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References

BERSTAN 2008

R. Berstan, A. W. Stott, S. Minnitt, C. Bronk Ramsey, R. E. M. Hedges & R. P. Evershed, *Direct dating of pottery from its organic residues, New precision using compound-specific carbon isotopes*. Antiquity **82** (2008), 702–713.

Techniques for identifying organic residues in pottery have been refined over the years by Professor Evershed and his colleagues. Here they address the problem of radiocarbon dating these residues by accelerator mass spectrometry (AMS) which in turn dates the use of the pot. Fatty acids from carcass and dairy products cooked in the pot were isolated from early Neolithic carinated bowls found at the Sweet Track, Somerset Levels, England, and then dated by AMS. The results were very consistent and gave an excellent match to the dendrochronological date of the trackway. The method has wide potential for the precise dating of pottery use on sites.

Keywords: England | Somerset Levels | Neolithic | pottery | organic residues | fatty acids | radiocarbon | dendrochronology

COPLEY 2003

M. S. Copley, R. Berstan, S. N. Dudd, G. Docherty, A. J. Mukherjee, V. Straker, S. Payne, & R. P. Evershed, *Direct chemical evidence for widespread dairying in prehistoric Britain*. PNAS **100** (2003), 1524–1529.

Domesticated animals formed an important element of farming practices in prehistoric Britain, a fact revealed through the quantity and variety of animal bone typically found at archaeological sites. However, it is not known whether the ruminant animals were raised purely for their tissues (e.g., meat) or alternatively were exploited principally for their milk. Absorbed organic residues from pottery from 14 British prehistoric sites were investigated for evidence of the processing of dairy products. Our ability to detect dairy fats rests on the observation that the d13C values of the C18:0 fatty acids in ruminant dairy fats are ≈2.3‰ lower than in ruminant adipose fats. This difference can be ascribed to (i) the inability of the mammary gland to biosynthesize C18:0; (ii) the biohydrogenation of dietary unsaturated fatty acids in the rumen; and (iii) differences (i.e., 8.1‰) in the d13C values of the plant dietary fatty acids and carbohydrates. The lipids from a total of 958 archaeological pottery vessels were extracted, and the compound-specific d13C values of preserved fatty acids (C16:0 and C18:0) were determined via gas chromatography-combustion-isotope ratio mass spectrometry. The results provide direct evidence for the exploitation of domesticated ruminant animals for dairy products at all Neolithic, Bronze Age, and Iron Age settlements in Britain. Most significantly, studies of pottery from a range of key early Neolithic sites confirmed that dairying was a widespread activity in this period and therefore probably well developed when farming was introduced into Britain in the fifth millennium B.C.

EVERSHED 2002

Richard P. Evershed et al., *Chemistry of Archaeological Animal Fats*. Accounts Chemical Research **35** (2002), 660–668.

Richard P. Evershed, Stephanie N. Dudd, Mark S. Copley, Robert Berstan, Andrew W. Stott, Hazel Mottram, Stephen A. Buckley & Zoe Crossman

Animal fats are preserved at archaeological sites in association with unglazed pottery, human and animal remains, and other deposits or hoards. High-temperature gas chromatography (HT-GC) and combined HT-GC/mass spectrometry (HT-GC/MS) has confirmed the presence of animal fats in lipid extracts of artifacts. Degradation products and pathways have been discerned through the analyses of archaeological finds and the products of laboratory and fieldbased decay experiments. The origins of preserved fats have been determined through detailed compositional analysis of their component fatty acids by GC, by GC/MS of dimethyl disulfide derivatives of monoenoic components, and by GC-combustion-isotope ratio-MS (GC-C-IRMS), to derive diagenetically robust d13C values. Regiospecific analysis of intact triacylglycerols by high-performance liquid chromatography/MS (HPLC/MS), with atmospheric pressure chemical ionization, provides a further criterion for establishing the origin of fats. Preparative GC has been employed to isolate individual fatty acids from archaeological pottery in sufficient amounts for 14C dating.

Stott 2001

A. W. Stott, R. Berstan, P. Evershed, R. E. M. Hedges, C. Bronk Ramsey & M. J. Humm, *Radiocarbon Dating of Single Compounds Isolated from Pottery Cooking Vessel Residues*. Radiocarbon **43** (2001), 191–197.

We have developed and demonstrated a practical methodology for dating specific compounds (and octadecanoic or stearic acid—C18:0—in particular) from the lipid material surviving in archaeological cooking pots. Such compounds may be extracted from about 10 g of cooking potsherd, and, after derivatization, can be purified by gas chromatography. To obtain sufficient material for precise dating repetitive, accumulating, GC separation is necessary. Throughout the 6000-year period studied, and over a variety of site environments within England, dates on C18:0 show no apparent systematic error, but do have a greater variability than can be explained by the errors due to the separation chemistry and measurement process alone. This variability is as yet unexplained. Dates on C16:0 show greater variability and a systematic error of approximately 100–150 years too young, and it is possible that this is due to contamination from the burial environment. Further work should clarify this.