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Experimental Observations on Adipocere Formation

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ABSTRACT: Adipocere, "grave wax," is a waxy or greasy decomposition product formed by hydrolysis and hydrogenation of tissue fats. Once formed, it appears stable for extended periods. Adipocere has generally been considered to result from bacterial action, commonly in warm, damp, anaerobic environments. However, its frequency, rate of formation, factors affecting its formation and physical characteristics are not well defined. To study the frequency, time course, and effects of temperature and clothing on adipocere formation, we submerged human adipose tissue samples in aquaria under controlled conditions and conducted serial observations.

Adipocere formed with high frequency, within a few months, in tissues submerged in warm tap water; similar changes took longer, 12 to 18 months in cold water submersion. Presence of clothing over the tissue appeared to accelerate adipocere formation.

KEYWORDS: pathology and biology, adipocere, postmorten changes, taphonomy

Adipocere ("grave wax"), a waxy or greasy decomposition product formed from hydrolysis and hydrogenation of adipose tissues [*1,2*], has been described for centuries. Adipocere has generally been considered to be formed by bacterial action, in warm, damp, anaerobic environments [*3–5*]. However, it has also been observed in buried bodies, dry environments, and cool water submersions [*6–8*]. Once formed, adipocere appears stable for extended periods [*1,2,9–11*] thus representing a type of spontaneous preservation.

While factors affecting formation have been studied in the laboratory [*1,2*], the frequency, time course of formation and effects of clothing, etc., have not been well defined. Most reports of adipocere are anecdotal or case reports. Knowledge of such factors would be useful in the determination or confirmation of postmortem interval in decomposed remains [*12–14*].

We conducted serial observations on submerged human adipose tissue samples (skin and subcutaneous) to address these questions.

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Material and Methods

Fresh tissue samples (skin with subcutaneous tissue) from research protocol autopsy cases contributed to the National Museum of Health and Medicine (NMHM) were used. The research protocol for this study was approved as an Armed Forces Institute of Pathology (AFIP) research protocol, including environmental and human subjects reviews. Ten blocks of tissue measuring approximately 10 by 10 by 4 cm were prepared, weighted down, and submerged in tap water in plastic aquaria (0.5 to 2.0 L) at two controlled temperature levels (40°F or 65°F).

In a subsample, tissues were wrapped in cotton cloth to simulate the effects of clothing. Tissues were examined every two weeks, for up to 18 months duration and the consistency, color, odor, and stability, and other physical characteristics noted [*1*,*2*]. Melting point and fluorescence under Wood's lamp [*2*] were noted in stable specimens after 18 months.

Results

There was variability in the extent of postmortem changes noted. Of ten adipose tissue samples submerged, seven demonstrated a final waxy grey consistency that remained stable at room temperature, characteristic of adipocere. The odor was described as a "peculiar" ammonia, cheeselike one by several pathologists and mortuary workers, and was much less offensive on drying. Characteristics became recognizable in 2 to 3 months at 60 to 70°F, and were well formed at 18 months. Similar adipocerelike changes were slower in 40°F water, and generally took 12 to 18 months for recognizable characteristics to develop. These characteristics appeared stable for several months at room temperature.

Adipocere formation appeared more extensive in cotton cloth-covered tissue samples. White-violet fluorescence under Wood's lamp was noted in well-formed adipocere. The melting point was 55 to 60°C [*2*].

Discussion

The preliminary results of these experimental studies are consistent with previous observations [*1–4*,*6*,*7*] that adipocere forms well in warm water. Adipocerelike changes were noted in approximately two months in warm water submersions (60 to 70°F), but took approximately one year in cold water (40°F). As a chemical reaction, adipocere formation is accelerated at higher temperature. Adipocere formation is also accelerated by covering tissues in cloth.

Observation of ultraviolet fluorescence, melting point [*2*], or assay for free fatty acids [*1*,*2*,*5*] may be useful for more objectively documenting adipocere formation in casework materials.

Further serial observations on larger tissue samples and samples submerged or buried under various natural conditions would be useful in further studying postmortem interval. More studies on the histology and chemistry of adipocere formation may also be useful [*1*,*2*,*5*,*15*] in assessing postmortem interval.

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