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ORGANIC SUBSTANCES FROM A THINITE JAR: IDENTIFICATION AND SIMULATION OF AGEING PROCESSES

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Introduction

The organic materials from the neck and bottom of a Thinite jar discovered in Abydos and dated back to the first Egyptian dynasties (3100-2700 B.C.) were investigated using gas chromatography-mass spectrometry (GC-MS) in order to determine their molecular composition, origins, mode of preparation, and possible use. The oxidative alteration processes (autoxidation) undergone by the organic material were reproduced using laboratory experiments.

Results

GC-MS analysis of the volatile constituents from the organic materials found in the bottom of the jar revealed the presence of resin acids in low amounts and the predominance of sesquiterpenoids related to cuparene (**1**; Fig. 1), himachalenes (**2**-**4**), and longiborneol indicating that this material mainly originated from conifers. Himachalene and cuparene derivatives predominantly occurred as aromatic and/or oxidized analogues (e.g. **5**-**8**; Fig. 1) which could be identified based on mass spectrometric data (**5**) and comparison with standards obtained by synthesis (**6**-**8**). This indicates that the organic substance in the bottom of the jar was exposed to severe oxidative alteration. Laboratory experiments involving essential oil from *Cedrus atlantica* - an oil particularly rich in himachalenes (**2**-**4**) - and oxygen aimed at reproducing autoxidation processes undergone by these sesquiterpenoids led to the complete degradation of himachalenes and to the formation of aromatic analogues or compounds bearing additional oxygenated functionalities identical to those occurring in the archaeological sample (**5**-**8**, notably). Our results suggest that the organic substances in the bottom of the jar contained a significant proportion of material originating from *Cedrus* sp. Since the jar is postulated to originate from the Levant based on its typology, we propose that the organic material has been prepared from *Cedrus libani* which is native from this region (Fig. 1). An additional contribution from the Cupressaceae family such as junipers or cypresses is highlighted by the presence of the cuparene-related terpenoids since cuparene is not synthesized in significant amount by real cedars (e.g. Otto and Wilde, 2001). The predominance of sesquiterpenoids which are volatile constituents led us to envisage that, similarly to cade oil, this material has been prepared by dry distillation of conifer wood. However, the absence of specific molecular markers for wood tar (e.g. alkylguaiacols or aromatic diterpenoids, like retene, suggests that the organic material in the bottom of the jar might have been prepared by steam distillation of plant material rather than by pyrolysis.

The material sampled in the neck of the jar presented a different molecular distribution. Predominant constituents were oxidized homologues (e.g. **9**) of abietic acid (**10**) indicating that conifer resin from Pinaceae (e.g. Otto and Wilde, 2001) has been likely used as an ingredient. This material also contained a significant proportion of oil or fat as evidenced by the identification of fatty acid diols (e.g. **11**) and dicarboxylic acids (**12**, **13**) which result from the oxidative alteration of unsaturated fatty acids such as **14** and **15**. The uncommon predominance of oxidation products (e.g. **12**, **13**) of erucic acid (**15**) suggests that the fatty substance likely corresponded to oil from a member of the Brassicaceae family. (e.g. rapeseed, mustard). In this respect, the use of a plant oil from Brassicaceae as fuel for oil lamps in Egypt has been previously described by Romanus et al. (2008) and Colombini et al. (2005). We propose that the organic material from the neck of the jar corresponds to a mixture of plant oil from Brassicaceae and resin from Pinaceae used for securing the stopper of the jar. In this context also, sugars (rhamnose, glucose, xylose, mannose and galactose) identified after methanolysis of this sample could originate from the degradation of cellulose and hemicellulose from remains of a linen fabric impregnated with the mixture of resin and oil used to insure the tightness of the closure system of the jar.

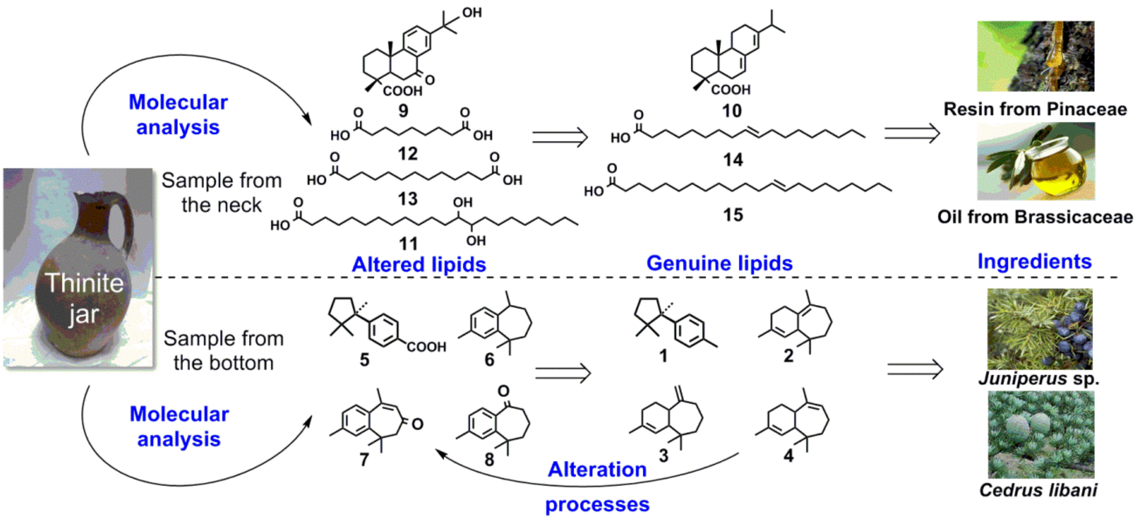

Figure 1 *Constituents of organic substances from samples collected in the neck and the bottom of a Thinite jar and genetic relationship with their potential lipid and vegetal precursor sources.*

References

Colombini, M.P., Modugno, F., Ribechini, E., 2005. Organic mass spectrometry in archaeology: evidence for Brassicaceae seed oil in Egyptian ceramic lamps. Journal of Mass Spectrometry 40, 890-898.

Otto, A., Wilde, V., 2001. Sesqui-, di-, and triterpenoids as chemosystematic markers in extant conifers – A review. The Botanical Review 67, 141-238.

Romanus, K., Van Neer, W., Marinova, E., Verbeke, K., Luypaerts, A., Accardo, S., Hermans, I., Jacobs, P., De Vos, D., Waelkens, M., 2008. Brassicaceae seed oil identified as illuminant in Nilotic shells from a first millenium AD Coptic church in Bawit, Egypt. Analytical and Bioanalytical Chemistry 390, 783-793.