Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Monsieur MARTIN Clément,

Titulaire d'un master en bioingénieur : chimie et bioindustries,
à finalité spécialisée,

présentera en vue de l'obtention du grade et du diplôme de

DOCTORAT EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 16 juin 2023, à 13h précises (personne ne sera admis après cette heure),

en l'auditorium ES (Espace Senghor - Bât. 125),

Passage des Déportés, 2, à 5030 Gembloux et en visioconférence.

Cette dissertation originale a pour titre :

« The smell of death - Development of detection methods and applications for « cadaver dogs » trainings ».

Le jury est composé comme suit :

Présidente : Prof. M.-L. FAUCONNIER, Professeure ordinaire,
Membres : Prof. F. VERHEGGEN (Promoteur), Prof. C. DIEDERICH (Promotrice cotutelle - UNamur), Prof. Y. BROSTAUX, Prof. J.-F. FOCANT, Prof. F. FRANCIS, Prof. M. VANDENHEEDE, Prof. P. BOXHO, Prof. S. FORBES (Université de Windsor, Canada).

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Abstract

The decomposition of a human corpse is a complex process in which the body's building blocks (e.g., carbohydrates, proteins, lipids) are broken down into by-products thank to chemical reactions mediated by bacterial activity. Volatile organic compounds (VOCs) are quickly released, but their diversity and abundance are changing over the course of the decomposition. Although several studies have attempted to characterize its composition, the methodologies used would greatly benefit from being optimized. The characterization of the so-called "the smell of death" can lead to several applications, including the training of police dogs specialized in the location of human remains. Unfortunately, this research topic is still largely understudied.

During the present PhD thesis, we have performed two reviews of the scientific literature: (i) on the odor profile of human cadavers and (ii) on the selection and training procedures of "cadaver dogs". Then, we have set three specific -but complementary- objectives: (i) Optimizing methods for collecting cadaveric compounds, especially in complex environments, and at the same time deciphering the impact of the environment a corpse decays in on the emission of VOCs; (ii) Developing a gas chromatography method to characterize cadaveric VOCs of freshly deceased people; and (iii) Optimizing training conditions for police dogs in order to improve their performance when searching for human bodies.

In **the first experimental chapter** of this thesis, we have evaluated the impact of three environmental conditions on the decomposition of vertebrate cadavers, using rats as surrogate human models: open-air decomposition, underground decomposition, and underwater decomposition. We have developed original methodologies to collect the cadaveric VOCs. In all scenarios, sulfur and nitrogen containing compounds were highlighted. During the open-air decaying process, we found necrophagous insects not only hasten the decaying process, but also impact the diversity of volatiles released at the beginning of the decomposition. When studying underground decomposition, we found the texture of the soil to influence the diffusion of VOCs in surrounding soil layers, where most decomposition VOC could be identified. Finally, while studying immersed vertebrate remains, we collected less cadaveric compounds than in other scenarios, suggesting that many could be dissolved in the water. No influence of the water salinity has been observed on the odor profile released at the water surface.

Investigating human cadaveric profile remains a major issue, which justifies the use of animal models (*i.e.*, pig and rats) Limitations in the existing literature dealing with human cadaveric volatilome include the small sample size and the high variability of investigated decomposition stages. In **the second experimental chapter**, we developed a target ion gas chromatography method to characterize the VOCs profile released by freshly deceased people, a decomposition stage barely studied. We succeeded in identifying 30 cadaveric compounds among which those containing sulfur were the most abundant.

The use of dogs to locate decaying remains is common. However, we have very limited information to understand what make these dogs efficient or how they could be efficiently trained to perceive specific cadaveric odors. In **the third experimental chapter**, we explored the post-training abilities to locate cadaveric volatiles in human remains detection dogs. For the first time, a definition of an efficient detection dog is suggested as well as a method to assess dogs' performance. Behavioral assays performed on police dogs also highlighted that sulfur containing compounds drive the target recognition, and that they could either belonged to cadaveric compounds or not.

To conclude, the results of this thesis provide new and complementary information on the cadaveric volatile profile, as well as on the behavior of human remains detection dogs.