at archaeological sites. Unlike organic plant remains, phytoliths are abundant at most archaeological sites, and are chosen as the preferred method when the macroremains are not well preserved (Crawford, 2005; Harvey and Fuller, 2005). The husk phytoliths of millets are easily preserved and display unique anatomical characters, five of which were selected to distinguish between foxtail millet and common millet (Lu et al., 2009). Recently, there has also been a report about prominent diagnostic differences in the phytoliths of foxtail millet (*S. italica*) and green foxtail (*Setaria viridis*) (Zhang et al., 2011). In all studies, large phytoliths with undulate extremities tend to be fragmented after long burial and during complicated extraction processes. It is clear that if the structures of the husk phytoliths of millets from the soil of archaeological sites can be retained intact, the identification of both millets will take less time and be more secure.

At present, there are two basic methods for extracting phytoliths from modern plants, viz. dry ashing and wet oxidation. It has been suggested that both these methods may modify the resulting samples in different ways (Rovner, 1983; Parr et al., 2001; Emma, 2009; Wu et al., 2012). For most archaeological soil samples, in order to remove sand, clays, carbonates, etc., the procedures involve sieving, wet oxidation and then heavy liquid extraction. The method varies according to the preference of the analyst, although the full impact of these procedures on the resulting phytolith assemblage remains unknown (Emma, 2009). Studies on the comparison of different methods have been focused on plant domestication in West Asia by using modern samples. However, the difference between phytoliths of foxtail millet and common millet extracted from archaeological soil samples, has rarely been studied. These samples tend to contain abundant charcoal, especially from

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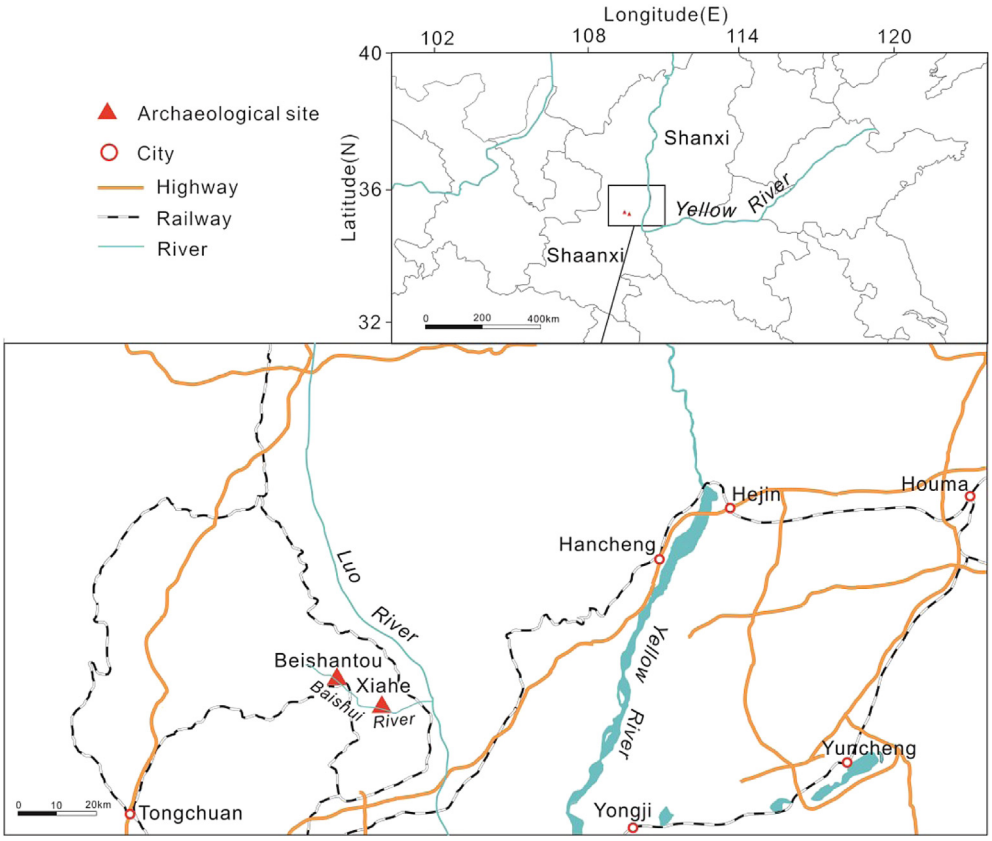

Fig. 1. Map showing the sites referred to in the paper.

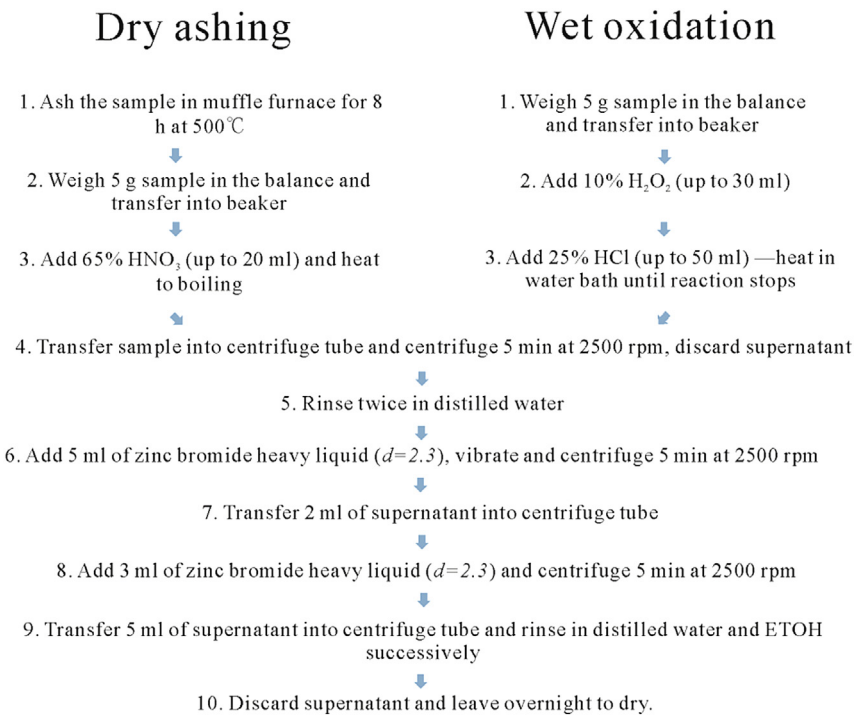

Fig. 2. Description of dry ashing and wet oxidation method.