

FOOD AS A WEAPON

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Food safe to eat and sufficient in quantity has been a human preoccupation for time out of mind. Infections and poisons consumed in food have been a time-honored method of assassination, siege, and terrorism. The court taster was as much a part of the aristocratic entourage as the court jester. During the past century food safety and sufficiency were transformed from a household necessity to a public expectation. The contemporary capacity to grow, harvest, process, and market foodstuffs is as much an achievement for human health as the development of antibiotics and vaccines. However, there is no free lunch. The food system, just like the health care system, is vulnerable to natural and artificial adulteration and contamination (1-4).

Methods of weaponizing food and choice of targets depend upon the motivations and objectives of the perpetrator(s) (Table 1). Destroying farmland and destroying crops are among the oldest uses of food as a weapon. Destruction of farms, crops, and food supplies is a tactic of warfare between nations or armies. As the processing and distribution of food become more complex and far-flung, people dependent upon others for their food supply are vulnerable to malnutrition and starvation, and to food-borne poisoning or infection. Food is a natural vehicle for pathogenic microbes and their toxins. Contamination or adulteration of food and water for select target populations are the methods of terrorists interested in revenge or displaying ideological principles. Food bioterrorists are likely to be disgruntled individuals or small ideologically-driven groups, such as an angry employee of a supermarket or food processor, or groups advocating so-called direct action, like the religious group that gave *Salmonella* to a lot of people in Oregon (5), or the rabid animal rights and environmental groups. Bioterrorists would be able to disrupt the life of localities by contaminating water supplies with agents like *Cryptosporidia*. An outbreak of diarrheal disease could shut down the operations of a police force, an aircraft carrier, or a military base. Schools with their centralized kitchens and set menus are a prime target for a food bioterrorist. Schools are such a public concern and community focus that any hostile act against them, no matter how small, can destroy a community.

Table 1 - FOOD AS WEAPON

Motive	Objective
Warfare	1. Select targets
Terrorism (revenge / ideology)	2. Enough casualties and disruption to <ol style="list-style-type: none">Produce fear and media recognitionDestroy confidence in infrastructureDestroy market for particular food products or producers

Table 2 - WHY WOULD TERRORISTS CHOOSE FOOD AS A WEAPON

1. Illness and disability; not widespread fatalities

- a. Disrupt daily life
- b. Adulteration of food is an inefficient method of killing large numbers in a setting of large varieties and choices
- c. Except when a population is dependent upon a restricted variety of foodstuff
 - i. Emergency food relief is an ideal situation for making food a lethal vector of chemical or infectious agents

2. Probable targets

- a. Localities
- b. Food vendors: e.g. chain franchise restaurants
- c. Food sources for special groups
 - i. Military bases
 - ii. Schools
 - iii. Ships, aircraft
- d. Food producers, especially meat and dairy

I have found the notion of "food paths" helpful. A food path is the route of a mouthful of food from seed or embryo to the stomach. In the United States we have become accustomed to food cornucopia. Our markets are a constant source of amazement with a profligate variety of sources, supplies, and kinds of food. Our diet has a multitude of food paths. A terrorist would have a difficult time producing mass casualties by adulterating only a single food item. On the other hand, a refugee camp dependent upon a single supplier of only basic foodstuffs is a splendid target for a terrorist who could produce mass casualties relatively easily. As a general rule, the longer and the narrower or more restricted the food path is, the greater the vulnerability to food weapons. Some of the features of our present food supply system that predispose to vulnerability from food terrorism include centralization of processing and factory-like animal and poultry husbandry.

Figure I - FOOD PATH

The route of the mouthful from the seed or embryo to the gourmet's stomach

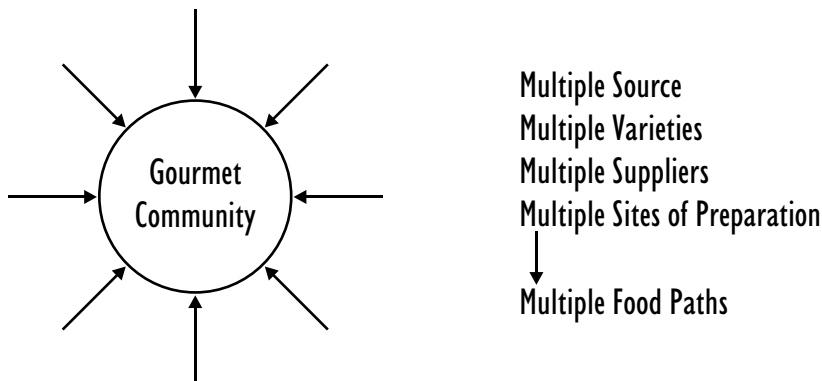
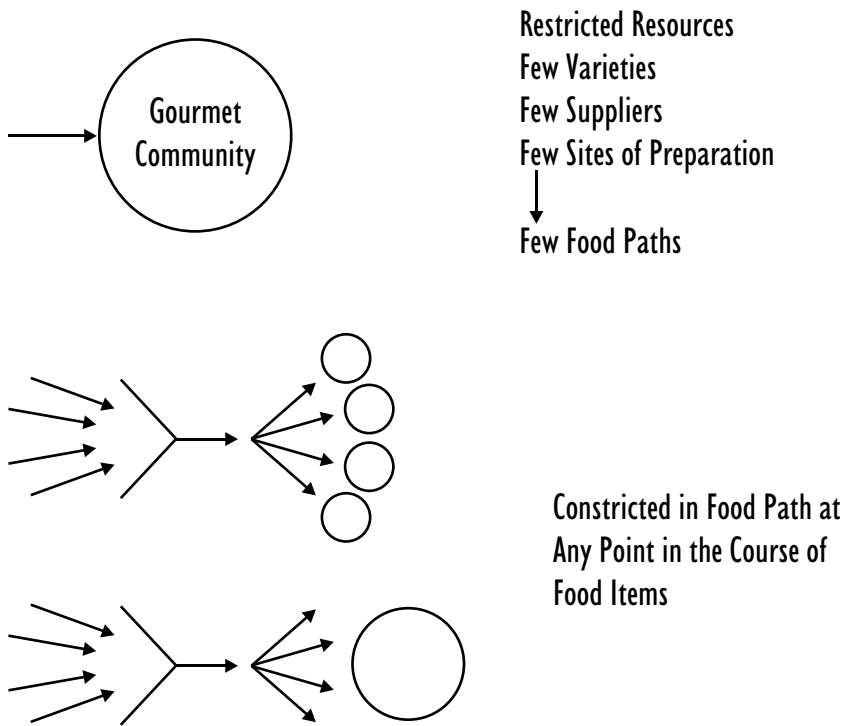


Figure 1 - FOOD PATH (Cont.)



The narrower the "food path" the greater the vulnerability

It is important to recognize that contemporary poultry and animal husbandry are especially vulnerable to bioterrorism using pathogens that kill or spoil the meat of birds and quadrupeds. The surreptitious introduction of Newcastle virus or rinderpest could ruin a producer and seriously reduce meat supplies. The introduction of taura or white spot virus into shrimp farms would have a similar effect upon large aquaculture enterprises. The huge manure lagoons that are an essential component of mass production of meat animals are targets: breaching the dikes and allowing the contents to spread into the watershed and water supply would create an infectious and olfactory health hazard. Outbreaks of *E. coli* 0157:H7 have been attributed to runoff from dairy and cattle operations; and the outbreak of *Pfisteria* infection along the Atlantic coast and Chesapeake Bay followed heavy rains and flooding of animal wastes into the watershed.

Figure 2 - VULNERABILITY FACTORS FOR BIOTERROIST ACTS AGAINST FOOD SUPPLY

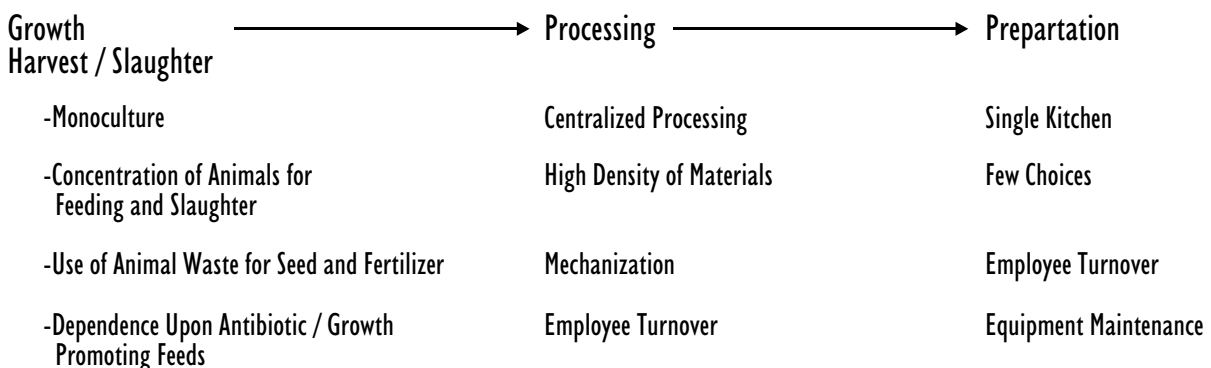


Table 3 - METHODS OF FOOD ADULTERATION

1. Genetic Modification

2. Chemical Additives During Growth

- a. Incorporation of chemicals in tissue of plants and animals
- b. Surface residues

3. Infectious Agents Added During Growth

- a. Night soil and manures

4. Chemicals and Infectious Agents Added During...

- a. Harvest
- b. Storage
- c. Processing
- d. Preparation
- e. Serving

5. Contamination / Alteration of Water Supplies

- a. Irrigation
- b. Processing
- c. Preparation

There are in fact only a few methods to weaponize food: to contaminate, to adulterate, or to take it away. And there are only a few ways to contaminate and adulterate food. As you all know, there is growing vocal opposition to genetically modified foods because tampering with DNA is seen as adulteration, whereas selective breeding is not. Chemicals or infectious pathogens can be added at various points along the food path, including using water as the vehicle. The longer the distance between the gourmet and the point of adulteration, the more specialized the adulterant must be in order to be viable or to be toxic when eaten by the consumer.

It is essential for us all to recognize that most of the dangerous food-borne pathogens and toxins are "natural": produced by bacteria, algae, fungi, and venomous creatures that are normal flora and fauna. Moreover these organisms have evolved life styles adapted to the human condition and will not stop adapting even as we take measures to contain them.

Some bacterial pathogens are cold tolerant or grow better at temperatures less than 37°C. *Listeria monocytogenes* and *Yersinia enterocolitica* species are good examples. These organisms may enter foodstuffs very early in the food path and, unless there is heating or cooking, can persist, even multiply, during refrigeration. The *Listeria* outbreaks associated with processed meats or with unpasteurized soft cheeses are characteristic. Other pathogens are heat tolerant when contained in food items, like *Mycobacterium paratuberculosis*, the organism that infects mammary glands and milk, and that causes Johne's disease in cattle and possibly causes Crohn's disease in humans. Cyst-forming parasites, such as *Cryptosporidia*, *Giardia*, and *Entamoeba histolytica*, may resist standard chlorination and thus contaminate drinking water and wash water for food items. Milk and eggs provide safe passage for a variety of pathogens from glomerulonephritis-causing streptococci (6) to the usual food poisoning bacteria of *Salmonella* and staphylococci. Or imagine the effect of a saboteur in a processing plant, planting *E. coli* 0157:H7 in the product before vacuum packaging or finishing the product.

Table 4 - ADULTERATION / CONTAMINATION WEAPONS

I. Chemicals (synthetic and naturally occurring)

- a. Metals
- b. Compounds
 - i. Nitrates
 - ii. Pesticides
 - iii. Cyanide generating compounds

2. Infectious Pathogens

- a. Enteric pathogens: staph, Clostridia, *Salmonella*, *Campylobacter*, etc.
- b. Parasites: *Cryptosporidia*, *Giardia*, *Cyclospora*
- c. Perinatal pathogens: *Listeria monocytogenes*
- d. Pathogens with prolonged incubation before clinical disease
 - i. *Yersinia enterocolitica*
 - ii. *Mycobacterium paratuberculosis* (Johne's disease, Crohn's disease)
 - iii. *Entamoeba histolytica*
- e. Pathogens that produce secondary disease
 - i. Streptococcal glomerulonephritis

3. Toxin Producing or Containing Fungi or Fish: Mushrooms, Ciguatera, Fugu

The natural history of most food-borne pathogens makes them "natural" weapons. Using these organisms as weapons requires making the opportunity to insert them into the food system so that they will be viable and virulent when they are eaten. The notion that weaponizing food-borne pathogens requires sophisticated biological manipulation is a myth coming from the production of biologic weapons for mass casualties. All it takes to make food into a weapon is a little bit of entrepreneurial, basic microbiologic information and access to soil, manure, and untreated water.

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