

RESEARCH ARTICLE

The Archaeology of Neolithic Cooking Traditions: Archaeobotanical Approaches to Baking, Boiling and Fermenting

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The Neolithic was not only a shift in how food was obtained, through farming, but it also set up long-lasting traditions in how foods were prepared and cooked. Archaeologists have increasingly recognized regionally distinctive emphases on cereal preparations, such as baked breads or boiled porridges that characterize different Neolithic traditions. While these can be inferred through features, such as ovens on archaeological sites, it has become possible to recognize the charred crumbs of past breads, batters or porridges from typical charred archaeobotanical assemblages. We illustrate recent developments in micro-structural analysis of such remains, including wheat breads from Neolithic and pre-Neolithic western Asia, and sorghum breads and porridges from Early Historic (Meroitic) Sudan. The study of such archaeobotanical remains has great potential to help map the distribution of cereal cooking practices in time and space.

Introduction

Food, as a biological necessity, has long been associated with the structuring of social identities and long-term cultural traditions. Cooking can be said to make us human (e.g. Wrangham 2009; Wright 2004), but can also be seen to vary in systematic ways that help defining cultural differences, much as languages do (see, e.g. Hsu, Huber and Weckerle 2017; McCann 2009). As with many other aspects of social life the Neolithic can be regarded as a watershed period in terms of transforming cooking and establishing long-lasting regional patterns in culinary culture. Cooking can be considered as a key

component of alternative regionally distinctive *Neolithicities*. For nearly a century, archaeologists have recognized the Neolithic was a key transition in the material lives of human societies and in their impact on the world around them (Peake and Fleure 1927). Gordon Childe's (1936) thinking set out a definition of the Neolithic that has been a focal point for much archaeological research for decades, defining the Neolithic in terms of a set of linked technological and subsistence innovations: food production, sedentism, ceramics and other creative technologies like textiles. Childe later referred to this as a “new aggressive attitude to the environment... producing new food supplies... [and] new substances that do not occur ready-made in nature” (Childe 1958: 49). More recently, authors have noted that the Neolithic was a turning point in terms of the production and

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the increase in material culture, more symbolic artefacts (Renfrew 1998), and simply more artefacts of all kinds, and more entanglement of all human activities with a growing range of things (Hodder 2012, 2018). Thus there must have been parallel Neolithic transitions, towards more materiality, more sedentism and food production that took place in different world regions, and by this logic we can consider distinctive regional manifestations of *Neolithicity*. Thus we recognize a pre-pottery Neolithic in western Asia, while pottery was trait of the Mesolithic in parts of Africa, and the late Palaeolithic of eastern Asia (e.g. Gibbs and Jordan 2016; Gibbs et al. 2016). Pottery and its uses, however, were central to the diversifying material repertoire of Holocene China alongside the domestication of plants and pigs. Thus ceramic technology and its uses were essential to the Neolithic cultural patterns in China, to an extent that was not true of the early Neolithic (Pre-Pottery) societies of western Asia. This suggests that we need to define a series of regional distinctive *Neolithicies* in terms of how they created an increased range of cultural constituents (artefacts, domesticates), and how these things were connected to particular practices of sustaining families and communities. The way people consumed foods, cooked into cultural products rather than raw, represents substances that were not readymade in nature, and relies on alternative techniques of food processing and cooking. The use and sequence of techniques such as pulverizing, soaking, boiling, roasting, fermenting, mixing etc. transform raw food stuffs, making them potentially more edible, more nutritious, more storable, but also affecting their sensual characters, their taste and thus their potential for cultural construction (Wollstonecroft 2011).

In recent years, a number of authors have recognized the importance of new cooking methods in the Neolithic and contrasts in cuisine between different regional Neolithics. Hayden, Nixon-Darcus and Ansell (2016), for example, have considered bread as a new luxury food stuff, a “prestige technology” (sensu

Hayden 1998), of the emergent Neolithic in the Near East. Indeed the utility of certain cereal species, which contain a high concentration of gluten such as wheat and barley, for making breads has been suggested to be among the reasons why these taxa rose in prominence and came to be cultivated (Fuller and Rowlands 2011; Lyons and D’Andrea 2003). In this line current data does indicate that cereals were not the all-important caloric staples in the West Asia Pre-Pottery Neolithic as they would become in later periods (Maeda et al. 2016). Haaland (2007) has contrasted the aceramic bread making traditions of the Neolithic Levant with a porridge and beer tradition that she argued characterized the pottery making, and sorghum-focused Neolithic of northern Sudan. Similar to the contrast between the ceramic Neolithic of Africa and the aceramic, quernstone Neolithic of the Near East was a contrast between eastern and western Eurasia, that has been characterized as a distinction between a grinding and roasting cultural ecological niche and a steaming and boiling niche in the East (Fuller and Rowlands 2011). This difference in the predominance of cooking methods and the resulting food was argued to relate to differing ritual traditions and perceptions of the supernatural over the long term. Boiling and steaming of cohesive foods has been considered to be entangled with sharing amongst kin and ancestors contained within the house in the east (also, Hsu, Huber and Weckerle 2017), while the smoke of dry roasts fed distant gods for the bread-sharing communities of the west. Thus difference in cuisine, linked to differences in the material cultural of food processing and cooking, may help to structure long-lasting patterns in cultural traditions of sociality, kinship and religion that have persisted from the Neolithic through to more recent times. While this may operate at a broad level of macro-geography, it may also play a key role at a more regional level by providing the kinds of contrasts that help in constructing cultural identities. In the fourth millennium BC in Southwest Asia, for example, there is

an apparent contrast between immigrant Kura-Araxes (Trans-Caucasian) cultural tradition, with portable stoves and closed cooking/stewing vessels, and established Mesopotamian tradition of open vessels linked to consumption of breads and roasted meats (Wengrow 2014: 39; Wilkinson 2014).

Nevertheless, these patterns and contrasts, however compelling, have been based largely on generalizations from artefact assemblages, and in the present paper we outline the potential of microstructural analysis to documenting the empirical evidence of past cooking preserved in archaeobotanical samples. We consider this an emerging subfield of archaeobotany that documents empirically prepared food products, and not just the species people ate and farmed. We illustrate this in particular with examples for the divergent traditions of bread making in Western Asia, and porridges in Nubia. Thus a world archaeology of *Neolithicit*ies and their established core traditions of culinary culture offer an exciting new comparative archaeology and focus for archaeological science.

Evidence for a bread-centred Neolithicity

For most people in Europe and the Middle East, bread is central to life. Breads in various forms are daily staples and they play a central role in world religions that emerged in the Middle East (Rubel 2011). This can be suggested to derive from a long cultural tradition stretching back to the Neolithic or even before, as explored by Haaland (2007) in contrast to Nubian and sub-Saharan porridge and beer cuisine. Baked breads, along with roasted meats, can be regarded as vital to both the cooked cuisines and the ritual use of food in early urban civilisation in both Egypt and Mesopotamia emerging from earlier food practices from a pre-ceramic world of cooking and early cultivation (Fuller and Rowlands 2011). A more nuanced understanding of the emergence of bread and its social role, however, is possible through the systematic study of the preserved remains of cooked foodstuffs themselves, which in turn

can be considered alongside other lines of evidence such as constructed bread making fire installations, i.e. ovens or hearths, and flour-making tools such as querns.

Small charred fragments of prepared foods are surprisingly common but under-studied (**Figure 1A**). Routine flotation for the recovery of plant remains often recovers small quantities of “amorphous charred objects” (Heiss 2013: 346), which are more often than not set aside by archaeobotanists as indeterminate fragments, perhaps alongside potential parenchyma tissues from charred tubers. Such remains, however have great potential for study, as recognized in pioneering work by Hansson and Isaksson (1994); the increasing recognition of such remains in European archaeobotany was reviewed by Heiss (2015) and Popova (2016), but probably represents an under estimate as remains are likely more often found than actually reported. For example, archaeobotanical research at Neolithic Çatalhöyük in Central Anatolia has recovered charred amorphous food fragments in at least ~80% of flotation samples (based on a study of a subset of about 200 samples by LGC), while much poorer (less seed and charcoal dense) samples from Neolithic Jarmo in Iraqi Kurdistan (from UCL excavations in 2014) still produced remains in >50% of samples. This high ubiquity, however, masks the methodological challenge of identifying what these remains mean. Work on whole bread loaves from ancient Egypt (e.g. Samuel 2000), or “galettes” from pre-historic European contexts laid key groundwork (e.g. Hansson 2002; Heiss 2013; Heiss et al. 2015, 2017), while work on the effects of charring on fragmented cereal grains from food such as *bulgur* have also been formative (e.g. Heiss 2013; Heiss et al. 2017; Valamoti 2011). Recent methodological developments involve studying these remains with a scanning electron microscope (SEM) and characterizing them based on the included plant particles, often identifiable by cell forms in surviving tissue fragments, and by characterising porosity size and form and distribution alongside plant particle size, form and

distribution (Heiss et al. 2015; Heiss et al. 2017; Gonzalez Carretero et al. 2017). Just as ceramicists characterize pastes by porosity type and inclusion size and density, Gonzalez Carretero et al. (2017) proposed the use of percentage inclusion charts for a systematic semi-quantitative approach to characterizing these food remains. On this basis both experimental and archaeological remains were determined as deriving from breads (unleavened flat breads: **Figure 1B**), doughs, i.e. charred before baking (**Figure 1C**), or porridges (**Figure 1E–F**), and all of these three foodstuffs occurred at Neolithic Çatalhöyük, although the dominance of breads throughout the classic occupation of site, known for its household ovens (Cutting 2006; Farid

2011), was apparent. Although dominated by cereals (**Figure 1D**), some remains included starchy sedge tubers, coarsely ground pulses (like lentil and bitter vetch) and small wild mustard seeds (Gonzalez Carretero et al. 2017). The consistently small size of cereal fragments (wheat and barley) noticed in these remains from the beginning of the sequence at the site indicates the use of fine flours which means that cereals must have been both heavily ground and sieved. This contrasts with the coarse cereal remains used in the porridges during the late Neolithic period at the site.

The study of charred food fragments by these methods has made it possible to push back the beginnings of bread making to

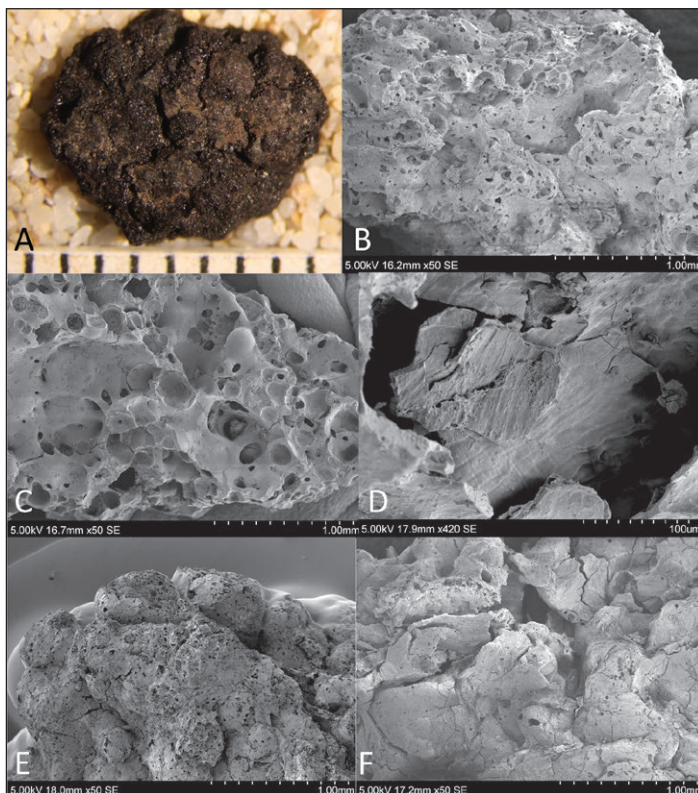


Figure 1: Example of archaeological charred food remains, and their microstructure under the SEM, all examples from Neolithic Çatalhöyük, Turkey (7100–5950 cal. BC). **A.** Charred “amorphous object”, determined as flat bread. **B.** SEM of bread-type matrix. **C.** SEM of dough- type matrix. **D.** Close-up of wheat bran from within a bread matrix. **E.** Porridge type matrix. **F.** Close-up of porridge matrix. (Photos by LGC).

prior to agriculture and cereal domestication. In a collaboration with colleagues from University of Copenhagen, we have analysed food remains from the hearths of the Epipalaeolithic site of Shubayqa 1 in Jordan, dating back to 12,300 BC (Arranz-Otaegui et al. 2018). SEM analysis of 49 charred food remains carried out at UCL found 24 were bread-like in constituents. This included fine flours, presumably sieved, from cereals, including a single-celled thick aleurone layer (the layer underneath cereal bran) which is consistent with that from wild einkorn wheat (*Triticum boeoticum/urartu*), which was found among the grain remains from the same samples. Among the most common plant macroremains were charred tuber fragments from a sedge, *Bolbolschoenus glaucus*, and fragments of tissue of this sedge were also found to be part of the bread alongside fine cereal flour (Arranz-Otaegui et al. 2018; on the edibility of this sedge, see also Wollstonecroft et al. 2008). This find indicates that flat breads were prepared before cereals were domesticated, and that they were one among many wild gathered plant foods. This supports the suggestion that finds of rock-cut mortars of similar age in Southern Levant would have functioned to make fine flour for wild cereal breads (Eitam et al. 2015). Its social significance derives from the fact that, the making of bread before agriculture, implies extra effort into the production of bread with wild plant resources, possibly as a special food, a product that was about more than mere calories. As noted by Heiss (2015: 71), “bread is one of the most time-consuming and elaborate cereal products,” requiring major labour inputs, and potentially investment in feature construction, such as ovens. There are easier means to prepare cereals, and this production of new labour-intensive foods, using labour-invested tools like querns and lined hearths may have been part of new formalized feasting regimes that aided social cohesion as groups became less mobile (Wright 2004). In due course, the interest in bread might have motivated the desire for certain grasses that

came to be cultivated and ultimately became the first domesticated cereals.

The importance of bread is indicated some millennia later by the development of ovens, clay-built structures for trapping dry heat, which began to be made even before ceramic cooking pots in western Asia (**Figure 2**). Evidence of domed ovens (called *tabun* or *firin*) can be found in the archaeological record from the end of the Middle Pre-Pottery Neolithic B (ca. 7500 cal. BC) as recovered from sites like Cafer Höyük (southeast Turkey), Abu Hureyra (Syria), Tell Bouqras (Syria), Jarmo (Iraqi Kurdistan) (e.g. Akkermans and Schwartz 2003; Cauvin 1989; Moore et al. 2000), and Çatalhöyük, from its earliest levels from ca. 7100 BC (Fig. 2a). Ovens appear in at least some Southern Levant sites by the 7th Millennium BC (e.g. Wright 2004). A later, more specialized bread-baking oven type is the *tannur*, a tall cylindrical oven (**Figure 2B, C**), which is first known from the site of Tepecik Çiftlik in Central Anatolia dated to ca. 6400 BC (Akkermans and Schwartz 2003; Moore et al. 2000; Tkáčová 2015). In both types of ovens flat breads can be baked by being stuck to the clay walls (**Figure 2b**). Domed (*firin*) ovens appear to have been quite integral to many households in these sites. Houses at Çatalhöyük typically have an oven throughout most of their lifespan, a presumed element of day to day cooking activities (Farid 2011; Hodder 2006). As agriculture spread from the Near East into Europe domed ovens spread too as typical components of many houses on Neolithic tell sites in Greece, Macedonia and in the Balkans (e.g. Marinova 2007; Naumov et al. 2009; Renfrew 1971). Ovens were standard household components of the Tripolye culture of the western Ukraine region that produced massive towns of long houses in the 4th millennium BC (e.g. Rassamakin and Menotti 2011). Further spread of ovens to the west of the European continent may be a late adoption associated with eastern Mediterranean influences, as highlighted by their Iron Age

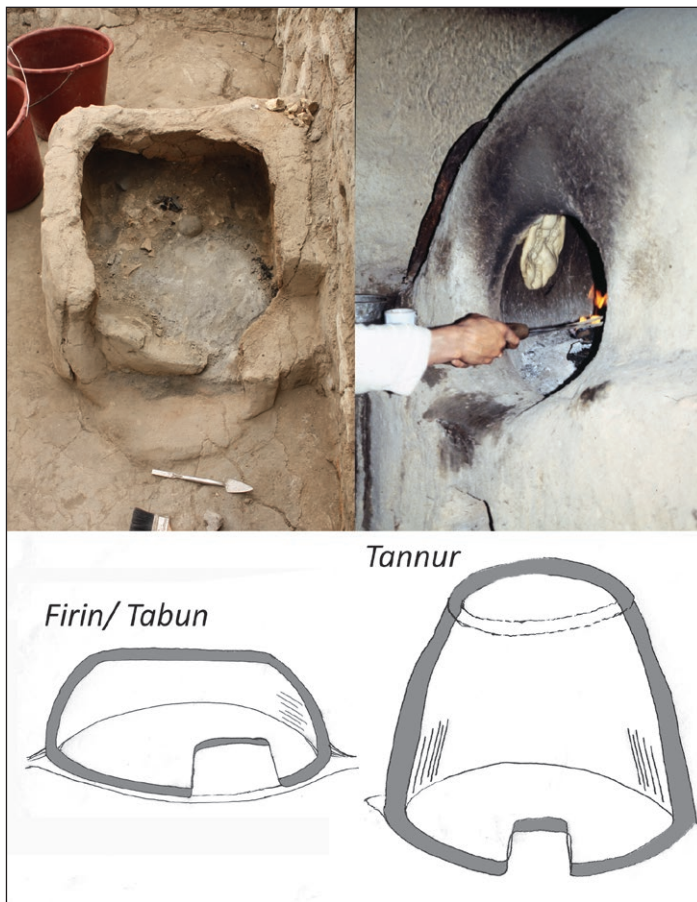


Figure 2: Examples of bread oven types. A. *Firin*-type oven from Neolithic Çatalhöyük, Turkey (Photos by DQF, 2015). B. A modern *tannur* type oven with *naan* bread baking, in Swabi, Pakistan (Photo by DQF, 1997). C. Sketches of general *firin* and *tannur* oven types.

appearance in Portugal and Spain (Delgado and Ferrer 2007; Vaz et al. 2017). As part of the eastward spread of Neolithic agriculture, ovens were also part of the typical household inventory, as seen from sites such as Jeitun in Turkmenistan (Harris 1997), Mundigak in Afghanistan (Casal 1961), or Mehrgarh in Pakistani Baluchistan (Possehl 1999: 453). A first effort to map the spread of early ovens associated with the earlier Neolithic is shown in **Figure 3**. What is striking is the apparent limits of the oven culture, and by inference, bread making traditions in central Europe, around the Indus valley, and near the transition from Egypt to Nubia.

The prominence of a bread-making tradition indicated for Neolithic West Asia and

Southeast Europe, as implied by the presence of ovens, can be contrasted with non-bread cuisine in northwest Europe, as suggested by the analyses of Neolithic food remains from the Netherlands and Britain. Work on charred food crusts preserved inside Late Neolithic ceramic vessels in the Netherlands was undertaken by Kubiak-Martens, Brinkkemper and Oudemans (2015), which represented the remains of porridge or stew-like compositions combining cereals with wild foods like acorns or sedges tubers, as well as fish (identified from scale remains) and chemically detected lipids of animal origin. Charred food remains from Neolithic Yarnnton, despite press coverage suggesting it was “bread” (e.g. Whitehouse 1999), appear

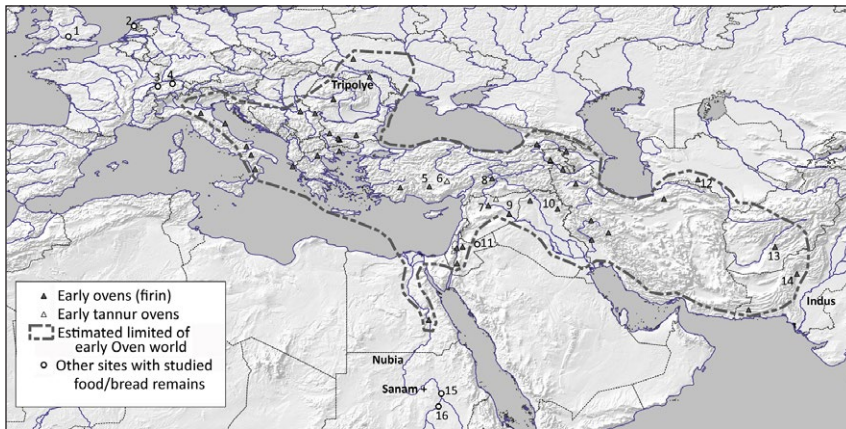


Figure 3: Map illustrating the early spread of ovens (mainly of *firin* type), and additional sites mentioned in the text. Selected sites numbered: 1. Yarnnton, 2. Keinsmerburg, Mienaker, Zeewijk (Neolithic Netherlands), 3. Twann; 4. Zurich; 5. Çatalhöyük; 6. Tepecik Çiftlik; 7. Abu Hureyra; 8. Cafer Höyük; 9. Tell Bouqras; 10. Jarmo; 11. Shubayqa; 12. Jeitun; 13. Mundigak; 14. Mehrgarh; 15. Dangeil; 16. Hamadab. (Image by DQF).

to be coarsely crushed barley, and not bread-like in consistency (Robinson 2000: 89). This is in keeping with interpretations based on the rather limited quern stone assemblages in Britain that argue against a major roll of bread or flour-based foods (Peacock 2013: 19). Nevertheless, at some later stage the bread-baking tradition must have reached western Europe, as recent studies on bread loaves from Switzerland suggest a possible leavened bread was reported from Twann at Lake Biel, Switzerland (Heiss 2015) while two flat breads have been published from late Neolithic Zurich (ca. 3160 BC) (Heiss et al. 2017). The current picture is incomplete but highlights the need to increase the study of cooked cereal remains across Europe to assess when and how the transition to bread-baking took place.

Boiling Neolitics: an example from Nubia

As already noted, early ovens are known from upper Egypt, but seem to be associated primarily with later Egyptian fortresses and influences further south in Nubia. Box ovens were constructed to bake bread in ceramic moulds, following the Egyptian tradition (Maillot 2016), while cylindrical *tannurs* are known from New Kingdom towns

founded by Egyptians in Nubia, such as at Amara West (Spencer, Stevens and Binder 2014). Nevertheless, as attested by different authors, indigenous Sudanese cooking traditions were rather different. Haaland (2007) identified a pot-based culinary culture, focused on the preparation of different types of porridge and beer. This also appears in ancient sources, as reviewed by Pope (2013), who finds that Late Egyptian Demotic texts refer to Nubians as “eaters of *iwesh*”, and he identified *iwesh* as referring to gummy or sticky foods. As revealed in a temple inscription of Sanam in Sudan (from 690–664 BC) *iwesh* foods were brought as temple offerings in what are depicted as necked globular jars, with grapes, dates and bread loaves as distinct categories of offerings. The importance of “sticky” foods, which probably means porridge-like products, had also been revealed through the excavation of ceramics from the site of Dangeil in Sudan, where ceramic “bread moulds” at an Amun temple were found to contain remnants of a sorghum porridge that had been formed to take on a conical loaf shape (Anderson et al. 2007).

As part of archaeobotanical work on flotation samples from the Meroitic town of Hamadab, being carried out in collaboration with the German Archaeological Institute,

we have been studying a total of 60 archaeobotanical samples dating to the Meroitic period, between the 2nd century BC and the 3rd century AD. The most common cereal in these samples was Sorghum, a native crop of the central Sudan (Fuller and Stevens 2018), alongside evidence for other millets (*Pennisetum glaucum*, *Setaria* sp.), cotton and only a small amount of wheat and barley. But many of these flotation samples were also very rich in amorphous charred objects, i.e. food remains. A total of 31 flotation samples (51.56%) contained remains of cooked foods, including many samples from an archaeological structure categorised as a “kitchen” area. Initial results on the study of these materials found only a very few bread-like remains, containing probable fine sorghum and wheat flours (Figure 4C). In contrast, much more common were the remains of sorghum porridges, which present a highly lumpy matrix with large particles comprised in their totality of cracked sorghum grains,

large cracks and channel voids (Figure 4A, B, D). Thus, the inferences of a sorghum porridge tradition associated with the central Sudan from the Neolithic through the Meroitic era (Edwards 2003; Haaland 2007) can now be illustrated by empirical archaeobotanical evidence. Previously, Edwards (2003) suggested that Christianization of Nubia (from the 6th c AD) may have increased the importance of bread in the Nubian diet. The archaeobotanical methods outlined here provide a means to empirically test this idea. As more archaeobotanical assemblages are sorted for their food remains, it will become increasingly possible to map the forms of cereal meals and how these correlate to past cultural areas and transitions.

Towards an archaeological science of food traditions

Archaeobotany is a fundamental component of archaeological field research, and the growth of datasets around the world

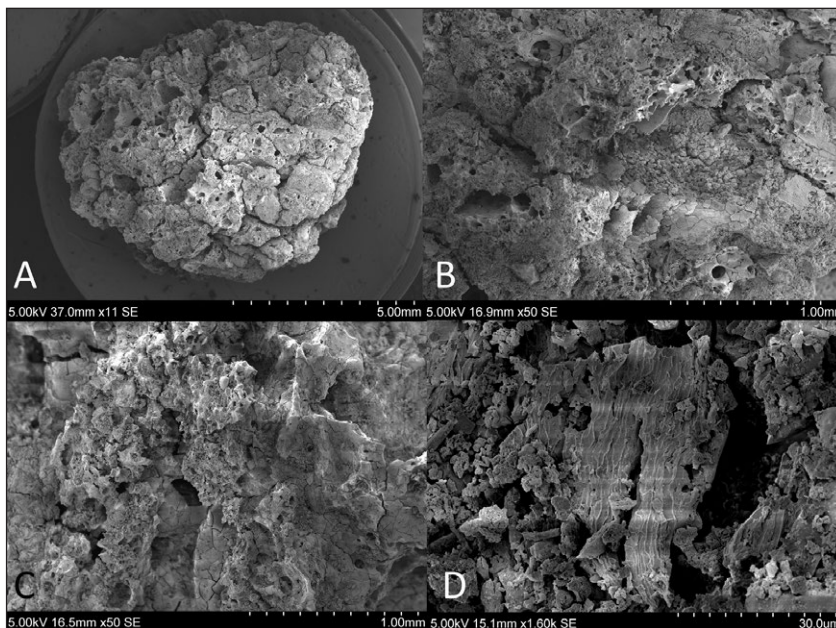


Figure 4: Examples of archaeological charred food remains from Meroitic Hamadab, Sudan (200 BC–AD300). **A.** Charred fragment of sorghum porridge. **B.** Close-up of structure in sorghum porridge. **C.** Example of bread-like fragment. **D.** Fragment of sorghum-type bran from within a porridge matrix. (Photos by LGC).

provides a basis for tracking the spread of various crops and agricultural systems (e.g. Colledge and Connolly 2001; Fuller et al. 2015). Archaeobotany is well-established for identifying past food plant use, plant domestication and ecological niche construction (e.g. Fuller and Stevens 2017). However, a key component of niche constructions by past societies and a fundamental aspect of the cultural traditions that spread with agriculture, has always been cooking. While we are some way from being able to reconstruct whole recipes or complete menus, current advances in the micro-structural analysis of charred food remains, a regular but overlooked component of many flotation samples, offers a powerful new tool for understanding past cuisine and food consumption.

There remains more methodological work to do. While we can recognize the cooked cereal foods that have come from doughs, breads, and porridges, there are many potential methods for preparing cereals and other plant foods, including various forms of leeching, fermenting, drying and rewetting, mixing, etc. In addition, we have not discussed fermented foods, such as beers or leavened breads, which should also be identifiable by the microstructure of their charred remains, even if yeast cells themselves are not identifiable after charring. The champion of Old World fermentation is surely *Sacromyces cerevisiae*, which is used to turn grapes into wine, malted grain into beer, and dough into leavened bread (Money 2018). Phylogenetic data from modern yeast genomes indicates that bread yeasts derive from early wine yeasts that in turn come from wild yeasts of western Asia (Almeida et al. 2015; Legras et al. 2007), and thus fermentation traditions also dispersed but perhaps in the later Neolithic/Chalcolithic as a secondary innovation (e.g. Sherratt 1999). East Asian rice wines, like Japanese sake, rely on a phylogenetically separate domestication of *S. cerevisiae* (Almeida et al. 2015), as well as the domesticated *Aspergillus oryzae* fungus that turns starch into sugar in the absence of malting (Gibbons et al. 2012). As our work

expands to more regions, more periods and more culinary traditions, we can expect more varieties of cooked foodstuffs, requiring more experimental work to characterize archaeological food remains.

The examples we have outlined above have pushed back bread making in the Near East to before the advent of agriculture, and have highlighted how the association of bread making with wheat and barley was contingent on a particular tradition, i.e. one example of a *Neolithicity*. Whereas a focus on sorghum for the production of porridges, and probably beer, would represent a distinct Sudanic *Neolithicity*. In many ways we can think of cultural traditions as being cooked up differently by regional circumstances; a Sudanese Neolithic that was stewed, while the Fertile Crescent was baked.

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Competing Interests

The authors have no competing interests to declare.

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