AACT Herbal Dietary Supplement SIG Abstracts July 2015

1. Notes from the field: Fatal gastrointestinal mucormycosis in a premature infant associated with a contaminated dietary supplement— Connecticut, 2014.

MMWR Morb Mortal Wkly Rep. 2015 Feb 20;64(6):155-6.

Vallabhaneni S, Walker TA, Lockhart SR, Ng D, Chiller T, Melchreit R, Brandt ME, Smith RM; Centers for Disease Control and Prevention (CDC).

Abstract:
In October 2014, a hospital in Connecticut notified CDC and the Connecticut Department of Public Health of a fatal case of gastrointestinal mucormycosis in a preterm infant. The infant, born at 29 weeks' gestation and weighing 1,400 grams (about 3 pounds), had developed signs and symptoms initially consistent with necrotizing enterocolitis approximately 1 week after birth. Exploratory laparotomy revealed complete ischemia of the gastrointestinal tract from the esophagus to the rectum; a portion of necrotic cecum was sent for microscopic examination. Following surgery, the infant developed multiple areas of vascular occlusion, including a large clot in the aorta, findings not usually associated with necrotizing enterocolitis. The infant died soon after. Histopathology results from the resected cecum revealed an angioinvasive fungal infection consistent with mucormycosis. Gastrointestinal mucormycosis is an extremely rare fungal infection caused by mold in the order Mucorales. It occurs predominantly in low birth weight infants, patients with diarrhea and malnutrition, and those receiving peritoneal dialysis; mortality is 85%. Local investigation revealed that the infant had received a dietary supplement, ABC Dophilus Powder, for 7 days, beginning on day 1 of life.
PMID: 25695322

2. A Clinician's Guide to Drug-Drug Interactions with Direct Acting Antiviral Agents for the Treatment of Hepatitis C Virus Infection.

Hepatology. 2015 May 29. doi: 10.1002/hep.27920. [Epub ahead of print]

Dick TB, Lindberg LS, Ramirez DD, Charlton MR

Abstract:
The FDA has recently approved a number of new direct acting antiviral agents for the treatment of chronic hepatitis C virus that have significantly increased the likelihood of a virologic cure. These agents are highly effective but present a substantial risk for a host of clinically relevant drug-drug interactions. These interactions must be considered both when starting and stopping any medication, including over-the-counter medications and herbal supplements. These drug-drug interactions can increase the risk of toxicity or decrease the likelihood of treatment response. Knowledge of these interactions is paramount in optimizing the success of antiviral therapy. In this review we summarize the available data regarding drug-drug interactions for direct acting antiviral agents. The interactions included are the most clinically relevant currently known. This review is intended to serve as a clinician's guide to understanding and managing these complex interactions.
PMID: 26033675

3. Eosinophilic esophagitis associated with Cynanchum wilfordii (letter).

Ann Allergy Asthma Immunol 2015;114: 257-259.

Oh JY, Min KH, Park HS, Hur GY.

First paragraph:
Eosinophilic esophagitis (EoE) is a chronic esophageal inflammatory disease characterized by eosinophilic infiltration into the esophageal epithelium. The cause of EoE is not well understood, but a likely cause involves antigenic exposure to food allergens and/ or aeroallergens that induces a response in genetically predisposed individuals. Cynanchum wilfordii belongs to the family Asclepiadaceae and is distributed in eastern Asia. Its tuberous root has been used as traditional herbal medicine. It recently received attention as a health supplement food, and EstroG-100 (herbal extract containing C wilfordii) was approved by the US Food and Drug administration as a new dietary supplement. Cynanchum wilfordii significantly alleviated menopausal symptoms of perimenopausal women without any reported serious side effects, including allergic reactions. We describe 1 case of EoE after repeated use of C wilfordii for health promotion purposes.
PMID: 25648564

4. Iatrogenic vitamin D toxicity in an infant—a case report and review of literature.

J Steroid Biochem Mol Biol. 2015;148:14-8. doi: 10.1016/j.jsbmb.2015.01.022. Epub 2015 Jan 27.
Ketha H, Wadams H, Lteif A, Singh RJ.

Abstract:
Public concern over vitamin D deficiency has led to widespread use of over the counter (OTC) vitamin D (-D3 or -D2) supplements, containing up to 10,000 IU unit dose (400 IU=10μg). Overzealous use of such supplements can cause hypercalcemia due to vitamin D toxicity. Infants are particularly vulnerable to toxicity associated with vitamin D overdose. OTC supplements are not subject to stringent quality control regulations from FDA and high degree of variability in vitamin D content in OTC pills has been demonstrated. Other etiologies of vitamin D induced hypercalcemia include hyperparathyroidism, granulomatous malignancies like sarcoidosis and mutations in the CYP24A1 gene. The differential diagnosis of hypercalcemia should include iatrogenic and genetic etiologies. C24-hydroxylation and C3-epimerization are two important biochemical pathways via which 25-hydroxyvitamin D3 (25(OH)D3) is converted to its metabolites, 24,25-dihydroxyvitamin D3 (24,25(OH)2D3) or its C3 epimer, 3-epi-25-OH-D3 respectively. Mutations in the CYP24A1 gene cause reduced serum 24,25(OH)2D3 to 25(OH)D3 ratio (<0.02), elevated serum 1,25-dihydroxyvitamin D (1,25(OH)2D3), hypercalcemia, hypercalciuria and nephrolithiasis. Studies in infants have shown that 3-epi-25(OH)D3 can contribute 9-61.1% of the total 25(OH)D3. Therefore, measurements of parathyroid hormone (PTH) and vitamin D metabolites 25(OH)D3, 1,25(OH)2D3, 3-epi-25(OH)D3 and 24,25(OH)2D3 are useful to investigate whether the underlying cause of vitamin D toxicity is iatrogenic versus genetic. Here we report a case of vitamin D3 associated toxicity in a 4-month-old female who was exclusively breast-fed and received an oral liquid vitamin D3 supplement at a dose significantly higher than recommended on the label. The vitamin D3 content of the supplement was threefold higher (6000 IU of D/drop) than listed on the label (2000 IU). Due to overdosing and higher vitamin D3 content, the infant received ~50,000 IU/day for two months resulting in severe hypercalcemia, hypercalciuria and nephrocalcinosis. We also review the relevant literature on vitamin D3 toxicity in this report.
PMID: 25636720

5. A comprehensive scientific overview of Garcinia cambogia.

Fitoterapia. 2015;102:134-48. doi: 10.1016/j.fitote.2015.02.012.

Semwal RB, Semwal DK, Vermaak I, Viljoen A.

Abstract:
The fruit rind of Garcinia gummi-gutta, commonly known as Garcinia cambogia (syn.), is extensively used traditionally as a flavourant in fish curries due to its sharp sour taste. Additional ethnobotanical uses include its use as a digestive and a traditional remedy to treat bowel complaints, intestinal parasites and rheumatism. This small fruit, reminiscent of a pumpkin in appearance, is currently most popularly used and widely advertised as a weight-loss supplement. Studies have shown that the extracts as well as (-)-hydroxycitric acid (HCA), a main organic acid component of the fruit rind, exhibited anti-obesity activity including reduced food intake and body fat gain by regulating the serotonin levels related to satiety, increased fat oxidation and decreased de novo lipogenesis. HCA is a potent inhibitor of adenosine triphosphate-citrate lyase, a catalyst for the conversion process of citrate to acetyl-coenzyme A, which plays a key role in fatty acid, cholesterol and triglycerides syntheses. The crude extract or constituents from the plant also exerted hypolipidaemic, antidiabetic, antiinflammatory, anticancer, anthelmintic, anticholinesterase and hepatoprotective activities in in vitro and in vivo models. Phytochemical studies of various plant parts revealed the presence of mainly xanthones (e.g. carbogiol) and benzophenones (e.g. garcinol) together with organic acids (e.g. HCA) and amino acids (e.g. gamma aminobutyric acid). Currently, a large number of G. cambogia/HCA dietary supplements for weight management are being sold although the possible toxicity associated with the regular use of these supplements has raised concerns. In most cases, complaints have been related to multicomponent formulations and at this stage G. cambogia has not been confirmed as the potentially toxic culprit. This review presents a scientific overview of G. cambogia with reference to relevant botanical aspects, ethnobotanical uses, phytochemistry and biological activity as well as toxicity.
PMID: 25732350

6. Sibutramine, a serotonin-norepinephrine reuptake inhibitor, causes fibrosis in rats.

Environ Toxicol Pharmacol. 2015 May 22;40(1):71-76. doi: 10.1016/j.etap.2015.05.011. [Epub ahead of print]
Oberholzer HM, van der Schoor C, Bester MJ.

Abstract:
Sibutramine hydrochloride monohydrate is a weight loss agent indicated for the treatment of obesity. Although it has been banned from most markets, studies are still relevant as it is often a hidden ingredient in herbal and over the counter slimming products. Sibutramine induces liver fibrosis with steatosis in female Sprague-Dawley rats fed a high-energy diet without significant weight gain. In this study, using the same animal model, the effect of Sibutramine on lung morphology was investigated using histological evaluation of the terminal bronchiole and transmission electron microscopy evaluation of the respiratory tissue. From these results Sibutramine was found to induce lung fibrosis in Sprague-Dawley rats as increased collagen synthesis, mast cell accumulation and aggregates of Bronchus Associated Lymphoid Tissue (BALT) in the terminal bronchiole as well as increased collagen deposition in the respiratory tissue was seen.

PMID: 26070021

7. Toxicity of remedies for infantile colic.

Arch Dis Child. 2014;99:1147-8. doi: 10.1136/archdischild-2014-306885.

Rodríguez-González M, Benavente Fernández I, Zafra Rodríguez P, Lechuga-Sancho AM, Lubián López S.

No abstract.
PMID: 25169823

8. Hepatopathy following consumption of a commercially available blue-green algae dietary supplement in a dog.

BMC Vet Res. 2015;11:136. doi: 10.1186/s12917-015-0453-2.

Bautista AC, Moore CE, Lin Y, Cline MG, Benitah N, Puschner B

Abstract:
BACKGROUND: Dietary supplement use in both human and animals to augment overall health continues to increase and represents a potential health risk due to the lack of safety regulations imposed on the manufacturers. Because there are no requirements for demonstrating safety and efficacy prior to marketing, dietary supplements may contain potentially toxic contaminants such as hepatotoxic microcystins produced by several species of blue-green algae. CASE PRESENTATION: An 11-year-old female spayed 8.95 kg Pug dog was initially presented for poor appetite, lethargy polyuria, polydipsia, and an inability to get comfortable. Markedly increased liver enzyme activities were detected with no corresponding abnormalities evident on abdominal ultrasound. A few days later the liver enzyme activities were persistently increased and the dog was coagulopathic indicating substantial liver dysfunction. The dog was hospitalized for further care consisting of oral Sadenosylmethionine, silybin, vitamin K, and ursodeoxycholic acid, as well as intravenous ampicillin sodium/sulbactam sodium, dolasetron, N-acetylcysteine, metoclopramide, and intravenous fluids. Improvement of the hepatopathy and the dog's clinical status was noted over the next three days. Assessment of the dog's diet revealed the use of a commercially available blue-green algae dietary supplement for three-and-a-half weeks prior to hospitalization. The supplement was submitted for toxicology testing and revealed the presence of hepatotoxic microcystins (MCs), MC-LR and MC-LA. Use of the supplement was discontinued and follow-up evaluation over the next few weeks revealed a complete resolution of the hepatopathy. CONCLUSIONS: To the authors' knowledge, this is the first case report of microcystin intoxication in a dog after using a commercially available blue-green algae dietary supplement. Veterinarians should recognize the potential harm that these supplements may cause and know that with intervention, recovery is possible. In addition, more prudent oversight of dietary supplement use is recommended for our companion animals to prevent adverse events/intoxications.
PMID: 26087767

9. Pro-toxic dehydropyrrolizidine alkaloids in the traditional Andean herbal medicine "asmachilca".

J Ethnopharmacol. 2015 Jun 16. pii: S0378-8741(15)00420-1. doi: 10.1016/j.jep.2015.06.012

Colegate SM, Boppré M, Monzón J, Betz JM.

Abstract:
ETHNOPHARMACOLOGICAL RELEVANCE: Asmachilca is a Peruvian medicinal herb preparation ostensibly derived from Eupatorium gayanum Wedd.=Aristeguietia gayana (Wedd.) R.M. King & H. Rob. (Asteraceae: Eupatorieae). Decoctions of the plant have a reported bronchodilation effect that is purported to be useful in the treatment of respiratory allergies, common cold and bronchial asthma. However, its attractiveness to pyrrolizidine alkaloid-pharmacophagous insects indicated a potential for toxicity for human consumers. AIM OF THE STUDY: To determine if commercial asmachilca samples, including fully processed herbal teas, contain potentially toxic 1,2-dehydropyrrolizidine alkaloids. MATERIALS AND METHODS: Two brands of "Asmachilca" herbal tea bags and four other commercial samples of botanical materials for preparing asmachilca medicine were extracted and analyzed using HPLC-esi(+)MS and MS/MS for the characteristic retention times and mass spectra of known dehydropyrrolizidine alkaloids. Other suspected dehydropyrrolizidine alkaloids were tentatively identified based on MS/MS profiles and high resolution molecular weight determinations. Further structure elucidation of isolated alkaloids was based on 1D and 2D NMR spectroscopy. RESULTS: Asmachilca attracted many species of moths which are known to pharmacophagously gather dehydropyrrolizidine alkaloids. Analysis of 5 of the asmachilca samples revealed the major presence of the dehydropyrrolizidine alkaloid monoesters rinderine and supinine, and their N-oxides. The 6th sample was very similar but did not contain supinine or its N-oxide. Small quantities of other dehydropyrrolizidine alkaloid monoesters, including echinatine and intermedine, were also detected. In addition, two major metabolites, previously undescribed, were isolated and identified as dehydropyrrolizidine alkaloid monoesters with two "head-to-tail" linked viridifloric and/or trachelanthic acids. Estimates of total pyrrolizidine alkaloid and N-oxide content in the botanical components of asmachilca varied from 0.4% to 0.9% (w/dw, dry weight) based on equivalents of lycopsamine. The mean pyrrolizidine alkaloid content of a hot water infusion of a commercial asmachilca herbal tea bag was 2.2±0.5mg lycopsamine equivalents. Morphological and chemical evidence showed that asmachilca is prepared from different plant species. CONCLUSIONS: All asmachilca samples and the herbal tea infusions contained toxicologically-relevant concentrations of pro-toxic 1,2-dehydropyrrolizidine alkaloid esters and, therefore, present a risk to the health of humans. This raises questions concerning the ongoing unrestricted availability of such products on the Peruvian and international market. In addition to medical surveys of consumers of asmachilca, in the context of chronic disease potentially associated with ingestion of the dehydropyrrolizidine alkaloids, the botanical
origins of asmachilca preparations require detailed elucidation.
PMID: 26087231

10. Detection of pyrrolizidine alkaloids in German licensed herbal medicinal teas.

Phytomedicine. 2015 Jun 1;22(6):648-56. doi: 10.1016/j.phymed.2015.03.020. Epub 2015 Apr 29

Schulz M, Meins J, Diemert S, Zagermann-Muncke P, Goebel R, Schrenk D, Schubert-Zsilavecz M, Abdel-Tawab M.

Abstract:
BACKGROUND: Because of the hepatotoxic, mutagenic, and cancerogenic effects of pyrrolizidine alkaloids (PAs) the German Federal Institute for Risk Assessment (BfR) recommends not to exceed a daily PA intake of 0.007 µg/kg body weight (0.42 µg/60 kg adult).

In a recent study conducted by the BfR, up to 5647 µg PA/kg dried herbal material were detected in tea products marketed as food. PURPOSE: The present study aimed at elucidating whether medicinal teas licensed or registered as medicinal products contain PAs as well. STUDY DESIGN: One hundred sixty-nine different commercially available medicinal teas, i.e. 19 nettle (Urtica dioica L.), 12 fennel (Foeniculum vulgare Mill.), 14 chamomile (Matricaria recutita L.), 11 melissa (Melissa officinalis L.) and 4 peppermint (Mentha piperita L.) teas as well as 109 tea mixtures were analyzed for the presence of 23 commercially available PAs. METHOD: LC/MS was used for the determination of the PAs. RESULTS: In general, the total PA contents ranging 0-5668 µg/kg. Thirty percent of the tested single-ingredient tea products and 56.9% of the tested medicinal tea mixtures were found to contain PA concentrations above the limit of quantification (LOQ) of 10 µg/kg. In 11medicinal teas PA contents >300 µg/kg dry herb were determined thus exceeding the recommended limit for PA intake by BfR. In addition three products of the investigated tea mixtures revealed extremely high PA contents of 4227, 5137, and 5668 µg/kg. Generally, single-ingredient tea products contained much less or even no detectable amounts of PAs when compared to the tea mixtures. PAs in the range between 13 and 1080 µg/kg were also detected in five analyzed aqueous herbal infusions of the medicinal tea mixture products with the highest PA content. Two out of the five investigated herbal infusions exceeded the recommended BfR limit for PA intake. CONCLUSION: This study demonstrates clearly that also medicinal teas licensed as medicinal products may partly contain high amounts of PAs exceeding current recommendations. For that reason manufacturers are advised to carry out more rigorous quality control tests devoted to the detection of PAs. This is very important to minimize PAs in medicinal teas accounting for possible additional exposure of the consumer to PAs from other food sources (e.g. honey).
PMID: 26055130

11. Toxicity studies of medicinal plants used in sub-Saharan Africa.

J Ethnopharmacol. 2015 Jun 16. pii: S0378-8741(15)00413-4. doi:10.1016/j.jep.2015.06.005. [Epub ahead of print]

Boukandou Mounanga M, Mewono L, Aboughe Angone S.

Abstract:
In sub-Saharan Africa, traditional medicine is widely used in rural and urban areas also. This is essentially due to the prohibitive cost of pharmaceutical-based medicine and the low incomes of a major part of the population. In addition, the efficacies of many of these traditional and plant-based medicines are proven, but the fact remains that certain plants used in traditional medicine have toxic effects. It is in this perspective that we investigated by bibliographic literature on the toxicity of plants used in traditional medicine. It is crucial to gain knowledge on these plant-based medicines prepared and prescribed by practitioners, particularly in terms of toxicity, composition, specific efficacy of disease and to advise practitioners of this alternative medicine on the protection and security of patients.
PMID: 26087230

12. Recent Advances in Traditional Chinese Medicine for Kidney Disease.

Am J Kidney Dis. 2015 May 23. pii: S0272-6386(15)00644-7. doi:10.1053/j.ajkd.2015.04.013. [Epub ahead of print]

Zhong Y, Menon MC, Deng Y, Chen Y, He JC.

Abstract:
Because current treatment options for chronic kidney disease (CKD) are limited, many patients seek out alternative therapies such as traditional Chinese medicine. However, there is a lack of evidence from large clinical trials to support the use of traditional medicines in patients with CKD. Many active components of traditional medicine formulas are undetermined and their toxicities are unknown. Therefore, there is a need for research to identify active compounds from traditional medicines and understand the mechanisms of action of these compounds, as well as their potential toxicity, and subsequently perform well-designed, randomized, controlled, clinical trials to study the efficacy and safety of their use in patients with CKD. Significant progress has been made in this field within the last several years. Many active compounds have been identified by applying sophisticated techniques such as mass spectrometry, and more mechanistic studies of these compounds have been performed using both in vitro and in vivo models. In addition, several well-designed, large, randomized, clinical trials have recently been published. We summarize these recent advances in the field of traditional medicines as they apply to CKD. In addition, current barriers for further research are also discussed. Due to the ongoing research in this field, we believe that stronger evidence to support the use of traditional medicines for CKD will emerge in the near future.
PMID: 26015275

13. Mercury poisoning in two 13-year-old twin sisters.

J Res Med Sci. 2015 Mar;20(3):308-11

Khodashenas E, Aelami M, Balali-Mood M.

Abstract:
Mercury (Hg) is a toxic agent that evaporates in room temperature and its inhalation may cause poisoning. Due to the nonspecific symptoms, diagnosis is difficult in special circumstances with no initial history of Hg exposure. We report two such cases of Hg poisoning. The patients were two sisters, presenting with pain in extremities, itchy rashes, sweating, salivation, weakness, and mood changes. They have used a compound that contains mercury, for treatment of pedicullosis three months before admission. This compound was purchased from a herbal shop and was applied locally on the scalps for 2 days. Their urinary mercury concentrations were 50 and 70 mg/L. They were successfully treated by D-penicillamine and gabapentin. In a patient with any kind of bone and joint pain, skin rash erythema and peripheral neuropathy, mercury poisoning should be considered as a differential diagnosis.
PMID: 26109979

14. Life-threatening cardiovascular toxicity following ingestion of Chinese herbal medicine (letter)

Emerg Med Australas 2014 Oct;26(5):512-3. doi: 10.1111/1742-6723.12281.

Martinez A, Dobos N, Rotella JA, Greene SL.
PMID: 25159087

15. Persistent metabolic acidosis and severe diarrhoea due to Artemisia absinthium poisoning.

J Pak Med Assoc. 2014;64:1081-3.

Kocaoglu C, Ozel A.

Abstract:
Herbs have long been used in the treatment of various disorders in traditional medicine since ancient age. Artemisia absinthium, one of these herbs, has traditionally been used in different societies for antibiotic, antiparasitic, antifungal and antipyretic purposes. Here, we report a poisoning case of a 10-month-old male infant progressing with severe diarrhoea and persistent metabolic acidosis after ingesting home-prepared Artemisia absinthium extract which was given for the treatment of common cold.
PMID: 25823193

16. Toxic metal content in 52 frequently prescribed herbal medicines on the Korean market.

Food Addit Contam Part B Surveill. 2015 May 22. [Epub ahead of print]

Kim D, Hwang KH, Lee M, Kim JH, Jung K, Park SK.

Abstract:
This study was conducted to investigate the toxic metal content (Pb, As, Cd and Hg) of 52 frequently prescribed herbal medicines and to identify herbal medicines that exceed the Korea Food and Drug Administration (KFDA) maximum limits. A total of 3,534 samples, including 1,966 domestic samples and 1,568 imported samples were analyzed using an Inductively Coupled Plasma-Mass Spectrometer (ICP-MS). Total amounts of Pb, As, Cd and Hg were significantly different between domestic (0.63 mg kg(-1)) and imported medicines (0.81 mg kg(-1)) ($p<0.05$). Among the 52 kinds of samples, four kinds of herbs required quality control for Pb and 12 kinds of herbs required quality control for Cd. No samples contained As and Hg above the limits.
PMID: 26001121

17. [A Case of Lead Poisoning with Drug-induced Liver Injury after Ingestion of Herbal Medicine], [Article in Korean]

Korean J Gastroenterol. 2015 Jun 25;65(6):375-8. doi: 10.4166/kjg.2015.65.6.375

Jeon GJ, Park JH, Kim MS, Yu JW, Park JH, Kim MS.

Abstract:
A 61-year-old male patient was admitted because of unexplained abdominal pain and anemia. His past medical history was unremarkable except for having taken herbal medicine to treat facial palsy two months ago. The result of health examination performed about a month ago showed increased serum aspartate and alanine aminotransferase level, and he was diagnosed with toxic hepatitis by herbal medicine. When the patient presented to the outpatient department three weeks ago, follow-up liver function test results showed improvement but he complained of abdominal pain. Despite extensive blood chemistry tests and computed tomography, the cause of pain could not be found. After much deliberation, serum lead level and herbal medicines analysis was performed based on the fact that he took herbal medicine two months ago, and he could finally be diagnosed with lead poisoning. Since the serum lead level was high enough to be indicated for lead chelating therapy, conservative management was given. When a patient with toxic hepatitis due to herbal medication presents with abdominal pain, the possibility of lead poisoning should always be taken into consideration.

PMID: 26087694

18. Detection and characterization of SiO2 and TiO2 nanostructures in dietary supplements.

J Agric Food Chem. 2015;63(12):3144-52. doi: 10.1021/acs.jafc.5b00392.

Lim JH, Sisco P, Mudalige TK, Sánchez-Pomales G, Howard PC, Linder SW

Abstract:
Nanomaterials are beginning to enter our daily lives through various consumer products as the result of technology commercialization. The development of methodologies to detect the presence of nanomaterials in consumer products is an essential element in understanding our exposure. In this study, we have developed methods for the separation and characterization of silicon dioxide (SiO2) and titanium dioxide (TiO2) nanostructures in dietary supplements marketed in products specifically targeted for women. A total of 12 commercial products claiming the inclusion of SiO2 and TiO2, but not making any claims regarding the particle size, were randomly selected for purchase through various retailers. To isolate nanostructures from these products, a simple methodology that combines acid digestion and centrifugation was utilized. Once isolated, the chemical composition, size, morphology, and crystal structure were characterized using mass spectroscopy, light scattering, electron microscopy, and X-ray diffraction techniques. SiO2 and TiO2 nanostructures were detected in 11 of 12 products using these methods. Many of the isolated nanoscale materials showed a high degree of aggregation; however, identified individual structures had at least one dimension below 100 nm. These robust methods can be used for routine monitoring of commercial products for nanoscale oxides of silica and titanium.
PMID: 25738207