Defending the Military Food Supply
Acquisition, Preparation, and Protection of Food at U.S. Military Installations

Andrew Mara and Lynn McGrath

Center for Technology and National Security Policy
National Defense University

September 2009

The views expressed in this article are those of the authors and do not reflect the official policy or position of the National Defense University, the Department of Defense or the U.S. Government. All information and sources for this paper were drawn from unclassified materials.

Dr. Andrew Mara is the 2008-09 AAAS Science and Technology Policy Fellow at the Center for Technology and National Security Policy based at the National Defense University. Andrew earned his PhD in Molecular, Cellular and Developmental Biology from Yale University. He also holds dual undergraduate degrees in Molecular Biology and Economics from the University of California at San Diego.

Lynn McGrath is a Research Assistant at the Center for Technology and National Security Policy based at the National Defense University.

Defense & Technology Papers are published by the National Defense University Center for Technology and National Security Policy, Fort Lesley J. McNair, Washington, DC. CTNSP publications are available at http://www.ndu.edu/ctnsp/publications.html.

Contents

Introduction

As the world becomes smaller, the presence of U.S. military forces in foreign countries is likely to continue. The ongoing military engagements in both Iraq and Afghanistan have taught us that U.S. troops stationed abroad are attractive targets for hostile governments, organizations, and individuals. A safe food supply is a core capability required for sustaining a military presence in a foreign country. While there are limited examples of attempts to poison the military food supply,[1,2] one cannot ignore the fact that contaminated food could rapidly and effectively reduce the combat readiness of American forces.

Most Americans assume that the United States food supply is both safe and secure. However, in January 2009, 31 million pounds of peanut butter and peanut paste produced by the Peanut Corporation of America (PCA) were recalled due to over 600 confirmed cases of *Salmonella.*[3] Not surprisingly, PCA filed for bankruptcy shortly thereafter. This incident, in addition to other recent outbreaks of pathogenic *Escherichia coli* and *Salmonella* has raised doubts about food safety. Moreover, these epidemics have highlighted the fact that food produced domestically (as was the case with PCA and with *E. coli* tainted spinach from California in the fall of 2006)[4] and imported from abroad (*Salmonella* contaminated Serrano peppers from Mexico in the summer of 2008)[5] can be an effective vector for illness.

The cases mentioned above are due to lapses in food safety, so what exactly is food defense? In the context of this report, food defense deals with the prevention of intentional contamination of food with any substance that can cause harm. Food safety, on the other hand, is defined as the prevention of accidental contamination of food. Since both food safety and food defense deal with the prevention of contamination, it follows that measures for enhancing food safety and food defense often go hand in hand. Throughout this report we will examine current measures in place to defend the military food supply. Where current efforts could be expanded we provide a series of recommendations that will enhance food defense and often provide ancillary benefits to the military.

---

1 Associated Press, "Insurgent suspected of mass poisoning of Iraq police," *The Australian*, October 11, 2006, available at <www.theaustralian.news.com.au/story/0,20867,20560653-2703,00.html>.

2 James Risen and Don van Natta, "Plot to Poison Food of British Troops is Suspected," *The New York Times*, January 24, 2003, available at <query.nytimes.com/gst/fullpage.html?res= 9F01E0DC 1639F937A15752C0A9659C8B63>.

3 FDA, "Recall of Peanut Containing Products: *Salmonella* Typhimurium," April 10, 2009, available at <www.fda.gov/oc/opacom/hottopics/Salmonellatyph.html>.

4 California Department of Health Services, "Investigation of an Escherichia coli O157:H7 Outbreak Associated with Dole Pre-Packaged Spinach," March 2007, available at <www.dhs.ca.gov/fdb/HTML/Food/EnvInvRpt.htm>.

5 CDC, "Investigation of Outbreak of Infections Caused by *Salmonella* Saintpaul," August 28, 2008, available at <www.cdc.gov/Salmonella/saintpaul/>.

Scope of this Report

As described later, the military food supply chain is long and complex, making a comprehensive examination of military food defense extremely difficult. We have limited the scope of this report to the most vulnerable sections of the military food supply. Specifically, we will discuss food defense for troops stationed outside the United States. While domestic contamination of food is a possibility, the foreign supply chain is longer and ultimately more vulnerable. Furthermore, we will not deal with the defense of meals, ready-to-eat (MREs). The individually sealed packaging of MREs makes mass contamination difficult, rendering MREs a less than ideal target. Furthermore, MREs are produced exclusively in the United States and under strict regulation, further decreasing their attractiveness as a target.[6] For these very reasons, MREs and Unitized Group Rations (UGRs) are often designated as emergency food sources should a food defense breach occur. Finally, we will assume that food delivered from the United States is free from contamination when it leaves the production facility. For a number of reasons, it would be extremely difficult to specifically target food destined for the military this early in the supply chain.

[6] Interview with Dr. Ana Sanders, Chief, Quality Audits and Food Defense Branch at Defense Supply Center Philadelphia, October 17, 2008.

Likelihood of an Attack

The importance of the U.S. food supply was recently highlighted when the agricultural system was identified as a critical infrastructure.[7] Despite the apparent vulnerability of the food supply, there are limited examples of intentional contamination of food. In fact, a recent study of *all* food defense breaches *worldwide* from 1950 on concluded that only 391 fatalities and 4,355 injuries have resulted from intentional contamination. The most successful of these attacks occurred in 1984, when a cult in The Dalles, Oregon, contaminated restaurant salad bars with *Salmonella typhphimurium*. The attack, which made 751 people ill, appears to be the only publicly confirmed case of food terrorism in the United States. Several other instances of deliberate contamination have occurred, though they have been relatively minor, often affecting fewer than ten individuals.[8] Further, we could identify only two recent attempts to specifically poison military food supplies. In January 2003, several "Islamic militants" were arrested for plotting to poison food at a British military base, though no such attack ever took place.[9] In October 2006, approximately 400 Iraqi police officers succumbed to food poisoning. There were few if any fatalities and it remains unclear if they were intentionally poisoned or simply were served spoiled food.[10]

The low number of attacks on the food supply and their relative ineffectiveness call into question the idea that food is an attractive target. In fact, a number of logistical problems may make food a difficult target. First, food is often washed, cooked, or prepared in ways that may render many contaminants inactive. Thus, in order to effectively compromise the food, it must be adulterated late in the supply chain, when mass contamination becomes more difficult. Supporting this idea, one study has indicated that 98 percent of food attacks occur at retail outlets, in homes, or at the workplace.[11] It may also be difficult to contaminate food specifically destined for the military. Many food items used by the U.S. military are also consumed by the general public. In order to direct an attack at military personnel, contamination would need to occur after food was designated for military use, decreasing the number of opportunities for attack. Furthermore, any contaminant added early in the food production cycle will likely become diluted (from the addition of more ingredients) or inactivated (by cooking), such that it may be reduced to ineffective levels or eliminated entirely. In addition, food contamination will likely not generate the same amount of publicity as a more radical attack, such as a bombing, would and may not even be recognized as an intentional attack. In the case of the Oregon cult, described above, the contamination was not recognized as intentional until a year after

[7] "Homeland Security Presidential Directive 7", December 17, 2003 and "Homeland Security Presidential Directive 9", January 30, 2004.

[8] W. Seth Carus, "Bioterrorism and Biocrimes: The Illicit Use of Biological Agents Since 1900," February 2001, available at <www.ndu.edu/centercounter/Full_Doc.pdf>.

[9] James Risen and Don van Natta, "Plot to Poison Food of British Troops is Suspected, " *The New York Times*, January 24, 2003, available at <query.nytimes.com/gst/fullpage.html?res=9F01E0DC 1639F937A15752C0A9659C8B63>.

[10] Associated Press, "Insurgent suspected of mass poisoning of Iraq police," *The Australian*, October 11, 2006, available at <www.theaustralian.news.com.au/story/0,20867,20560653-2703,00.html>.

[11] G. R. Dalziel, "Food Defense Incidents 1950–2008," Manyang Technological University, 2009, available at <www.rsis.edu.sg/CENS/publications/reports/RSIS_Food%20Defence_170209.pdf>.

the attack, and then only because a defector from the cult revealed the attack. Thus, the publicity benefit or "shock value" to a terrorist organization may be minimal. Finally, an attack on the food itself (agroterrorism), rather than its human consumers, may have a higher impact. For example, a release of avian influenza or foot and mouth disease virus (FMDV) could have catastrophic impacts on the U.S. economy that would dwarf the damage caused by targeting consumers.[12,13,14]

These facts, however, do not support the position that military food defense should be ignored. There is no doubt that contamination of the food served to U.S. troops overseas is a real possibility that could seriously decrease their combat readiness, both physically and psychologically. However, when thinking about food defense, we must be cognizant of the cost-benefit ratio of increased capabilities. Thus, when considering methods of increasing our food defense capabilities, we should be particularly aware of both the cost and the additional benefits of these methods. Fortunately, many of the techniques that can be used to defend the military food supply have additional benefits for food safety, delivery, and storage.

---

[12] GAO, "Much is Being Done to Protect Agriculture from a Terrorist Attack, but Important Challenges Remain," March 2005, GAO-05-214, available at <www.gao.gov/new.items/d05214.pdf>.
[13] Mark Polyak, "The Threat of Agroterrorism: Economics of Bioterrorism," *Business & Finance*, 2004, available at <www.biodefense.georgetown.edu/publication/economicsofbioterrorism.pdf>.
[14] Jim Monke, CRS Report RL32521, "Agroterrorism: Threats and Preparedness," August 13, 2004 available at <www.fas.org/irp/crs/RL32521.pdf>.

Threats to the Food Supply

Biological

The prevalence of accidental contamination of food with dangerous pathogens such as *E. coli*, *Listeria*, and *Salmonella* clearly demonstrates the difficulties in preventing biological contamination of food. Furthermore, biological agents have a number of properties that make them appealing weapons against the military food supply. Perhaps most importantly, biological agents are self-propagating. With a small initial sample size and rudimentary cell biology training, a motivated group or individual can grow a large amount of agent. Obtaining a small sample of the agent may be easier than expected, since many potential biological agents are naturally occurring or can be obtained for legitimate research purposes. There are certainly technological barriers to mass producing biological agents, but the contamination of salad bars in Oregon with *Salmonella* demonstrates that these barriers are not insurmountable.

The epidemiology of a biological attack also makes biological agents attractive food contaminants. Many pathogens do not produce symptoms until days or weeks after being ingested. Thus, many people may consume the contaminated food before there is any sign that contamination occurred. This delay in the onset of symptoms also makes it extremely difficult to determine the source of contamination. In the 2006 outbreak of pathogenic *E. coli* in spinach, there was a 6-month delay between the first reported case and the issuance of the FDA's final report that identified the *likely* source of contamination.[15] Furthermore, some pathogens are transmissible from person-to-person, increasing the effectiveness of the attack by infecting individuals who have not actually consumed the tainted food.

Biological toxins (botulinum, ricin, shiga, etc.) are special cases of biological agents. These agents come from biological sources and are chemical or protein based nonliving agents. These toxins are not self-propagating and are non-communicable, possibly rendering them less attractive as food contaminants. In addition, it may be difficult to obtain sufficient quantities of the toxins to effectively contaminate food. Toxins also cause symptoms in humans relatively quickly (hours rather than days), so that a toxin attack will likely be detected much sooner than a bacterial or viral attack. Nevertheless, toxins should also be considered as biological threats to food defense.

The wide range of biological threats makes it difficult to effectively test the food supply for the presence of each possible agent. Thus, preventing contamination of food with biological agents should be focused on the agents with the highest probability of use and impact of attack. Agents identified by the CDC as category A or B bioterrorism agents[16] (see table 1) are of great interest, especially agents in which food is known to be an effective vehicle for transmission. Naturally occurring food pathogens such as

---

[15] California Department of Health Services, "Investigation of an Escherichia coli O157:H7 Outbreak Associated with Dole Pre-Packaged Spinach," March 2007, available at <www.dhs.ca.gov/fdb/HTML/Food/EnvInvRpt.htm>.

[16] Centers for Disease Control and Prevention, "Bioterrorism Agents/Diseases by Category," available at <www.bt.cdc.gov/agent/agentlist-category.asp>.

Salmonella and pathogenic *E. coli* should be an area of focus. It is important to note that Category A agents are not necessarily a larger threat to the food supply than either Category B or unlisted agents. For example, given the natural occurrence and known food-borne transmission of *E. coli* and *Salmonella,* a strong argument can be made that these agents may be of higher priority than all of the Category A agents.

TABLE 1. RELEVANT BIOTERRORISM AGENTS AND DISEASES

CDC CATEGORY A[17]	*CDC CATEGORY B*[18]	*SELECT HHS/USDA*[19]
ANTHRAX	CHOLERA	BRUCELLOSIS
BOTULISM	E.COLI	EPSILON TOXIN
PLAGUE	Q FEVER	HENDRA VIRUS
SMALLPOX	RICIN TOXIN	NIPAH VIRUS
TULAREMIA	SALMONELLA	RIFT VALLEY FEVER VIRUS
FILOVIRUSES	SHIGELLA	STAPH ENTEROTOXINS
ARENAVIRUSES	VIRAL ENCEPHALITIS	T-2 TOXIN

Chemical

Uncountable numbers of chemicals are toxic if ingested in sufficient quantity (see table 2 for examples). This fact makes it very unlikely that food can be tested for all potential chemical weapons. The 2008 incident of melamine-contaminated milk in China is the perfect example of unexpected chemical adulteration. Prior to the discovery of melamine (a chemical used primarily in plastics and concrete) in dairy products, this chemical would not have even been considered as a potential food contaminant.[20] The addition of melamine to dairy products appears to have been for economic gain (melamine disguised the low nitrogen content of heavily diluted milk). However, more nefarious examples of chemical contamination have also occurred. For example, in January 2008, the board members of an Iraqi sporting club were poisoned with thallium that had been added to a cake. Ten people were poisoned, four of them fatally.[21] Again, testing food for thallium (a heavy metal used in some manufacturing processes) is extremely unlikely, given the low probability of its use as a poison.

TABLE 2. SELECTED POTENTIAL/PREVIOUSLY USED CHEMICALS

ARSENIC	*ETHYLENE GLYCOL*	*SARIN*
BLEACH	MELAMINE	SODIUM AZIDE
CYANIDE	MERCURY	THALLIUM
DRANO	PARATHION	VX

[17] Ibid.
[18] Ibid.
[19] National Select Agent Registry, "HHS and USDA Select Agents and Toxins," available at <www.selectagents.gov/agentToxinList.htm>.
[20] For more information on melamine see <http://www.fda.gov/oc/opacom/hottopics/melamine.html>.
[21] CDC, "Thallium Poisoning from Eating Contaminated Cake – Iraq, 2008," *Morbidity and Mortality Weekly Report,* September 19, 2008 available at <www.cdc.gov/mmwr/preview/mmwrhtml/ mm5737a3.htm.>

The large number of readily available chemicals that could be used to poison food should cause some concern.[22,23] However, a number of factors make the use of chemical poisons difficult. Many chemicals will alter the taste, smell, or appearance of food, increasing the chance that the contamination is detected. Furthermore, if the chemicals have rapid, acute toxicity, few victims are likely to have ingested the food before the contamination is noticed and identified. Finally, chemical poisons are not transmissible between people, meaning that individuals must actually eat the food to be affected.

The huge number of potential chemical agents that could be used severely limits the effectiveness of testing for the presence of specific chemicals. Food defense measures to combat chemical contamination must focus on prevention of contamination rather than detection. Accordingly, most food defense plans focus on the secure storage of toxic chemicals and limited access to food preparation areas. By the time the chemical has been added, there is little chance that it will be detected, because quality control for many food ingredients is limited to visual inspections. Unfortunately, many toxic chemicals can look very similar to food ingredients.[24]

Radioactive

Radioactive contamination has received additional attention since September 2001, particularly because of fear of "dirty bombs," which use conventional explosives to disperse radioactive materials. Radioactive materials could be used to contaminate food, and the general anxiety about radiation may magnify the disorganization and hysteria caused by such an incident. Additionally, radioactive isotopes can be effective poisons, as evidenced by the poisoning of Alexander V. Litvinenko, a former KGB official, with polonium-210 in 2006.[25] However, a number of factors make radiological contamination of food unlikely. First, it is difficult to obtain enough radioactive material to sicken a large number of people, due to dilution of the radioactive agent in the food. Further hampering this sort of attack, most potent sources of radiation are tracked and carefully documented, limiting the access of potential terrorists. Of eight identified cases of radiological material being added to food, five were conducted by researchers who had legitimate access to the radioisotope. Furthermore, all eight cases led to only one fatality and 36 injuries.[26] Thus, biological and chemical attacks may be much more likely. Given the difficulty in obtaining radioactive material, it is more likely that such material would be used in a high profile incident, such as a "dirty bomb."

---

[22] For some examples see Donald Hickman, "A Chemical and Biological Warfare Threat: USAF Water Systems at Risk," September 1999, available at <www.au.af.mil/au/awc/awcgate/cpc-pubs/hickman.htm>.

[23] For a list of household agents that have been used to poison food see G. R. Dalziel, "Food Defense Incidents 1950-2008," Manyang Technological University, 2009, available at <www.rsis.edu.sg/CENS/publications/reports/RSIS_Food%20Defence_170209.pdf>.

[24] Presentation by Shaun Kennedy, Director of the National Center for Food Protection and Defense.

[25] Alan Cowell, "Radiation Poisoning Killed Ex-Russian Spy," *The New York Times*, November 24, 2006, available at <www.nytimes.com/2006/11/24/world/europe/25spycnd.html>.

[26] G. R. Dalziel, "Food Defense Incidents 1950-2008," Manyang Technological University, 2009, available at <www.rsis.edu.sg/CENS/publications/reports/RSIS_Food%20Defence_170209.pdf>.

The U.S. Military Food Supply Chain: From Domestic Source to Foreign Military Base

The U.S. military receives food through a long and complex system. As noted earlier, this report focuses on food delivered to foreign bases, as we believe this supply chain to be most vulnerable. Most packaged, non-perishable food is obtained from U.S. manufacturers and distributed through the Defense Supply Center Philadelphia (DSCP) Prime Vendor program. In fact, most food must be purchased from U.S. sources, as required by the Buy American Act and the Berry Amendment.[27] Food procurement for Iraq and Afghanistan has been excluded from the Berry Amendment due to operational considerations. However, most non-perishable food is still acquired from U.S. manufacturers.[28] Food from the manufacturer is then shipped to a prime vendor distribution center, which handles the logistics of packaging the various food items for shipment in large shipping containers. Food is loaded into shipping containers and hauled by truck to the port of embarkation, where it may sit unattended for up to a week. Eventually, the containers are loaded onto a U.S.-flagged ocean vessel. The transit takes roughly 40–50 days, after which the container is stored at the port of debarkation for up to a week, though longer delays are possible. From the port, containers are moved via truck to the foreign-based prime vendor distribution facility, where they are unloaded. Depending on the final destination of the container, it may be loaded onto smaller watercraft or rail cars. The food is stored at the prime vendor facility until it is ready for delivery to the military installation. When an order for food comes into the distribution center, the food is packed onto pallets and shipped via truck to the military installation, were it is unloaded and stored according to the protocol for each installation.[29]

The U.S. Military Food Supply Chain: From Foreign Source to Foreign Military Base

Generally speaking, perishable food items such as fresh produce, dairy products, and baked goods are not shipped from U.S. manufacturers. Instead they are procured from sources in each country either directly, or through the prime vendor. Prior to supplying a U.S. military installation, each facility must first be approved by the U.S. Army Veterinary Command (VETCOM) (for the continental United States, Europe, and the Pacific) or by a similar unit in Central Command (CENTCOM) (all other areas).[30] Goods are shipped directly from these local suppliers to the military installation or to the prime vendor who then ships them to the military installation.

The U.S. Military Food Supply Chain: Preparation of Food at Military Bases

The operation of dining facilities has largely been contracted to civilian companies. Food is transported to various dining facilities and then stored and prepared by contractor personnel that are often drawn from the local population or other foreign countries.

---

[27] Valerie Grasso, "Department of Defense Food Procurement: Background and Status," CRS Report, August 28, 2008, available at <http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-10644:1>.
[28] Interview with Dr. Ana Sanders.
[29] Ibid.
[30] Interview with COL Tim Stevenson, US Army, Deputy Director, DOD Veterinary Service Activity on February 20, 2009.

Current Food Defense Measures

Food defense was not a major concern in the United States prior to the attacks of September 11, 2001. In fact, food production facilities were not even required to register with the FDA until December 2003 (a requirement of the Public Health Security and Bioterrorism Preparedness and Response Act of 2002).[31] While this requirement was a step forward in food defense, by providing the Government with a list of food producers that could be referenced in response to an attack, it offers very little help in the prevention of food-based attacks. Domestically, the FDA and USDA are primarily responsible for monitoring the safety of food.[32] Even so, there are no universal government requirements for food defense. For example, no Government agency has the authority to institute a *mandatory* food safety recall. Nevertheless, for the purposes of this report, we will assume that the food produced at domestic facilities is safe, and that intentional contamination would occur after production (i.e., during transport, storage, or preparation).

While there are no government-wide food defense requirements, the Department of Defense (DOD) requires some level of food defense as specified by the Antiterrorism Standards set forth in DOD Instruction 2000.16. Depending on the current Force Protection Condition (FPCON), certain standards of food defense come into effect. For example, at FPCON Bravo, DOD installations must "Initiate food and water risk management procedures, brief personnel on food and water security procedures, and report any unusual activities."[33] These standards are necessarily vague, given the individual needs of different installations. However, food defense is at least a recognized and required component of DOD antiterrorism efforts.

Each military installation is required to have a food defense plan, which the Army has provided a framework for developing. All Army installations must have a Food Defense Assessment Team (FDAT) that conducts food vulnerability assessments and crafts a regularly updated food defense plan. The Army provides a guide to identify vulnerabilities and implement additional security measures that limit these vulnerabilities based on the potential hazard and likelihood of an attack. Possible security measures include additional training for food service personnel, increased physical security of food service areas, background checks and ID cards for food service personnel, and monitoring of self-service food areas. Obviously, the effectiveness of the food defense plan at each installation depends on the quality of the FDAT.

Widening the view beyond the installation level, all parts of the food chain regulated by DSCP are required to have a food defense plan that complies with the DSCP Food Defense Checklist. The checklist is detailed and quite comprehensive, including provisions dealing with personnel, physical security of the premises, review and implementation of the food defense plan, emergency procedures, and recall capability.

---

[31] See <http://www.fda.gov/oc/bioterrorism/Bioact.html> for more info.
[32] For more details, see Donna Vogt, CRS report, "Food Safety Issues in the 109th Congress," February 4, 2005, available at <digital.library.unt.edu/govdocs/crs/permalink/meta-crs-6475>.
[33] DODI 2000.16, available at <www.dtic.mil/whs/directives/corres/html/200016.htm>.

All DSCP food contracts require that the facilities be inspected by DSCP to ensure that the proper food defense measures are in place. In general, after the initial inspection, facilities are inspected again on a yearly basis. Obviously, the food defense plan for each contractor will be specific to their particular operations. Thus, it is difficult to provide a comprehensive look at food defense plans in general, though the DSCP Food Defense Checklist provides a framework. Still, the requirement of food defense plans in subsistence contracts was a valuable step forward in promoting a safe food supply for the U.S. military.[34]

Perishable items, which are generally outside the jurisdiction of DSCP, are acquired locally. All facilities from which these items are purchased must be approved by VETCOM or CENTCOM, which perform periodic inspections of each facility. Traditionally, these inspections were based on food safety and primarily concerned with sanitary conditions. However, the inspections have been updated to include measures of food defense.[35] Generally speaking, facilities are inspected on a yearly basis, though some smaller manufacturers or producers of "low-risk" food items may be inspected less frequently. "High-risk" producers may be visited more frequently (up to four times per year). Visits consist of physical inspection of the facility for compliance with the various requirements of the food defense audit report. Microbiologic, chemical, and radiologic testing is conducted as part of the facility inspection. While facilities must have an employee screening mechanism in place, these mechanisms may not be as rigorous as those in comparable U.S. facilities.[36]

[34] Interview with Dr. Ana Sanders.
[35] Military Handbook 3006C, "Guidelines for Auditing Food Establishments," June 1, 2008, available at <http://assist.daps.dla.mil/quicksearch/basic_profile.cfm?ident_number=208822>.
[36] Interview with COL Tim Stevenson.

Figure 1. The Food Defense Checklist

The Defense Supply Center Philadelphia (DSCP) is a subsidiary of the Defense Logistics Agency (DLA) and is tasked with providing the United States armed service members with food, clothing, textiles, medicines, medical equipment, and construction supplies and equipment. Within DSCP, the Subsistence Directorate serves as the key link between the Armed Forces and the U.S. Food Industry. As part of this mission, DSCP requires subsistence contractors to address Food Defense concerns using the DSCP Food Defense Checklist. This Checklist serves three purposes:

1) As a communication tool to inform prospective contractors of areas of concern that must be addressed and expected to be covered/included in their Documented Food Defense Plan submitted to DSCP
2) As a guideline used by DSCP Auditors to evaluate the adequacy of Documented Food Defense Plans
3) As a guideline (along with a contractor's approved Food Defense Plan) to verify implementation, compliance, and effectiveness of the plan in protecting the type of products and facility in question.

The DSCP Food Defense Checklist delineates the subsistence supply chain, and it is required that contractors' Food Defense Plans outline appropriate preventative measures to protect each stage of this supply chain. These stages include: receipt, production, storage, assembly, delivery, and shipment. The Food Defense Plan is subsequently submitted to DSCP where it is given a rating of acceptable, marginally acceptable, or unacceptable.

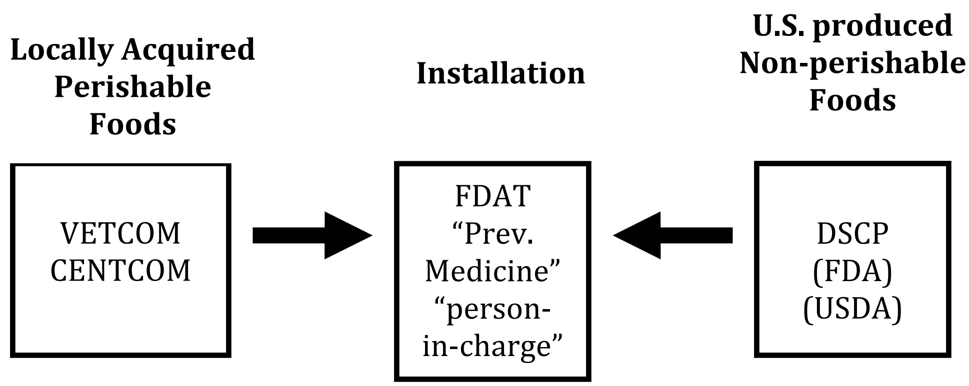
A copy of the DSCP Food Defense Checklist can be found at this web address: www.dscp.dla.mil/subs/fs_check.pdf.

Once food is delivered to a military installation, shipments are inspected by VETCOM or CENTCOM. These inspections include looking for signs of physical damage, inconsistent storage conditions, and food deterioration.[37] Food is then stored and prepared for serving at dining facilities. Dining facilities undergo periodic inspections for food safety and food defense. These inspections are performed by each service's office of preventative medicine. For example, the Army's Proponency Office for Preventative Medicine (POPM) performs safety inspections for Army facilities on anywhere from a yearly to bi-weekly basis depending on the perceived risk of the facility.[38] These inspections are primarily concerned with issues of food safety (sanitation, proper food storage, pest control, etc.), though in the last several years, they have been upgraded to include measures of food defense (restricted access, secure storage of chemicals, etc). POPM also performs physical inspections of some food shipments at each dining facility. Oversight of the daily operations of dining facilities falls into the hands of the contracting company. The designated "person-in-charge" is required to make daily inspections of the facility and document weekly inspections. Again, these inspections focus primarily on

[37] Interview with COL Tim Stevenson.
[38] See Technical Bulletin "MED 530: Occupation and Environmental Health Food Sanitation," available at <www.army.mil/usapa/med/index.html

food safety but do provide an additional element of food defense.[39] The primary motivation for food service contractors to ensure food is safe seems to be monetary, though pride may be an additional motivator. Incidents of food-borne illness may cause individual employees to be fired, or the loss of lucrative contracts at the corporate level.

Figure 2. Food Defense Areas of Operation for a Generic Army Installation



The Vulnerabilities

Transportation

As the military food chain described earlier shows, food can spend days or even months in transport from the United States to a foreign military installation. For much of this time, food is stored in locked naval shipping containers that are often not actively monitored. A recent report from the Volpe National Transportation Systems Center noted that it may be possible to gain access to these containers while remaining undetected. Furthermore, shipping containers or the goods contained in them may be clearly marked for the U.S. Military, identifying ideal targets for attack. Currently, shipping containers are protected with physical seals that must be broken in order to access the cargo. While these seals can be effective, shipping containers are often opened for legitimate reasons (i.e., customs inspections), requiring that new seals be attached. Then, all new seal information must be recorded and tracked to ensure that all seal changes were appropriate. In addition, the seals are particularly low tech, and the fabrication of fake seals is a distinct possibility. Even if a fake or broken seal is identified, inspectors and investigators will be unable to determine when the container was actually breached. The close stacking of cargo containers on ships may prevent access to many containers while on sea vessels. Unfortunately this same situation does not occur while the containers are stored at ports.

Outside of shipping containers, food is often transported from manufacturers to distribution centers and from distribution centers to military installations by truck. In

[39] Ibid.

hostile areas, these trucks may be guarded by military convoys. Generally, these trucks are secured with physical locks, though it is possible that food inside the trucks could be compromised.

The Volpe report suggests that food not be overtly marked for delivery to U.S. forces. However, as the report noted, other more subtle factors may identify military bound shipments, such that additional measures may be necessary to further protect the food supply.

Storage
Food is stored outside shipping containers several times throughout the supply chain. For example, non-perishable goods from the United States are stored in the warehouses of the continental U.S. prime vendor, the foreign prime vendor, and again at the military installation. All of these storage facilities could be potential points of food contamination. Currently, food defense plans submitted to DSCP or developed by the FDAT should have measures in place to ensure that these facilities are secure.[40] Beyond the enforcement of these plans and regular inspections, it may be difficult to further secure storage areas. Storage at the military installation may be an exception.

Preparation
As noted earlier, it may be difficult to effectively contaminate military food early in the supply chain due to dilution effects and the fact that food preparation may inactivate some agents. For this reason, many of the documented cases of effective food contamination involve contamination at these late stages. Therefore, adulteration of military food during preparation is perhaps the most serious and likely risk. Food preparation for U.S. military forces has been increasingly contracted out to private companies. Contracting out some aspects of military operations has budgetary advantages. However the hiring of foreign nationals (via these contracts) to prepare food for the U.S. military may create additional complications for food defense. For example, a typical background check for a food service worker may consist solely of a call to the local sheriff's office. Even then, a minor criminal record may not disqualify a worker.[41] By definition, these workers have intimate access to military food immediately before it is served to troops. In addition, oversight of food workers is often left to the contracting "person-in-charge." As stated by Technical Bulletin MED 530 "Ultimately, the responsibility for providing safe sanitary food lies with the person-in-charge of the food establishment."[42] While monetary and ethical concerns should ensure that this person remains diligent about the safety of food, a similar system of incentives in domestic food safety has recently shown a number of cracks, suggesting that an "honor code" system of supervision may not be sufficient.

[40] Interview with Dr. Ana Sanders.
[41] Interview with COL Tim Stevenson.
[42] See Technical Bulletin "MED 530: Occupation and Environmental Health Food Sanitation," available at <www.army.mil/usapa/med/index.html>.

Enhancing Food Defense Capabilities

For many reasons, some of which were discussed earlier in this report, it is impossible to ensure that food consumed by U.S. troops is 100 percent safe. In fact, there are questions about the likelihood of an attack on the military food supply. Keeping these points in mind, enhancements to military food defense capabilities should be cost-effective and ideally will provide additional benefits that help offset what costs they do have.

Transportation

It is impossible to physically monitor food at each stage during transportation, and requiring military oversight of the entire supply chain would be both unwieldy and extremely expensive. A number of recent technological advancements may allow for efficient, remote monitoring of shipments during transport. As discussed earlier, military food supplies spend a large amount of time in 40-foot shipping containers. These containers spend days or weeks in ports and aboard sea vessels where they are virtually unmonitored. However, it will be possible in the short term to monitor the location and integrity of these containers in real-time. The Mobile Asset Tag Tracking System (MATTS) being developed by iControl Systems and the U.S. Department of Homeland Security (DHS) will allow for real-time GPS tracking of the location of shipping containers for up to 70 days, even when they are stored below the deck of a cargo ship. Furthermore, MATTS will integrate with container security devices (CSDs), currently being developed by the Science Applications International Corporation and the Georgia Tech Research Institute. These CSDs can detect any opening of the shipping container door beyond two inches and immediately record the date and time of the breach and notify a data center that a breach has occurred. [43,44,45] Since most authorized openings of shipping containers can be predicted, any unanticipated access can be immediately investigated. Obviously, knowing the location and status of cargo at all times during shipment will decrease the likelihood of unnoticed contamination. Containers that have been subject to unauthorized openings can be further examined for problems before continuing delivery to military installations.

The MATTS/CSD combination has several advantages that make it a good fit for food defense. First, the MATTS system has undergone substantial testing and proved effective in monitoring the location of cargo through trans-ocean shipping. According to DHS, it should be ready for use in 2009. CSDs are also undergoing testing and should be ready for use sometime shortly after MATTS. Thus, MATTS/CSD can be deployed in the field relatively quickly. Second, MATTS/CSD is not prohibitively expensive. DHS expects the cost of MATTS/CSD to be approximately $100 per shipping container per trip.[46] Given that the value of the cargo far exceeds this amount (for example, one case of 12 MREs costs almost $100 on its own) MATTS/CSD appears to be a relative bargain. Furthermore, being able to track the location and status of shipping containers has

[43] For more information, see the iControl website <www.icontrol-inc.com>.
[44] Interview with George Cavage General Manager at iControl Incorporated on November 6, 2008.
[45] Interview with Ken Concepcion, DHS Project Manager on December 17, 2008.
[46] Ibid.

multiple benefits for the U.S. military. Knowing the location of shipping containers could allow the military to streamline its supply chain, similar to the "just in time" shipping methods employed by large retailers around the world. During the run-up to the Iraq war, many shipping containers sat in foreign ports waiting for transport to distribution hubs. Being able to track the shipments in real-time may allow for better planning to avoid these types of problems in the future. In addition, tracking data could promote the recovery of stolen military shipments. Together, these two benefits could lead to an actual net savings by implementing MATTS/CSD on military food shipments. Finally, while the current CSDs monitor only door openings, future CSD could also monitor cargo temperature, light levels, and even take periodic photos of the cargo which could be analyzed later to detect tampering.

Implementation of the MATTS/CSD system on all military food shipments would provide valuable tracking and status information that would significantly enhance our food defense capabilities. The cost to implement this system seems minor compared to the cost of the cargo itself. Additionally, the benefits of real-time tracking and status updates may lead to additional capabilities and cost savings that would outweigh the cost of MATTS/CSD itself. The considerations make MATTS/CSD a viable option to increase our military food defense.

In addition to transporting food in large shipping containers, food is often transported to or from distribution centers via cargo trucks. Whiles these trucks can not currently be outfitted with a MATTS/CSD device, DHS has helped develop another technology, called an M-Lock which provides many of the benefits of MATTS/CSD in a simple compact device. M-Lock is basically a large padlock with integrated GPS systems. This lock also records all openings. Similar to MATTS/CSD the M-Lock would enhance security of food shipments and provide additional cost saving benefits by combating theft of military cargo. Costs for M-Locks are predicted to be in the $400-600 range in addition to any costs to develop the monitoring infrastructure.[47,48] At this price point, M-Locks may be an appropriate addition to military food defense.

Decontamination of Foreign Produce

Perishable food such as produce, milk, and baked goods are often acquired from foreign markets that are located close to the military installation. While these facilities must be approved by VETCOM, the foreign food safety systems may not be as robust as those in the United States. In addition, this food may be accessible to the general public and more susceptible to contamination. Finally, since these products are consumed raw or without further processing, contaminants are likely to remain active and undiluted.

Washing produce can help to physically remove contaminants from produce. Adding an anti-microbial agent to the wash water increases the effectiveness of washing by orders of magnitude.[49] Ozonated water washes could enhance the safety of produce served at

---

[47] Interview with George Cavage.
[48] Interview with Ken Concepcion.
[49] Reviewed in M.A. Kadre et al, "Microbiological Aspects of Ozone Applications in Food: A Review," *Journal of Food Science*, 66, no. 9, 2001.

military installations. Compared to antimicrobial chemicals, ozone has several advantages. First, ozone naturally degrades into oxygen, leaving no dangerous or toxic chemicals in discarded wash water.[50] In addition, ozone is a general oxidizing agent, meaning that it can destroy both biological and chemical agents with varying efficacy.[51] Ozonated wash water has been tested against a number of naturally occurring food pathogens and was shown to quickly reduce the levels of many bacteria by several orders of magnitude.[52] Installing an ozone wash station in military facilities could greatly enhance the safety of foreign produce by reducing both accidental and intentional contamination. These wash stations do not require large amounts of equipment (just a basin, spray bar, and ozone generator) and could be installed for approximately $60,000.[53] While ozone treatment is a promising technology, DOD would have to test the efficacy of these wash systems on the range of concentration, contaminants, and food items that are the most likely threat to the military food supply. It is possible that intentional contamination would lead to such high levels of agent that contamination reduced 100- or 1,000-fold would still cause significant casualties. In addition, some foods or agents may be resistant to ozonated washes. A research program to test the effectiveness of ozone washes on fresh produce would determine if the benefits of such a system outweighs its costs.

Reduced Contracting of Military Food Preparation

A number of budgetary concerns have led to the increased use of contractors in the U.S. military.[54] Conventional wisdom states that some activities, such as food preparation, that are not “inherently governmental” should be outsourced to minimize their costs.[55] There is certainly some logic behind this wisdom. By hiring contractors only when services are actually necessary, the government can decrease the number of troops in our “standing army.” More contracts can be awarded when a “surge” in capacity is necessary so that the government pays for this capacity only when it is used.

On the surface, preparation of food seems to be a function that could easily be outsourced to contractors. Food preparation is not “inherently governmental” and can be performed cheaply by unskilled labor. Furthermore, within the United States, food workers can be extensively screened with background checks, limiting the chances that they will attempt to compromise military food. Unfortunately, this situation changes drastically in foreign countries. Here, food workers are often drawn from the local population, where proper background checks and screening may be extremely difficult. For extended foreign

---

[50] J.G. Kim et al, “Application of Ozone for Enhancing the Microbiological Safety and Quality of Foods: A Review,” *Journal of Food Processing*, 62, no. 9, 1999.

[51] For example, destruction of cyanide, J.M. Monteagudo et al., “Advanced oxidation processes for destruction of cyanide from thermoelectric power station waste waters,” *Journal of Chemical Technology and Biotechnology*, 79, no. 2, 2004.

[52] Reviewed in M.A. Kadre et al, “Microbiological Aspects of Ozone Applications in Food: A Review” *Journal of Food Science*, 66, no. 9, 2001.

[53] Interview with Andy Smith VP of Products, PurFresh Inc on November 6, 2008.

[54] GAO report “DOD’s Extensive Use of Logistics Support Contracts Requires Strengthened Oversight,” July 2004, available at <www.gao.gov/new.items/d04854.pdf>.

[55] Office of Management and Budget Circular A-76, May 29, 2003, available at <www.whitehouse.gov/omb/circulars/a076/a76_incl_tech_correction.html>.

engagements (such as those in Afghanistan and Iraq) or for extremely high-risk facilities, the military could benefit from "in-sourcing" the preparation of food. While this option is certainly more expensive, there is no doubt that the security of military food could be greatly enhanced by keeping it within the control of military personnel. We recommend that a cost-benefit analysis be performed specifically examining the additional cost of maintaining an enlisted group of personnel designated for food preparation in high-risk areas of foreign countries. Alternatively, enhanced oversight of contractors at dining facilities might serve the same function at a reduced cost. Along these lines, the assignment of just a few military personnel per facility who are specifically charged with supervising workers to ensure food safety and defense may effectively limit food defense vulnerabilities and enhance food safety.

Increased Use of Pathogen Detection Systems

As noted earlier, the most effective food attacks will likely occur late in the supply chain. Agents added early in the supply chain could be diluted or deactivated due to preparation steps. Testing for pathogens should occur late in the food chain, since testing at this point will detect agents that have been added at *any* time prior to the test.

Unfortunately, current testing technologies are generally slow, expensive, and limited in the scope of threats that they can detect. Indeed, the range of toxic chemicals that could be added to food is so vast that it is virtually impossible to list them, let alone design a test for them. On the other hand, the list of biological agents or toxins likely to be used for food contamination is substantially lower, such that effective testing methodologies may exist. That is not to say that testing for biological agents is a simple task. Many tests require an enrichment period of up to 24 hours to amplify the agent to a testable level.[56] In the world of food preparation, this testing period may be far too long. However, such testing capabilities could be applicable for DSCP/VETCOM/POPM inspections or as a suggestion for manufacturers in food defense audits. Here we provide the few examples of commercially available, or nearly available technologies that could be used to test for food contamination. These detectors are by no means the only technologies being developed. However, a recent review of sensor technology demonstrates that many technologies have not been tested on complex, food-based samples.[57,58] While they may provide sensitive and accurate results with pure biological samples, the presence of the food (e.g., ground meat) can inhibit testing reactions. We recommend that DOD provide funding for the testing of these technologies on food samples (see box "Breaking the Barriers between Food Safety and Food Defense).

There are currently only two detectors available that allow for the rapid detection of a wide spectrum of biological agents and toxins: the RAZOR EX developed by Idaho Technologies[59] and the RAPTOR by Research International.[60] While these detectors have

---

[56] For example, Idaho Technologies RAPID LT Food Security System. For more information see <www.idahotech.com/RAPIDLT/RAPIDLT-FSS.html>.

[57] AK Bhunia, "Biosensors and Bio-Based Methods for the Separation and Detection of Foodborne Pathogens," *Advances in Food Nutrition and Research*, 54, 2008.

[58] Communication with Dr Arun Bhunia, Professor at Purdue University, December 2008.

[59] For more information see <www.idahotech.com/RAZOREX/index.html>.

[60] For more information see <www.resrchintl.com/raptor-detection-system.html>.

their relative merits, they also suffer from a number of problems that lessen their usefulness.

The RAZOR EX is a portable, automated system that detects a wide range of bioagents and naturally occurring food pathogens from samples that are collected using a swab. The RAZOR detects the DNA of pathogens using polymerase chain reaction (PCR) chemistry. One run tests for eight likely biological food contaminants in less than 30 minutes. Unfortunately, each test can process only one sample, and the test kits are expensive (approximately $200 per test). In order to rapidly screen a number of food items in a dining facility, testing personnel would require several machines (at ~$40,000 apiece) and many testing kits.[61] Obviously a thorough testing regime would be extremely expensive. In addition, the RAZOR is a "quick and dirty" type testing device and is capable of detecting only gross contamination. For example, current detection thresholds for bacteria are around 2,000 colony forming units per milliliter (CFU/ml),[62] whereas the infective dose of pathogenic *E. coli* can be as little as 10 bacteria total.[63] To put this measure into further perspective, the EPA considers just 235 CFU/ml of any type of *E. coli* to be unacceptable in water for recreation (swimming, etc.) let alone for consumption.[64] The fact that the RAZOR operates so quickly precludes it from detecting low levels of bacteria. In terms of terrorism, this high detection level is considered acceptable, since terrorist attacks are likely to involve very high levels of bioagents. In a more diluted food setting, it remains to be seen if the same circumstances will hold. Due to the low level of detection, use of the RAZOR would be limited to detection of intentional contamination only. Unintentional contamination, such as that often seen in commercial recalls, would likely remain undetected, such that there are likely few collateral benefits to employing a device such as the RAZOR. Moreover, a negative test result may provide a false sense of security, since a "negative" sample may still contain enough agent to sicken military personnel.

[61] Interview with Christina Flowers, Eastern Sales Manager-Biodefense, Idaho Technologies on January 27, 2009.
[62] Ibid.
[63] H. Petridis et al, "E. coli O157:H7 A Potential Health Concern," University of Florida, October 2002, available at <edis.ifas.ufl.edu/SS197>.
[64] EPA, "Ambient Water Quality for Bacteria-1986," January 1986, available at <www.epa.gov/waterscience/beaches/files/1986crit.pdf>.

Breaking the Barriers between Food Safety and Food Defense

It is clear that the military does not have the funding or resources to perform routine microbiological testing of the 20,000+ military food suppliers. The military can encourage routine testing by the suppliers themselves through DSCP/VETCOM food defense checklists, however suppliers may still not have an economic incentive to institute such testing.

All food suppliers however, have a large incentive to ensure that their food remains safe from natural food contaminants. As was the case with *Salmonella* contamination and the Peanut Corporation of America, a massive safety recall often leads to bankruptcy. Thus, if easy to use food defense tests can be combined with food safety tests, food manufacturers may voluntarily conduct their own testing for both naturally occurring food pathogens and biological warfare agents.

Currently, an invisible wall separates biological warfare agents and natural occurring pathogens in terms of research and development funding and policy decisions. Given that the detection of both categories relies on the same testing principles there is no reason that testing devices/regimens should be separated for food safety and food defense. In fact, combining testing in these two areas may provide the economies of scale to make wide-scale microbiological testing a reality.

Furthermore, the RAZOR was not specifically designed to test food samples. Thus, it has not been extensively tested on a wide range of food products. Idaho Technology claims that is has been used to test some food items, though it is limited to sample swabbing techniques that test the surface of the food. Therefore, the tester could swab an area of food that is not highly contaminated (for example, the underside of a piece of lettuce) and obtain a false-negative test result. In addition, it is not clear how food that is collected on the swab (like ground beef) will affect test results. While representatives at Idaho Technology claim that these problems should be relatively minor, more thorough testing on food samples is necessary.[65]

Research International has developed a competing detector, the RAPTOR, which operates on fluorescent antibody detection, rather than PCR.[66] The RAPTOR is extremely similar to the RAZOR, despite these technological differences. For this reason, many of the potential problems discussed above also apply to the RAZOR. The systems are similar in cost, although each test kit for the RAPTOR can test up to 30 samples as long as it does not sense a positive result (positive tests must be discarded while negative tests can be reused). Thus, the incremental costs for the RAPTOR will be lower. The RAPTOR can currently test for only four contaminants at a time, although a new version (the BioHawk) can test for eight. Similar to the RAZOR, the RAPTOR was not designed

[65] Interview with Christina Flowers.
[66] For more information see <www.resrchintl.com/raptor-detection-system.html>.

for food defense, and has not been extensively tested on food samples.[67] One academic lab has tested the RAPTOR on various food matrices with encouraging results.[68] The RAPTOR is a "quick and dirty" type detector and will most likely be unable to detect unintentional contamination.

In summary, the commercially available, broad spectrum, rapid biodetectors may not be particularly well suited for routine testing of military food supplies. Of the instruments available, the RAPTOR has the lowest cost per test if a positive result is unlikely. The vast majority of tests conducted on military food are likely to be negative, thus the RAPTOR (or its successor the BioHawk) may be the preferable detector for food defense. The relatively low marginal cost of RAPTOR operation (~$10 per test)[69] may make weekly or even daily testing of a small set of food samples an effective way to enhance the military's food defense capabilities. If nothing else, it could provide a valuable deterrent effect. Alternatively, use of a device like the RAPTOR could be limited to instances when contamination is suspected. For example, processing several samples from a shipping container that has been subject to an unauthorized breach may build confidence that the food in that container has not been contaminated.

Testing and Development of New Contamination Sensors

There are relatively few commercially available, broad spectrum detectors for potential food contaminants. However, there is no shortage of potentially high-impact new technologies that allow for rapid detection of food pathogens at low levels. Advances in piezoelectric sensors, immunomagnetic separation, surface plasmon resonance, and other technologies show promising results in pathogen detection.[70] Unfortunately, most of the technologies have been tested on a limited number of pathogens and may not have been tested at all on food samples. Some of these technologies are being developed for commercialization. For example, Creativ Microtech and Hanson Technologies have both licensed sensor technologies from the Naval Research Lab to develop high sensitivity biodectectors. Creativ Microtech has developed an extremely sensitive fluorometer which they believe will be able to detect bacteria in the 50-100 CFU/ml range, roughly 10X more sensitive than the RAPTOR or RAZOR. The testing protocols for the fluorometer are still under development, and Creativ has indicated that while they would like to develop a wide range of testing protocols for various food samples, they are currently unable to obtain funding to produce test kits including biowarfare agents. As such, they are focusing exclusively on natural food pathogens in their current product development.[71]

Another intriguing technology involves using color-changing labels on food packaging. These labels can detect pathogens in the food inside the packaging and undergo a chemical color change reaction when the pathogen is present. This change in color

[67] Interview with David McRae, Vice President, Research International on January 30, 2009.
[68] For example, Brian Tims and Daniel Lim, "Confirmation of viable E. coli O157:H7 by enrichment and PCR after rapid biosensor detection," *Journal of Microbiological Methods*, 55, 2003.
[69] Interview with David McRae.
[70] AK Bhunia, "Biosensors and Bio-Based Methods for the Separation and Detection of Foodborne Pathogens," *Advances in Food Nutrition and Research*, 54, 2008.
[71] Interview with Pete Amstutz, CFO, and Cha-Mei Tang, CSO, Creatv Microtech on February 2, 2008.

reveals a word or symbol indicating that the food is not safe for consumption. Several different groups are working on these types of labels, though none are ready for commercial use.[72] In addition, these stickers will initially detect only natural food pathogens. While this technology is not ready for military food defense, further development of pathogen sensitive labeling may yield an easily-identifiable, cost effective way of protecting the military food supply.

There are substantial numbers of new biodetectors that may be able to enhance food defense. Unfortunately, many of these sensors have not been thoroughly tested on a large number of bioagents or have not been tested in food-based applications. We recommend that DOD provide funding to test promising technologies on pathogen-contaminated food, especially fresh produce, which may be particularly vulnerable. While some funding of this type has certainly been provided, food defense is often an afterthought of companies developing biodetectors. By providing funding targeted specifically at detecting agents in food, DOD can promote the production of biosensors that enhance the security of the military food supply.

[72] For example see <www.toxinalert.com>.

Conclusion and Recommendations

The size and scope of the military food supply leave it vulnerable to attack. Terrorists and insurgents are aware of this vulnerability and have been attacking supply lines from Pakistan into Afghanistan.[73] Despite this vulnerability, there are a number of mitigating factors that may reduce the effectiveness and likelihood of an attack. Thus, measures used to increase military food defense should undergo a rigorous cost benefit analysis. We have made several recommendations that we feel could provide short term, high impact gains in military food defense. These recommendations often provide additional benefits to the military, helping mitigate their substantial costs.

Recommendation 1: Install Mobile Asset Tag Tracking System (MATTS)/Container Security Devices (CSD) or similar systems on all shipments of military food. These devices will provide continuous, real-time data on the location and status of all food shipments. In addition to their role as a "virtual watchdog" for military shipments, they will provide valuable tracking data that military logistics can use for supply chain streaming. MATTS/CSD or a similar asset tracking system should also act as a powerful deterrent for the theft of military goods. The projected cost of $100/trip/shipping container is low when compared to these benefits.

Recommendation 2: Field test ozonated wash stations for the decontamination of fresh produce. Since produce is acquired directly from foreign sources and often consumed raw or with little processing, it is especially vulnerable to contamination. Washing produce with ozonated water has been shown to quickly reduce the amount of contaminating bacteria by several orders of magnitude. In addition, ozone can degrade some chemical agents. The military should investigate the feasibility, cost, and effectiveness of ozone washes for food defense.

Recommendation 3: Investigate the feasibility of manning foreign dining facilities with military personnel or placing designated food safety/defense personnel at each dining facility. Food that is contaminated late in the supply chain is likely to have the largest effect on military troops. Currently, most food preparation is performed by contractors who often draw workers from the local population. It can be extremely difficult to perform sufficient checks on these workers' backgrounds. Thus, the extra cost incurred by manning foreign dining facilities with enlisted soldiers may be justifiable. The military should examine the additional costs of this strategy. An alternative plan could involve increased oversight of contractor personnel with assigned food safety/food defense personnel from the military.

Recommendation 4: Institute increased testing of military food with biosensors. Given the large number of potential bioagents and the short detection time necessary for food defense, any biodetector will need to be both versatile and agile. Unfortunately, these two qualifications often come with a substantial cost. For routine testing of food to

---

[73] Salman Masood, "Bridge Attack Halts NATO Supplies to Afghanistan," *The New York Times*, February 3, 2009, available at <www.nytimes.com/2009/02/04/world/asia/04pstan.html?partner=rss&emc=rss>.

be cost-effective, the cost per test must be quite low. The ability to reuse some of the reagents in the RAPTOR drives the cost per test to below $10. At this price point, use of the RAPTOR, or its successor the BioHawk, becomes feasible. Alternatively, devices like the RAPTOR could be used to test only suspicious samples, such as food from a container that has been subjected to an unauthorized breach. DOD could also strongly encourage the use of microbiological testing for both naturally occurring and biowarfare pathogens in facilities that wish to provide food to the U.S. military.

Recommendation 5: Increase funding dedicated to the testing and development of chemical and biological detectors for food-based samples. Many exciting detector technologies are being developed by academic, government, and commercial laboratories. However, the use of these detectors in food is often an afterthought. The few groups attempting to develop detectors for food applications are usually focusing their efforts on naturally occurring food pathogens. Given the military's somewhat unique need to detect both naturally occurring and intentionally added agents, DOD needs to provide a funding incentive to develop technologies that test for a wide spectrum of agents in food samples. These types of detectors are unlikely to be developed independently by industry. Recently increased attention on food safety may provide additional political willpower to fund this type of research.

Appendix 1: List of Abbreviations

Centers for Disease Control	CDC
Central Command	CENTCOM
Colony forming units	CFU
Congressional Research Service	CRS
Container Security Device	CSD
Defense Logistics Agency	DLA
Defense Supply Center Philadelphia	DSCP
Department of Defense	DOD
Department of Health and Human Services	HHS
Department of Homeland Security	DHS
Food and Drug Administration	FDA
Food Defense Assessment Team	FDAT
Foot and Mouth Disease Virus	FMDV
Force Protection Condition	FPCON
Government Accountability Office	GAO
Meal, ready-to-eat	MRE
Milliliter	ml
Mobile Asset Tag Tracking System	MATTS
Peanut Corporation of America	PCA
Polymerase Chain Reaction	PCR
Proponency Office for Preventative Medicine	POPM
Unified Group Ration	UGR
United States Department of Agriculture	USDA
Veterinary Command	VETCOM