LEVELS OF PFOA DETECTED IN FOOD PACKAGING MATERIALS

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Introduction:
The use of various chemical additives in disposable food storage containers has been a common practice for many years in countries throughout the world. These chemical are used to improve the integrity and usefulness of the containers as well as the quality and shelf-life of the products stored in those containers. The advent of these chemically treated materials allowed the food packaging industry to produce inexpensive disposable containers that can safely, conveniently, and economically be used for the transport, storage, and often preparation of the food stuffs. These containers replaced the more expensive reusable storage and handling options that had traditionally been used in food packaging and preparation operations. The use of disposable containers offers many benefits including lower costs, reducing likelihood of cross-contamination, reduced equipment and cleaning cost, flexible packaging and storage options, improved shelf-life, and convenience of food preparation. However, along with these benefits there are questions about the affect these chemically treated materials may have on the products stored in them, and ultimately on the health and well-being of those consuming the food products. One of the chemical products used in the treatment of various packaging materials to improve the integrity of the product are perfluorinated telomers [1, 2, 3, 4, 5, 6]. In this study we will analyze a variety of food packaging materials to determine the presence and levels of PFOA in those products.

Materials and methods:
Samples of food packaging materials used in baking, candy making, fast food packaging, take-out food containers, and snack food items were purchased from local grocery and food establishments. The baking items included cupcake papers, disposable baking papers, candy cups, and parchment paper. The fast food items included paper and cardboard wrappers from hot dog, hamburgers, tacos, french fries, fried chicken, pizza, drink cups, and paper plates. The snack food items included bags and cartons from potato chips, crackers, tortilla chips, and microwave popcorn. The take-out containers analyzed were made of either Styrofoam or coated cardboard/hardboard material. The baking containers were all purchased and tested prior to exposure to food items, while the fast food, snack, and take-out food containers were all tested after exposure to the food product.

Samples were collected in three groups, the first being a general survey group, the second focusing on fast food container types having the highest level detected in the first sampling event, and the third consisting of microwave popcorn packaging materials only. The first study consisted of 14 samples with 3-5 samples each from baking, fast food, and snack food packaging. The second group of samples collected focused on the fast food and snack food packaging and take-out food container, and the third consisted of various microwave popcorn packages. The second and third groups were selected based on the results of the first sampling group and literature indicating that elevated levels had previously been detected in microwave popcorn packaging materials.

A 100cm^2 section of each sample was collected for testing. Efforts were made to collect a representative sample by taking the section from part of the container that would normally be in contact with the food product, but not bias the sample by including large sections containing seams, adhesives, or other materials that would not normally be in contact with the food product. The samples did however consist of both the inside and the outside of the packaging material because a section was taken directly from the carton or bag. Samples were collected from several different sections of the packaging in cases where there was a significant visible difference in the composition of the container. This was most apparent in the microwave popcorn packaging where there was a difference in the materials on the “this side up” and “this side down” portions of the packaging. The samples were each collected using cleaned scissors and stored in a Ziploc plastic bag from the time of collection until extraction.

Sample extraction consisted of fortification of samples with 13C-labeled PFOA and PFOS standards to samples followed by treatment with a sodium hydroxide solution. Following the basic treatment for a minimum of 30 minutes the samples were extracted with methanol using a combination of bath sonication for 3 hours followed by rotary tumbling for a minimum of 24 hours. The extraction process caused most of the samples to become completely broken down to a mushy consistency. The samples were then adjusted to a predetermined volume, filtered, and analyzed by LC/MS/MS for perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonate (PFOS). Sample analysis was performed using a Waters Acquity UPLC coupled to a Waters Quattro Premier MS. The sample results were reported on a per sample basis with each sample consisting of a $100cm^2$ of packaging material.

Results and discussions:

PFOA and PFOS concentrations in samples

The first group of samples collected consisted of several materials each used in baking, fast-food, and snack food packaging. These samples were analyzed for both PFOA and PFOS by LC/MS/MS. There were no detectable levels of PFOS at or above the reporting limit in any of the samples in the group. There were also no detectable levels of PFOA in the baking materials, which included paper and foil baking cups, paper candy cups, cupcake wrappers, and parchment paper. The fast-food packaging materials had three of seven samples with levels of PFOA detected slightly above the reporting limit, but the levels in the other 4 samples were either below the reporting limit or non-detect. The two samples of the microwave popcorn bags, one popped and the other non-popped, had the highest levels of PFOA in the set at 12 and 86 $ng/100cm^2$. The presence of PFOA in microwave packaging materials was consistent with results from other studies[4], but the exact extent and source of the PFOA detected from the popcorn bags was difficult to interpret because one of the samples was taken from the "Down" side of a popped bag, and the other was taken from the "Up" side of a non-popped microwave popcorn bag. Based on the results from the first "Survey Sampling" group, additional samples of the fast-food packaging and microwave packaging were collected. The samples were divided into two groups, which consisted of fast-food and snack food packages, and microwave popcorn packaging.

The fast-food and snack food packaging group contained sixteen samples, which included five snack food packages and eleven fast-food packages. None of the samples in the group had any detectable levels of PFOS present, and only three of the samples had a detectable level of PFOA above the reporting limit. Two of the samples with detectable levels of PFOA were the snack food wrappers and the other sample was a paper french fry bag. The microwave popcorn packaging consisted of 14 samples, which were made up of samples taken from the "Up" side and "Down' side each of popped and non-popped bags from three manufacturers, and opposite "Up" and "Down" sides from samples analyzed in the first sampling group. Ten of the fourteen samples of the popcorn bags had detectable levels of PFOA above the reporting limit. The four samples that did not have detectable levels were all samples of popped and unpopped bags from the same manufacturer.

The results of the analyses indicated that no PFOS was detected in any of the samples analyzed, and that 27 of the 45 samples also had no PFOA detected above the reporting limits of 10ng/sample ($100cm^{2)}$. Of the remaining eighteen samples that did have detectable levels of PFOA above the reporting limit, twelve were microwave popcorn wrapper, four were fast-food wrappers, and two were snack food packaging. The range of concentrations in the popcorn bags were from a low of $14ng/100cm^2$ to a high of $86ng/100cm^{2,}$ with an average concentration of $26ng/100cm^2$. The levels detected in the fast-food wrapper ranged from $10\text{-}155ng/100cm^{2,}$ with an average of $47ng/100cm^{2,}$ and the values for the two snack food packages were 52 and $85ng/100cm^{2.}$

The results of the analyses indicated there was a wide range of PFOA concentrations detected across the various packaging materials, ranging from ND to $155ng/100cm^{2.}$ These values represent the analysis of an extract from a total dissolution or extraction of the sample, and should therefore be considered to be a maximum possible concentration, and not necessarily represent the amount of PFOA that would be available or in contact with the food product contained within the packaging. The results for PFOA in the samples of the popcorn bags are slightly lower than the values reported in the Tittlemier SA et al. study[4] when the sample results are corrected for the weight of the $100cm^2$ samples, which weighed an average of 1.8g per $100cm^2$. The results of the study

can be used to help design further studies of the packaging materials such as surface wipe sampling or contact studies with food products that would provide additional information about how much of the total PFOA would be available for contact with food materials, and under what conditions of temperature, pH, moisture content, etc. the exposure would be the greatest.

References:

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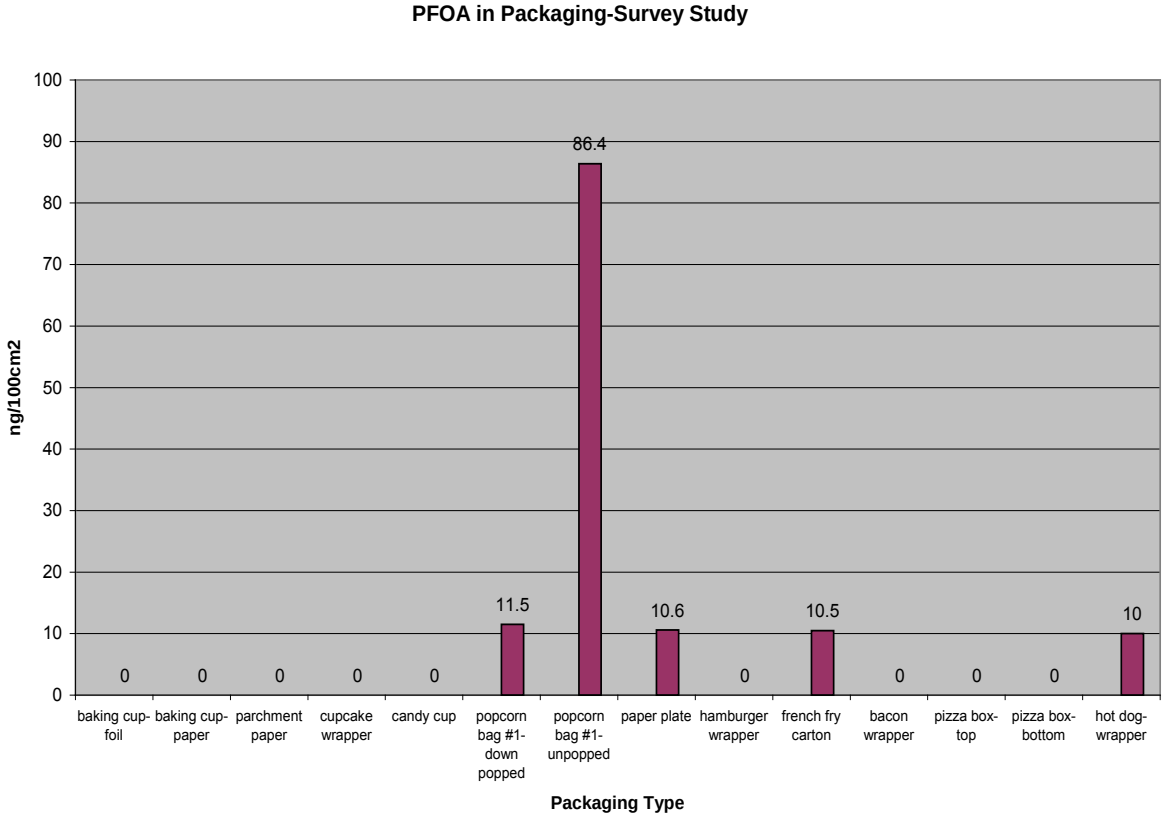
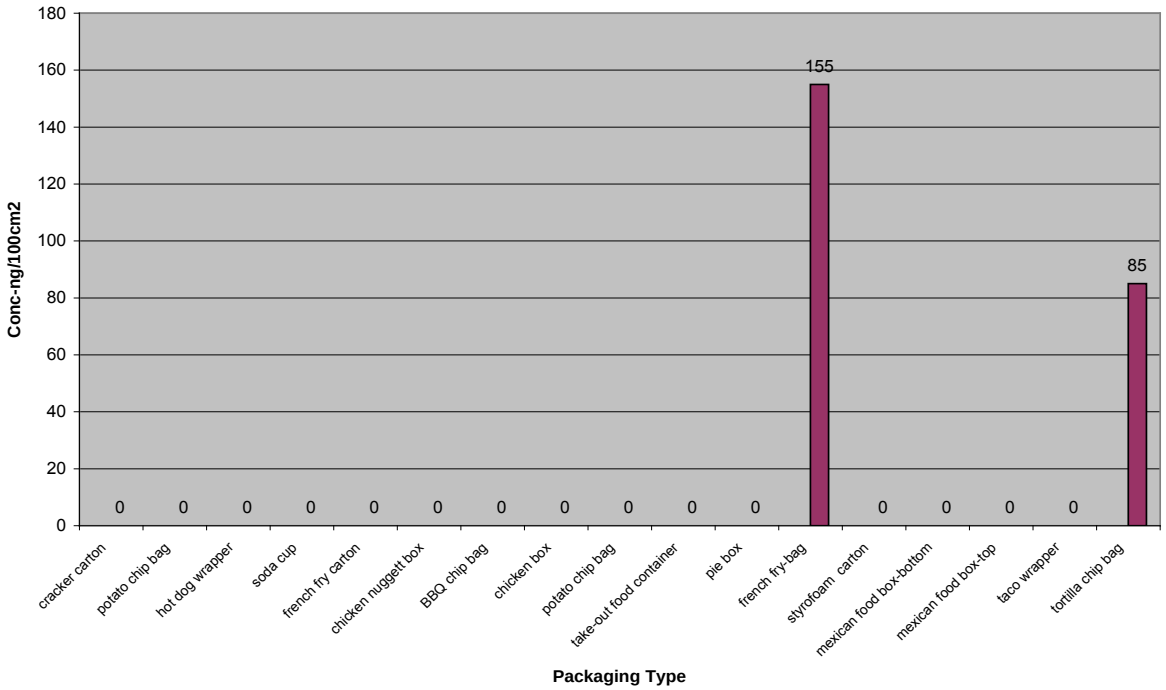


PFOA in Packaging-Various Packaging



PFOA-Popcorn Packaging