Raw Chocolate: Risks and Recommendations

National Confectioners Association

Executive Summary Statement

Cocoa beans are a raw agricultural commodity with the potential to be contaminated with *Salmonella* as a result of the conditions under which beans are harvested and dried. A validated kill step is required to process cocoa beans in order to eliminate the potential food safety hazard associated with the presence of *Salmonella*. NCA is concerned that finished chocolate products sold as raw may present a health hazard to consumers if a validated process is not used to destroy *Salmonella*.

Raw Chocolate: Trends and Definitions

Raw foodism is a dietary style that encourages consumption of raw organic foods. Followers of this diet are motivated by both health and social reasons.[1] Proponents of the raw diet believe all raw foods, but especially "superfoods." such as cocoa, are associated with extensive health benefits.[2, 3] It is not unusual to find claims on packaging or websites relating raw cocoa consumption to extended lifespan, improved neurological function, cardiovascular benefits, and elevated mood.

While interest in raw food exists in the United States and is gaining attention in other geographical areas, raw chocolate remains a very small, niche market. NCA estimates that less than 1 percent of new products launched in 2010 were raw chocolate products.[4] Most of these products, including finished chocolate, cocoa powder, cocoa butter, beans and nibs are available for purchase by the consumer via the internet.

Although there is no legal definition or industry standard for "raw," manufacturers of raw chocolate commonly report that their products are not exposed to temperatures that exceed 42°C [108°F]. Due to the heat restrictions, these chocolate products usually contain sweeteners other than refined sugar, such as agave nectar.

The Origin of Contamination: The Cocoa Farm

There are several possible sources of environmental contamination with *Salmonella* and other bacteria during harvesting, pod breaking, fermentation, and drying of cocoa beans. *Salmonella* is the primary pathogen of concern for cocoa, but contamination with other pathogenic bacteria such as *Listeria*, *E. Coli* and *Staphylococcus* is also possible. Additionally, contamination with excessive levels of some types of molds can lead to high mycotoxin levels, a naturally-produced toxin.

Cocoa trees are grown in hot, humid climates near the equator in West Africa, South America and Asia. Cocoa trees bear a pod fruit which may contain 30 to 40 cocoa beans. Most cocoa trees are grown on small farms and the beans are harvested by hand by farmers, fermented and dried on the farm prior to export.

Cocoa beans are removed from the pods by hand, put into boxes or formed into heaps, covered and allowed to ferment for several days. The fermentation serves to enhance the flavor of the cocoa beans. At no point during post harvest handling are the beans maintained under sterile conditions, and they may be exposed to pathogenic bacteria from the air, insects, birds, other animals and/or humans. While the fermentation step may generate temperatures as high as 51.7°C (125° F), these conditions will not inactivate pathogens, if present.

After fermentation, cocoa beans are spread on the ground, concrete, bamboo or wooden floors, or on large open-air racks to dry in the sun; beans can also be mechanically dried. At this point the beans will again be exposed to air, insects, humans, birds and animals – all of which are potential sources of pathogens.

Storage, transportation and post-harvest handling provide other opportunities for contamination. Assuming the beans are undamaged and whole, the bacterial contamination will remain on the surface/shell of the beans.

Salmonella and Chocolate

Salmonellosis is a potentially severe, and in some cases fatal, illness that develops 12-72 hours following consumption of a food containing *Salmonella*. The symptoms include diarrhea, fever, and abdominal cramps, and they can last between four to seven days. The elderly, infants, and those with impaired immune systems are especially prone to infection and more likely to develop severe symptoms.[5]

A small concentration of the bacterium can produce the illness; doses as low as one cell per gram of food can make an individual sick. The organism is especially insidious when it occurs in high fat foods, as the fat protects the microbe from typical human immune defenses.[6] Furthermore, *Salmonella* is a unique pathogen in that it is known to survive in low moisture foods.[7, 8] It can in fact live months to years in foods such as chocolate.[9]

Over the past 30 years, chocolate has been associated with several Salmonellosis outbreaks in various types of chocolate confectionery products. The exact source of the contamination varied and was not determined in some cases, but inadequate thermal processing is among the documented causes. These historical events are outlined in Table 1.

Table 1. History of salmonella outbreaks in chocolate and chocolate products

Year	Country	Species	Product	Source
2006	United Kingdom	*S. Montevideo.*	Chocolates	Leaky waste water pipe
2001	Germany, Denmark, etc	*S. oranienburg*	Chocolate bars	Inadequate thermal Processing
1987	Norway	*S. typhimurium*	Chocolate	Unknown
1986	Canada	*S. nima*	Chocolate coins	Cross-Contamination
1982-1983	United Kingdom	*S. Napoli*	Chocolate bars	Water
1973	US/Canada	*S. eastbourne*	Chocolate candy	Environment
1970	Sweden	*S. durham*	Confectionery	Cocoa powder

Legal and Regulatory Risks

In the event that *Salmonella* is detected in a chocolate product, a company will be encouraged to initiate a recall. If a company does not voluntarily recall the contaminated product, FDA now has the authority to mandate a recall.

FDA also has the ability to seek criminal penalties, including jail time, against manufacturers and distributors who violate the law. If a contaminated product is knowingly distributed, sentences could be up to three years imprisonment and fines up to $500,000. In the event that pending food safety legislation is passed, these sentences could likely be far more severe.

While the regulatory consequences are outlined here, the legal liability resulting from injured consumers and business losses throughout the distribution chain can easily surpass regulatory damages.

Heat Treatment: A Kill Step

There are several steps that will successfully control *Salmonell*a: prevention of contamination, destruction of the pathogen in food, and prevention of growth. Due to the difficulty in controlling the conditions on the farm, ***all raw cocoa as a commodity is considered potentially contaminated.*** Therefore, chocolate manufacturers must focus on destroying pathogens and preventing their growth. Since cocoa typically goes through a roasting step for flavor development, most manufacturers use this heat treatment as the primary bacterial inactivation method.

The effectiveness of a destruction method is typically expressed in terms of log kill. Each log kill is a 90% reduction in bacteria, so a 2-log kill is a 99% reduction, 3-log kill is a 99.9% reduction and so forth. During roasting, cocoa beans are exposed to high temperatures for a pre-determined period of time to achieve both flavor development and pathogen reduction. **Processors usually design their roasting process to achieve an adequate reduction of *Salmonella* spp. (e.g., by 4-5 logs).**

A variety of factors affect the kill rate of individual roasting processes. These factors include bed depth, belt speed/type, and air distribution (cold spots) within the system. Additional factors that impact the time and temperature conditions of individual roasting processes are characteristics of the beans themselves – the moisture level and size of the beans as well as the incoming temperature of the beans. To determine the time/temperature profile needed to achieve an adequate pathogen reduction (e.g. by 4-5 logs), each roasting process must be independently assessed and validated.

One of the most essential factors in determining an appropriate time/temperature profile is whether the beans go through a dry or moist roasting step. Since *Salmonella* survives better in a dry environment, a wet roasting process will achieve a faster and greater kill at lower temperatures. For example, the dry roasting time/temp profile described in a study sponsored by the Chocolate Manufacturers Association found that a 1-log kill took 20 hr at 71 C (160 F), while the introduction of moisture achieved the same kill at the same

temperature in just 4hrs.[10] Steam pasteurization systems are available from some equipment manufacturers. Once again, each roasting process needs to be independently assessed and validated.

Kill Step Validation

A validated system demonstrates through experimental data that a specific process consistently achieves the desired log kill of *Salmonella*. This can be conducted either by challenging a system with a non-pathogenic surrogate organism with similar sensitivities to the pathogenic organism (not by using the pathogen itself) or by measuring the physical delivery of a process (time, temp, degree of radiation, etc) and comparing this to documented evidence generated from published studies. Either way, the validation process provides hard scientific data that ensures a given system effectively controls *Salmonella*. This data is then used in building the HACCP plan that verifies compliance with the validated process parameters.

It should be noted that routine data demonstrating absence of *Salmonella* in finished product is useful for quality control purposes, but does not validate a kill step.

Additional references and resources:

- NCA Chocolate Safety Webinar Series
- NCA Chocolate Safety Resource Guide
- NCA Chocolate Best Practices
- NCA Good Manufacturing Best Practices
- NCA HACCP Best Practices

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[3] Wolfe, David. Superfoods: The Food and Medicine of the Future. Berkeley, California: North Atlantic Books, 2009.
[4] Mintel Quarterly Reports 2010
[5] "CDC - General Information on Salmonella." *Centers for Disease Control and Prevention*. Web. 29 Nov. 2010. <http://www.cdc.gov/salmonella/general/index.html>.
[6] D'Aoust, J. Y., & Pivnick, H. Small infectious doses of Salmonella. *The Lancet*, 1 (1976): 866.
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[10] Barrile J. and Cone F. Effect of added moisture on the heat resistance of Salmonella anatum in milk chocolate. Applied Microbiology, 19.01 (1970): 177-178