Title: Vulnerability Assessment of Critical Food Additives

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Research Theme: Risk Analysis

Participating State(s): Maryland, Minnesota

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Abstract: Several outbreaks of food borne illness have been linked to contaminated spices, occurring over the past 20 years and affecting hundreds of people (Van Doren, 2013). Meanwhile, the concern of intentional contamination of the food supply has grown as a priority among food producers, regulators, and security-focused agencies. The current study is a vulnerability assessment of the food supply to introduction of a chemical, toxin, or biological contaminant through a food additive. Quantitative methods were employed to identify additives and contaminants for the vulnerability assessment. Contaminants with sufficient toxicity to kill or infect people at very low doses, and which would survive food manufacturing processes were identified through a quantitative selection process. Additive selection was informed by initial modeling and by analysis of which additives are commonly consumed due to their presence in either a great number of foods or commonly consumed foods. Contamination was modeled using notional agents representing a wide range infectiousness or toxicity and stability. Notional agents were used to ensure the results could be shared at an unclassified level. The goal of the preliminary modeling was to identify foods in which specific additive/contaminant combinations would result in casualties. Initial results indicate that almost every food modeled represents a potential risk for additive contamination when using a highly stable and infectious or toxic agent. Work in Year 2 of the project will focus on data collection on additive use and manufacturing to inform the final risk assessment. Additional food contamination models will be built for foods that incorporate the selected additives. Research on the production, distribution, and use of additives will be leveraged along with the food contamination modeling to determine the extent to which contamination of an additive can impact the entirety of the food supply. By demonstrating the breadth of adulterated products and resulting casualties that can result from a single contaminated additive product, this study will fill a critical gap in our understanding of the vulnerability of the food supply to intentional contamination and will inform the development of systems.

Project Type: Research

End User Engagement:

- Center for Disease Control and Prevention
- DHS Science and Technology Directorate
- Food and Drug Administration
- U.S. Department of Agriculture

Executive Summary (2016): Food additives are minor ingredients that are added to foods in small amounts and have specific functions. Disease outbreaks involving the natural contamination of minor ingredients in foods, particularly spices, has demonstrated the possibility that contamination could result in illnesses or deaths. In this study, computer modeling of contamination scenarios was performed to

more clearly define the contribution of food additives to the vulnerability of the food supply to the intentional introduction of a chemical, toxin, or biological contaminant. Computational models were developed to simulate intentional contamination scenarios by tracking the fate of a contaminant through food production processes and distribution to estimate the potential illnesses and deaths in consumers. Models for 22 foods were developed using input from subject matter experts in the food and beverage industry and peer-reviewed scientific literature. Foods were selected to represent a diversity of food categories and processing conditions. Common additives in these foods were identified using an online food label database, from which ten additives were selected to be modeled based on their level of human consumption and overall prevalence of use. Fifteen biological, chemical, and toxin contaminants were selected based on properties such as infectiousness, toxicity, and environmental stability. Contamination scenarios were modeled using each contaminant in all food and additive combinations. At even modest contamination levels (0.01% to 1% of the additive is replaced with contaminant), almost all studied food and additive combinations can be contaminated and cause illnesses or deaths. Some foods can be targeted with additives containing as little as 1 ppm or less of a contaminant and still cause morbidity and mortality. The main factor reducing the vulnerability of different foods is heat processing steps, particularly high temperatures and long durations. Notably, common high temperature, short time (HTST) pasteurization practices are not sufficient to prevent illnesses or deaths caused by the chemicals, toxins, and atypical pathogens that may be used in an intentional attack. The contaminants that pose the highest hazard are typically the most toxic and hardiest toxins and chemicals. They are resistant to degradation in most processing conditions and also exhibit high toxicity, causing illnesses at low concentrations (less than 1 ppm in additives). Fortunately, such contaminants are few in number; most of those studied are either resistant to degradation or are highly toxic, but not both. Such agents can cause illnesses and deaths in many foods but only at high concentrations, or in relatively few foods but at less than 1 ppm in additives. The former group consists mostly of moderately toxic chemicals and toxins, while the latter group includes bacteria and heat-sensitive toxins. When assessing the vulnerability of food additives, the single most important factor is the typical inclusion rate (percent of the final product by weight) of the additive. Ingredients used at a higher inclusion rate can lead to more illnesses and deaths simply because they allow more contaminant to be introduced into a food. No other factors, including the function of the additive in foods, correlated with likelihood of illness or death.

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