important step in developing a HACCP plan. If a hazard analysis is performed appropriately, the rest of the HACCP plan becomes relatively simple. A poorly prepared hazard analysis often results in an overly complicated HACCP plan or a plan difficult to implement. Hazard analysis, and other "lessons learned", will be discussed.

148.
WORKPLACE SAFETY AND FOOD INGREDIENTS: THE EXAMPLE OF BUTTER FLAVORING. ***Ana Hubbs**, V. Castranova, W. Jones, D. Porter, W. Goldsmith, G. Kullman, L. Battelli, S. Friend, R.R. Mercer, D. Schwegler-Berry, and K. Kreiss, Veterinary Medical Officer, National Institute for Occupational Safety and Health, CDC, 1095 Willowdale Rd. M/S 2015, Morgantown, WV 26505, Fax: 304-285-5938, afh0@cdc.gov*

Chemical toxicity is often dependent upon the concentration and route of exposure. Therefore, compounds which are safe when consumed at low concentrations are not necessarily safe at higher concentrations and/or by a different route, such as inhalation. Due to a high prevalence of lung disease in microwave popcorn manufacturing workers, we investigated the potential for butter flavoring vapors to damage the epithelial lining of nasal passages and pulmonary airways. Inhaling a butter flavoring vapor mixture containing 203-371 ppm of the diacetyl component caused degeneration and death of rat nasal and airway epithelial cells. These are concentrations workers could encounter for short periods. We are actively investigating the specific agent(s) in butter flavoring which can injure respiratory epithelium.

149.
RATIONAL MODEL FOR CLINICAL STUDIES ON BOTANICAL ANTIOXIDANTS. ***Boxin Ou**, and Dejian Huang, Brunswick Laboratories, 6 Thatcher Lane, Wareham, MA 02571, Fax: 508-295-6615, bou@brunswicklabs.com*

Free radicals and other reactive species are considered to be important causative factors in the development of diseases of aging such as cancer and cardiovascular diseases. This relationship has led to considerable interest in assessing the antioxidant capacity of foods and botanicals and other nutritional antioxddant supplements. The use of the oxygen radical absorbance capacity (ORAC) assay as a tool for in vitro antioxidant assessment is proposed as a standard method for comparing botanical sources and for nutritional supplements. The effectiveness of antioxidant intake can be determined by measuring the biomarkers specific for DNA, protein and lipid oxidative damage. Decrease of oxidative stress level has been observed in human subjects following consumption of botanicals containing higti ORAC values. This study model provides a basis from which to establish appropriate dietary intakes that might impact health outcomes.

150.
ANTIOXIDANT ACTIVITY AND PHYTONUTRIENTS OF ARTICHOKE (*CYNARA SCOLYMUS*). ***Gary R. Takeoka**, Lan T. Dao, and Byeoung-Soo Park, Western Regional Research Center, Agricultural Research Service, U.S. Department of Agriculture, 800 Buchanan Street, Albany, CA 94710, grt@pw.usda.gov*

The artichoke (*Cynara scolymus*) is a thistlelike perennial plant of the Asteraceae family. Along with coffee they represent a significant dietary source of dicaffeoylquinic acids. These acids have reported antimicrobial, antioxidant and anti-HIV activity. There is extensive literature on the hypocholesterolemic effect of artichoke extracts. Artichoke leaf extract is used as a digestive aid and also as a liver protective and regenerative agent. We have studied the phytonutrients of artichoke seeds, leaves and the edible head. Constituents were isolated by HPLC and characterized by MS and NMR. Antioxidant activity of artichoke extracts was evaluated using different in vitro assays.

151.
WHEN EAST MEETS WEST: RELATIONSHIP OF YIN-YANG BALANCE WITH ANTIOXIDATION AND OXIDATION. *Boxin Ou, **Dejian Huang**, Maureen Hampsch-Woodill, and Judith A. Flanagan, Brunswick Laboratories, 6 Thatcher Ln, Wareham, MA 02571, Fax: 508-295-6615, bou@brunswicklabs.com, dejian@brunswicklabs.com*

In modern western medicine, the balance between anti-oxidation and oxidation is a critical concept for maintaining a healthy biological system. It is interesting to note that a similar concept of balance called yin-yang existed in traditional Chinese medicine (TCM). Such balance was first described in the Chinese medical treatise Su Wen written 2500 years ago. The yin and yang, however. do not have any concrete physical meaning in modern science and thus it is difficult to find an equivalent term in western medicine to express this dichotomy. In TCM, yin-yang is a term to express the dual opposite qualities of matter. Maintaining yin and yang in harmony is akin to attaining the homeostatic state. Those with counteractive properties like water, coldness, stillness, inhibition and weakness pertain to yin and those with proactive properties, such as fire, heat, movement, brightness, outward, and upward direction belong to yang. Therefore, anti-oxidation processes that prevent the over-oxidation (stress) can be called yin and energy generating oxidation processes naturally belong to yang. For this point of view, there may be a strong correlation between and the yin/yang balance of TCM and the modern theory of oxidation/anti-oxidation balance. Our study reported here is to reveal such a correlation.

152.
DETERMINATION OF APPARENT *N*-NITROSO COMPOUNDS BY CHEMICAL DENITROSATION USING CUPROUS CHLORIDE. ***Jia Wang**, Geoffrey W. Chan, Stephen A. Haut, Marc R. Krauss, Richard R. Izac, and Walter P. Hempfling, RD&E, Philip Morris USA, P. O. Box 26583, Richmond, VA 23261, Fax: 804-274-1994, Jia.Wang@pmusa.com*

A method for the determination of apparent total *N*-nitroso compounds by chemical denitrosation and subsequent chemiluminescence detection of the nitric oxide was developed. This method, based on denitrosation with CuCl and 70°C HCl, was rapid, reproducible, simple and sensitive. The detection limit was 1 pmol for *N*-nitrosoproline. Nitric oxide formation from *N*-nitrosoproline was linear (R^2=0.999) from 4 pmol to 2 nmol. Alkyl nitrite (O-nitroso), alkyl nitrate, nitrite, nitrate, C-nitro, C-nitroso, S-nitroso and other organic nitrogen compounds that could interfere were investigated. Only S-nitroso type compounds were found to give false positive response to any significant extent. This method has several advantages over other similar methods: 1) a commercially available nitric oxide analyzer is used; 2) the reaction is tolerant of aqueous samples; 3) NO release occurs rapidly and is easily quantified using available software. The mechanism of nitric oxide release will be discussed.

153.
CHARACTERIZATION OF THE AROMA OF A SEMI-HARD DUTCH CHEESE. ***Jacques P. Roozen**, Agrotechnology and Food Sciences, Wageningen University and Research center, Biotechnion 172, Lab. Food Chemistry, PO BOX 8129, 6700 EV Wageningen, Netherlands, Fax: +31 317 484893, Jacques.Roozen@Chem.Fdsci.WAU.nl, and Egle Bylaite, BioCentrum-DTU, Technical University of Denmark*

The volatile compounds of a semi-hard Dutch cheese have been isolated by "in vitro" devices like dynamic headspace (DH), dynamic headspace and mastication(DHM) and purge and trap (PT), and by a "in vivo" device sampling oral vapour in the mouth of assessors (OV). Gas chromatography(GC) combined with flame ionisation(FID), mass spectrometry(MS) and olfactometry(O) have been used to characterize the volatiles released in the devices. In GC/MS analysis 105 compounds were identified, including 17 ketones, 21 aldehydes, 15 esters, 18 alcohols and 2 sulphur compounds. The major volatile compounds were ethanol, acetone, 3-hydroxy-2-butanone and 2-butanone. Statistical analysis of FID peak areas of volatile compounds released in different devices showed that the OV results were closest to the DHM ones. Therefore, DHM has been chosen as the device which mimics best the release of volatiles 'in vivo'. Volatile compounds isolated by DHM were characterized by a GC-O panel of 16 trained assessors. The analysis demonstated, that 23 odour active compounds contribute to the aroma of semi hard Dutch cheese. Among them 2,3-butanedione, 1-octen-3-one and dimethyltrisulphide were the most potent compounds, followed by ethylbutanoate, hexanal, and 1-heptanol.

154.
INTRODUCTION TO CHEMOMETRICS IN FOOD RESEARCH. ***Karl J. Siebert**, Food Science & Technology Dept, Cornell University, Geneva, NY 14456-0462, Fax: 315-787-2284, kjs3@cornell.edu*

Most of the sensory properties in food (such as flavor, appearance and texture) result from the combined effects of several compounds perceived jointly. Many

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