Letter to the Editor

Styrene-Producing Microbes in Food-Stuff

Recently, an article was published in *Journal of Food Science*, August 2009 (Vol. 74, Nr. 6) entitled "Natural Formation of Styrene by Cinnamon Mold Flora" (Lafeuille and others 2009). It was encouraging to see further research devoted to the important topic of volatile organic compound (VOC) emission from ubiquitous foodstuff microbes. VOCs emitted from varying microbes have demonstrated a wide range of activities (Ezra and Strobel 2003; McAfee and Taylor 1999), acting as indicators of food spoilage (Schnurer and others 1999), and have been implicated in complex insect and plant interactions (Felton and Tumlinson 2008). Additionally, many fungi are known to produce toxins (mycotoxins) and thus present serious food safety issues (Campbell and others 2003; Robens and Cardwell 2003).

In the article regarding cinnamon mold flora, the authors reported on the production of styrene from several fungi typically found on cinnamon, and used cinnamic acid and similar analogues to elucidate a probable biogenesis of styrene. The authors concluded that styrene was generated from cinnamic acid by feeding cinnamic-d7 acid to the fungi and detecting the resultant styrene-d7 produced and emitted. Additionally, the authors demonstrated production of volatile styrene from 3 of the 5 fungi when incubated at room temperature (25 °C) within a 5-day time frame. The paper addressed the issue of styrene-producing microbes found in cinnamon from numerous regions.

However, it is a matter of concern that this paper did not cite previous studies on the same subject matter; papers that would have helped strengthen the authors' discussion on the biosynthesis of styrene in a food-stuff. In a report from Pagot and others (2007), the production of styrene by *Penicillium camemberti* in Czapek medium, cultured at 19 °C over a 20-day period, was demonstrated. The objective of this study was to probe the origin of volatile styrene by microbes during the ripening of cheese. In their report, Pagot and others (2007) also confirmed the metabolism of 13C-labeled phenylalanine and subsequent conversion into labeled styrene, as well as other labeled aromatic metabolic compounds. Additionally, that study provided several references for the well-established bioconversion of cinnamic acid to styrene by the fungus *Aspergillus niger* (Clifford and others 1969). In another relevant previous publication (Beck and others 2008), it was reported that relatively large amounts of styrene was produced by the ubiquitous soil-borne fungus *Fusarium oxysporum*, which is found in many agricultural crops worldwide. These researchers used 13C-labeled glucose to verify that *F. oxysporum* metabolized glucose to produce labeled volatile styrene, and hypothesized a biosynthetic scheme based upon the labeling study. The fungus was cultured on potato dextrose agar and broth and paralleled in the study performed by Lafeuille and coworkers by running at room temperature (about 22 to 25 °C). In their study, Beck and coworkers noted maximum styrene production at day 5 of the small scale experiment, and day 22 of the large scale experiment. In conclusion, while it is refreshing to see more research on the topic of fungi-produced volatiles, the authors of the article in question would have been able to provide a more in-depth discussion on the biosynthesis of styrene in cinnamon and possibly saved precious research resources had they undertaken a thorough literature search to locate and cite the reports from these previous studies. For example, the investigators could have explored the idea that the cinnamate precursors used in their study may be hydrolyzed to the corresponding acid, and then subsequently metabolized to styrene. Notwithstanding, the authors' report highlights the need for the undertaking of an in-depth biosynthetic study that isolates and verifies the various hydrophilic and hydrophobic metabolites produced during the genesis of styrene.

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References

Beck JJ, Merrill GB, Palumbo JD, O'Keeffe TL. 2008. Strain of *Fusarium oxysporum* isolated from almond hulls produces styrene and 7-methyl-1,3,5-cyclooctatriene as the principal volatile components. J Agric Food Chem 56(23):11392-8.

Campbell BC, Molyneux RJ, Schatzki TF. 2003. Current research on reducing pre- and post-harvest aflatoxin contamination of U.S. almond, pistachio, and walnut. J Toxicol Toxin Rev 22(2-3):225-66.

Clifford DR, Faulkner JK, Walker, JRL, Woodcock D. 1969. Metabolism of cinnamic acid by *Aspergillus niger*. Phytochemistry 8(3):549-552.

Ezra D, Strobel GA. 2003. Effect of substrate on the bioactivity of volatile antimicrobials produced by *Muscodor albus*. Plant Sci 165(6):1229-38.

Felton GW, Tumlinson JH. 2008. Plant-insect dialogs: complex interactions at the plantinsect interface. Curr Opin Plant Biol 11(4):457-63.

McAfee BJ, Taylor A. 1999. A review of the volatile metabolites of fungi found on wood surfaces. Nat Toxins 7(6):283-303.

Pagot T, Belin JM, Husson F, Spinnler HE. 2007. Metabolism of phenylalanine and biosynthesis of styrene in *Penicillium camemberti*. J Dairy Res 74(2):180-5.

Robens J, Cardwell W. 2003. The costs of mycotoxin management to the USA: management of aflatoxins in the United States. J Toxicol Toxin Rev 22(2-3):143-56.

Schnurer J, Olsson J, Borjesson T. 1999. Fungal volatiles as indicators of food and feeds spoilage. Fungal Genet Biol 27(2-3):209-217.

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