

Identification of Styrene and Hexanol During Baking of Sweetpotato Bread in a Closed Chamber

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ABSTRACT

The objective of the study was to quantify styrene and hexanol generated during the baking of a model sweetpotato bread (SPB) using three different sorbent based tubes. Volatiles were trapped from the ambient air and Gerstel TDU tubes packed with PDMS foam, Tenax and Carbopack B. The average mass of styrene from Tenax absorption tubes was 26.99 µg. The average mass of hexanol desorbed from the Tenax absorbent tubes was 6.2 µg. Considering the low amount of styrene and hexanol emitted from the SPB, it is believe that it is not enough to pose harm to the human body.

INTRODUCTION

One research area at Tuskegee University Center for Food and Environmental Systems for Human Exploration of Space (CFESH) focuses on processing sweetpotato [*Ipomoea batatas* (L.) Lam] root for use on space flights, but also having application for food systems on Earth. As part of the overall goal of CFESH, it is important to characterize and quantify residual volatiles from products derived from the sweetpotato, specifically sweetpotato bread (SPB), to ensure the safeness of the foods being prepared in closed environment. It is because of the unique features (high yields, limited agricultural technologies for growing, wide ecological adaptability) and nutritional value that NASA has selected the sweetpotato to be grown and incorporated into the diets of astronauts on space flights (Bovell-Benjamin, 2007).

Volatiles may be derived from many sources, including foods, and are usually generated during the cooking and

processing of foods (Hathorn et al., 2007). The identification of volatiles during cooking of sweetpotato has been reported in several studies (Horvat et al., 1991; Kays, 1992; Wang and Kays, 2000). Work has been reported on the identification of volatiles from cooked SPB and volatiles emitted during the cooking process of SPB (Hathorn et al., 2006; Hathorn et al., 2007). Those studies reported a number of volatiles from different classes such as, alcohols, acids, aldehydes, alkanes, alkenes, esters, ether and ketones. Also, different methods were employed to identify these volatiles, including Thermogravimetric Analyzer/Fourier Transform Infrared Spectrometer (TGA/FTIR) and Gas Chromatography-Mass Spectrometry and Solid Phase Microextraction (GC-MS/SPME). GC-MS showed the most promising results of identifying volatiles emitted from SPB during baking.

Spacecraft Maximum Allowable Concentrations (SMACs) are guideline values set by the National Aeronautics and Space Administration/ Johnson Space Center (NASA/JSC) Toxicology Group in cooperation with the National Research Council Committee on Toxicology (NRCCOT) (NASA, 1999). These values take into account a number of unique factors such as the effect of space-flight stress on human physiology, the uniform good health of astronauts, and the absence of pregnant or very young individuals (NASA, 1999). Short-term (1 and 24 hour) SMACs are set to manage accidental releases aboard a spacecraft and permit risk of minor reversible effects such as mild mucosal irritation (NASA, 1999).

1999). The long-term SMACs are set to fully protect healthy crewmembers from adverse effects resulting from continuous exposure to specific air pollutants for up to 180 days. Crewmembers with allergies or unusual sensitivity to trace pollutants may not be afforded complete protection, even when long-term SMACs are not exceeded (NASA, 1999). Crewmember exposure involves a mixture of contaminants, each at a specific concentration (C_n). These contaminants could interact to elicit symptoms of toxicity even though individual contaminants do not exceed their respective SMACs. The air quality is considered acceptable when the toxicity index (T_{grp}) for each toxicological group of compounds is less than 1. NASA is concerned with the indoor atmosphere aboard spacecrafts and protecting the health of crewmembers. Therefore, it is important to monitor volatiles emission from foods while being prepared on spacecrafts.

Currently the assessment of volatiles can be done through sorbent-based methods, where air is pulled through metal or glass tubes filled with appropriate sorbents such as activated charcoal, Tenax TA, XAD-2, Carbotrap, Carboxen 569 (Ribes et al., 2007). Another sorbent is a thick film of polydimethylsiloxane (PDMS) coated on the magnet of a stir bar incorporated into a glass jacket (Bicchi et al., 2005). The work presented in this paper is part of a boarder study in CFESH with a goal to quantify volatiles from food products developed from sweetpotatoes. Over 100 volatiles have been identified. Styrene and hexanol were two compounds to be quantified. Styrene is an important chemical, also known as vinyl benzene, and is used particularly in the manufacture of polymers and plastics (Filser et al., 2002). Also styrene is found in indoor air, in ambient urban air, in cigarette smoke and in fruits and vegetables in small amounts (Tang et al., 2000; Filser et al., 2002). It is important to note that styrene most commonly affects the nervous system,

causing symptoms similar to drunkenness, as well as being a carcinogen. Styrene could also irritate the eyes, nose, throat, lungs and skin. Hexanol is an organic alcohol, which appears as a colourless liquid. Hexanol is used in the production of plasticizers for PVC and other resins. The objective of the study was to quantify styrene and hexanol generated during the baking of a model sweetpotato bread (SPB) using three different sorbent based tubes.

METHODS AND MATERIALS

Preparation of Bread

The breads were made using 50 % Sweetpotato Flour (SPF) and 50% Hard Red Spring Wheat Flour (HRSWF). Other ingredients included sugar (36.4%), water (3.2%), oil (2.0%), yeast (1.5%), and salt (0.8%). The measured ingredients were placed in the order of liquids, dry ingredient, and yeast into a Breadman Dream Machine TR3000 bread machine (Salton/Maxim Housewares, Inc., Mt. Prospect, IL, USA) and baked on the "whole-wheat setting".

Construction of Chamber

An enclosed, semi airtight chamber was constructed to contain volatiles as they vented from the bread machine in a manner that may exist with a near airtight space aboard a space craft or in an airtight home base (Figure 1). The concentrations of volatiles were hypothesized to increase in such a container versus simply baking bread in an open room with ventilation. This would aid in determining volatile concentrations and detection capabilities. The chamber to house the bread machine was an 8' x 8' x 8'cube constructed by completely wrapping a PVC pipe frame (all 6 sides) with plastic sheets (Film Guard plastic sheeting, Covalence Plastics, Minneapolis) and 2-way adhesive tape. A door way was constructed and velcro was used to close and seal the door.