Bioelectronic 'nose' can detect food spoilage by sensing the smell of death

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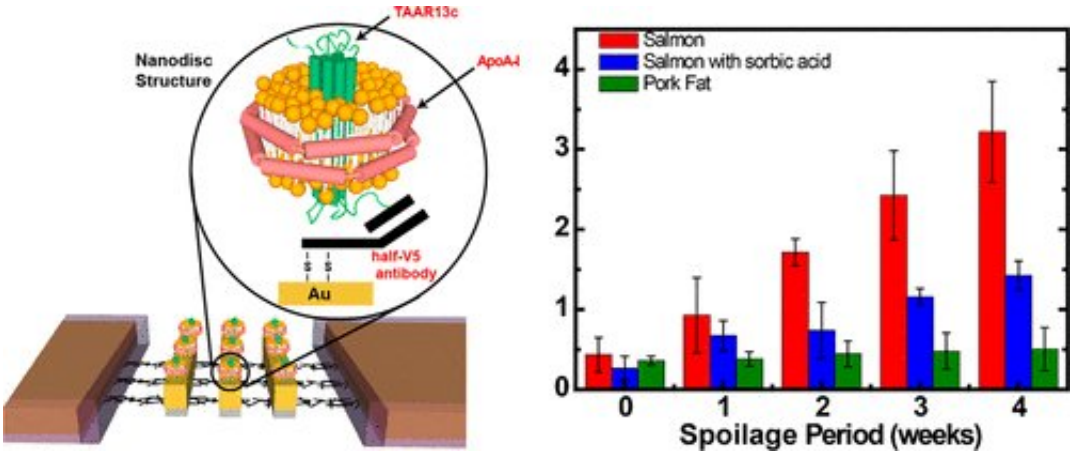

Credit: American Chemical Society

Strong odors are an indicator that food has gone bad, but there could soon be a new way to sniff foul smells earlier on. As reported in *ACS Nano*, researchers have developed a bioelectronic "nose" that can specifically detect a key decay compound at low levels, enabling people to potentially take action before the stink spreads. It can detect rotting food, as well as be used to help find victims of natural disasters or crimes.

When food begins to rot, the smell that we find repulsive comes from a compound known as cadaverine. That's also the substance responsible for the stench of rotting bodies, or cadavers—hence the name. The

compound is the result of a bacterial reaction involving lysine, which is an amino acid commonly found in various food products. A previous study has shown that a receptor in zebrafish has an affinity for cadaverine. To make this receptor in the laboratory, scientists have turned to *E. coli* as a host cell because it can easily produce large quantities of proteins. But the production of this receptor in *E. coli* has been a challenge because it needs to be in a membrane. One way to do this is to make the protein in a bacterial cell and reconstitute it in nanodiscs, which are water friendly, membrane-like structures that the receptor can reside in. So, Seunghun Hong, Tai Hyun Park and colleagues wanted to see if they could put the receptor into nanodiscs to create a sensitive and specific detector for cadaverine.

The researchers successfully produced copies of the receptor in *E. coli* and assembled them into nanodiscs. The receptor-containing nanodiscs were then placed in a special orientation on a carbon nanotube transistor, completing the bioelectronic nose. During testing with purified test compounds and real-world salmon and beef samples, the nose was selective and sensitive for cadaverine, even at low levels. Additionally, the researchers say the detector could someday prove useful in finding bodies, since the compound is also produced when a person dies.

More information: Heehong Yang et al. Nanodisc-Based Bioelectronic Nose Using Olfactory Receptor Produced in Escherichia coli for the Assessment of the Death-Associated Odor Cadaverine, *ACS Nano* (2017). DOI: 10.1021/acsnano.7b04992

Abstract
Cadaverine (CV), a death-associated odor, is an important target molecule for various sensor applications, including the evaluation of food spoilage. In this study, we developed an oriented nanodisc (ND)-functionalized bioelectronic nose (ONBN), based on carbon nanotube transistors and nanodiscs embedded with an olfactory receptor

produced in Escherichia coli (E. coli) for detection of CV. To fabricate ONBN devices, a trace-amine-associated receptor 13c (TAAR13c) binding to CV was produced in E. coli, purified, reconstituted into NDs, and assembled, in the desired orientation, onto a carbon- nanotube-based field-effect transistor with floating electrodes. The ONBN showed high performance in terms of sensitivity and selectivity. Moreover, the ONBN was used to measure CV in diverse real-food samples for the determination of food freshness. These results indicate ONBN devices can be utilized to evaluate the quality of food samples quantitatively, which should enable versatile practical applications such as food safety and preservative development. Moreover, the ONBN could provide a useful tool for detection of corpses, which could be practically used in disaster responses.

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