Odor suppression causes bad wine smell

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(Phys.org) —A bad, musty smell sometimes ruins a bottle of corked wine. Since the 1990s, researchers have known that this unpleasant odor comes from the chemical 2,4,6-trichloroanisole (TCA), which forms when a fungus that infects cork comes in contact with bleach or chlorine products used for sanitation at wineries. Hiroko Takeuchi of Osaka University and her colleagues have now discovered that TCA suppresses the sense of smell, and this causes us to detect a musty odor. The research appears in the *Proceedings of the National Academy of Sciences*.

A number of naturally occurring compounds, including TCA, ruin the smell and taste of food and beverages. Scientists thought these chemicals activate particular olfactory receptor cells (ORCS), which transmitted bad smells to the brain. However, they were not able to explain how

TCA can create its associated odor even at very low concentrations.

To understand the mechanism behind "corked wine smell," Takeuchi and her colleagues isolated ORCs from newts. When they exposed the ORCs to TCA, they found that rather than stimulating an electric current to flow across the cell membrane, as expected, TCA stopped the flow of current by preventing calcium ions from passing through cyclic nucleotide gated (CNG) channels in the membrane. TCA was much more effective at blocking CNG channels than geraniol, an olfactory masking agent used in perfume, and L-*cis*-diltiazem, a well known CNG channel blocker.

Because the researchers were able to create this effect using a much lower concentration of TCA then would be required to disrupt CNG channels directly, they hypothesized that lipid layers in the cell membrane absorb the chemical, which then disrupts many channels at once.

Takeuchi's team also tested the effects of TCA on human subjects: 20 panelists, trained to detect unpleasant odors, at the Daiwa Can packaging company in Tokyo. These volunteers were not trained wine tasters. They were able to detect the musty smell associated with TCA at concentrations of 10 parts per trillion for red wine and 15 parts per trillion for white wine. They also reported reductions in the original wine odor when tasting wine contaminated with TCA at similar concentrations.

The team then tested foods that had lost their original odor, but did not give off a musty smell, for the presence of TCA. They found TCA molecules in banana peels, starch, chicken, peanuts, sake, cashew nuts, green tea and beer. Further testing revealed the presence of TCA in a variety of substances that industrial specialists said exhibited flavor loss or an unpleasant odor, including mineral water, tap water, flour, green onions, eggs, building materials, paper bags and resin used in computers.

Takeuchi and her colleagues still haven't determined what makes us think some items contaminated with TCA smell bad. They hypothesize that the brain interprets the reduction of CNG channel activity or the suppression of output from ORCs as an odor.

More information: 2,4,6-Trichloroanisole is a potent suppressor of olfactory signal transduction, Published online before print September 16, 2013, DOI: 10.1073/pnas.1300764110

Abstract
We investigated the sensitivity of single olfactory receptor cells to 2,4,6-trichloroanisole (TCA), a compound known for causing cork taint in wines. Such off-flavors have been thought to originate from unpleasant odor qualities evoked by contaminants. However, we here show that TCA attenuates olfactory transduction by suppressing cyclic nucleotide-gated channels, without evoking odorant responses. Surprisingly, suppression was observed even at extremely low (i.e., attomolar) TCA concentrations. The high sensitivity to TCA was associated with temporal integration of the suppression effect. We confirmed that potent suppression by TCA and similar compounds was correlated with their lipophilicity, as quantified by the partition coefficient at octanol/water boundary (pH 7.4), suggesting that channel suppression is mediated by a partitioning of TCA into the lipid bilayer of plasma membranes. The rank order of suppression matched human recognition of off-flavors: TCA equivalent to 2,4,6-tribromoanisole, which is much greater than 2,4,6-trichlorophenol. Furthermore, TCA was detected in a wide variety of foods and beverages surveyed for odor losses. Our findings demonstrate a potential molecular mechanism for the reduction of flavor.