Innovations for Safe Egg Products

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Michael Foods was established in Minneapolis in 1987 and has grown steadily through internal development and acquisitions. There are four operating companies: Kohler Mix (dairy products), Northern Star (refrigerated prepared potato products), Crystal Farms (refrigerated retail foods), and Michael Foods Egg Products Company. The latter, the largest of the four, is a world leader as a full-line value-added egg-products company. There are five egg-processing plants in the United States (New Jersey, Pennsylvania, Iowa, Nebraska, and Minnesota) and two in Canada (Manitoba and Ontario). Our company operates farms and contracts egg production from approximately 14 million hens providing about 30% of raw eggs used for processing, with the focus primarily on value-added products.

In the past, discussing eggs and egg products in a meeting on foods for health would have seemed unlikely in view of negative opinion of eggs as food, because of cholesterol content and associations with food poisoning by *Salmonella enteritidis* (S.e.). However, opinion on cholesterol is changing; it is declining as a major issue for consumers. And public discussion seems to be moderating in terms of "bad food" vs. "good food" viewpoints.

Egg-associated S.e.—an ongoing concern—resulted in an action plan prepared by the President's Council on Food Safety (PCFS, 1999). I will discuss background information on the action plan and approaches used by Michael Foods to provide safe egg products.

Background

Over the period 1976 to 1994, the Centers for Disease Control noted an eight-fold increase in isolations of S.e. from humans. In the mid-1980s, a large portion of human illness from S.e. was linked to the consumption of contaminated shell eggs. Unexpectedly, the illnesses appeared to be related to sound-shell, clean, grade AA eggs. Studies in the United States and Europe then demonstrated ovarian transmission—eggs were contaminated by S.e.-infected hens during formation.

Current understanding indicates that trans-ovarian contamination occurs in one egg in every 20,000, with between twenty and a hundred S.e. cells per egg, at time of lay (USDA, 1998). Poor shell-egg handling practices and poor food-preparation practices are necessary for development of illness due to S.e.-infected eggs. As a point of perspective, the *per-capita* consumption is approximately 234 eggs per year in the United States, about 200 of which are consumed either at home or at food-service establishments provided with shell eggs. The other thirty-four eggs are consumed as processed products provided by companies such as Michael Foods Egg Products.

In 1996, the United Stated Department of Agriculture (USDA) and the Food and Drug Administration (FDA) began a comprehensive risk assessment (USDA, 1998). It is one of the first large-scale risk-assessments studies conducted on a basic food by government agencies. They developed a quantitative risk-assessment model that is being used to shape policy decisions and develop regulations. Following the risk assessment, the President's Council on Food Safety developed an aggressive egg-safety program (PCFS, 1999). The action plan covers all aspects of production and distribution, from farm to table, to reduce the risk of S.e. contamination of eggs. The overarching goal is to eliminate S.e. illnesses associated with the consumption of eggs by 2010, and the interim goal is a 50% reduction by 2005. It is likely that these goals will be met.

Two strategic choices were outlined (Table 1). One of them, being on-farm testing with diversion of eggs from infected flocks for use in pasteurized egg products. The second strategy, calls for the application of a lethal kill treatment achieved by pasteurization at the packer or processor level.

TABLE 1. STRATEGIES FROM ACTION PLAN TO ELIMINATE S.E. ILLNESSES DUE TO EGGS.

Strategy	Description
I	S.e. testing and egg-diversion system at the farm level using a consistent, nationwide S.e. risk-reduction program
II	The application of a lethal treatment or S.e. "kill step" (pasteurization) at the packer/processor level

An important point about egg-associated S.e. illness is that all of the documented cases have been associated with the consumption of shell eggs. There has been no S.e. or salmonella-associated illness due to consumption of pasteurized or precooked egg products. Egg-pasteurization standards (USDA, 1969) have been the basis for safe egg products for the past 33 years.

Innovations for Safe Egg Products

As noted above, egg-associated S.e. illness results from poor handling and preparation of internally contaminated shell eggs. Recent innovations in processing now provide the basis for safe egg products:

- the development of a pasteurization process for shell eggs,
- the development of in-line breaking of eggs to produce liquid egg for processing, and
- the development and production of high-quality precooked egg entrees.

Figure 1 presents an overview of the time-temperature relationship that provides a one-log reduction in the numbers of S.e. that may be present in the yolk of an intact shell egg. The time in minutes to achieve a 90% reduction is the D-value. As temperature increases, the D-value decreases.

It is often asked, "How is it possible to pasteurize shell eggs without cooking them?" The answer is that it is a controlled heating process that balances process efficiency and quality of the egg, while achieving a 5-log-reduction in salmonella as required by the FDA standard. There may be a small amount of opacity in the white of the pasteurized shell egg—influenced by the pasteurization temperature and chemical characteristics of the egg, such as the initial pH of the albumin. A range of cloudiness in the egg white is acceptable to most retail and food-service customers. Pasteurized shell eggs function as non-pasteurized eggs, except that it takes a little more time to whip the whites to make meringue

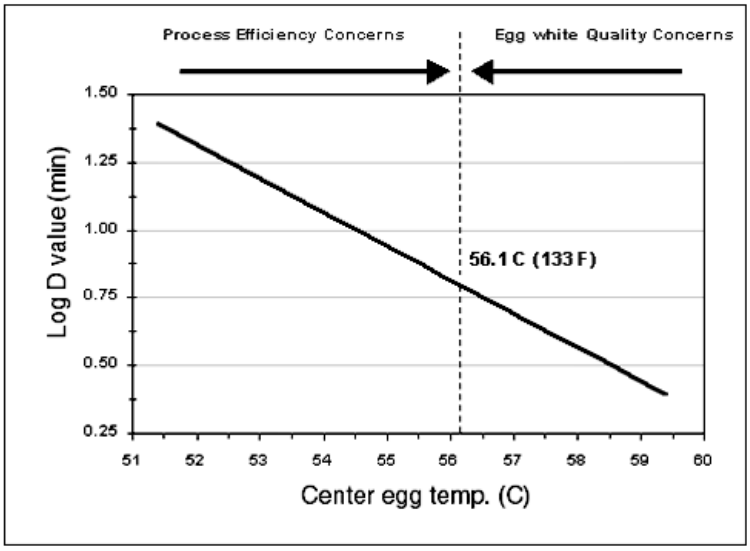

Figure 1. Decimal reduction time curve for *Salmonella* spp. within intact eggs.

The second innovation is the adoption of in-line breaking to produce liquid egg for further processing. In-line breaking is the close coupling of production of shell eggs with conversion to liquid egg. This operation is usually associated with large farms from which eggs are conveyed directly to breaking machines. The shells are washed before being presented to the breaking process for content removal, allowing conversion to a chilled liquid within hours of laying. Table 2 presents a summary of microbiological data collected from in-line breaking and off-line breaking over a year. All of the egg samples were from USDA-inspected plants and were considered wholesome. The results clearly show that in-line operations are capable of producing raw egg with significantly lower total microbiological content (<5,000 cfu/g compared to <100,000 cfu/g). It would be expected that pathogen and non-pathogen contents would both be reduced, enhancing the effectiveness of pasteurization. Cotterill (1995) anticipated the advantages of in-line breaking and attributed them to breaking stock with lower initial bacterial counts and more active natural bacterial inhibitors because of the "freshness" of the eggs.

TABLE 2. AVERAGE AEROBIC PLATE COUNT BY MONTH FOR 2,328 TANKER LOADS OF LIQUID EGG FROM IN-LINE BREAKING AND 325 TANKER LOADS FROM OFF-LINE BREAKING.

	In-line[a]	Off-line[b]
Month	Log cfu/g	
January	3.17	4.95
February	3.30	5.09
March	3.34	5.17
April	3.23	5.54
May	3.61	5.39
June	3.53	6.17
July	3.55	6.24
August	3.59	5.11
September	3.53	5.69
October	3.18	5.09
November	3.18	5.69
December	3.20	5.69

[a]From three in-line breakers in two mid-western states.

[b]From eleven different off-line breakers located in seven mid-western states.

Precooked egg entrees are a growing area of innovation for safe eggs. Prepared entrees—scrambled eggs, omelets, fried/poached eggs, and scrambled egg patties—are being successfully used as safe-egg products by quick-service restaurants, convenience stores, and catering. Their quality is excellent. Advances in ingredient and processing technology have allowed development and production of entrees that have widespread acceptance. The replacement of shell eggs with precooked entrees provides food-service operators with an enhanced margin of safety while reducing the amount of skilled labor required to prepare meals.

Summary

Pasteurized egg products have an excellent safety history. Shell eggs can be pasteurized to provide a safe alternative for foods made with raw or minimally cooked eggs. Closely coupling egg production and breaking results in very high-quality raw material for processing. Pre-cooked egg entrees provide safe high-quality alternatives to using shell eggs. Strategy II of the President's Council for Food Safety—lethal treatment—is enhanced by innovations in safe-egg products.

References

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