Development of microbiological guidelines for food-grade paperboard: a historical perspective

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A standard developed more than 50 years ago is still being used to evaluate the sanitary quality of food-grade paperboard.

The growing use of recycled fibers in paper manufacture, along with increased public concern about food safety in general due to some highly publicized cases of bacterial food contamination, has led to a need to reexamine the present microbiological quality and safety guidelines for food-grade paperboard. These guidelines trace their origin to the so-called "Dairyman's Standard." This standard was developed more than 50 years ago but is still used, with only minor modifications, to evaluate food board. A look at the historical background of the development and use of this standard and the related test methods for monitoring the sanitary quality of paperboard should be useful in establishing or updating guidelines to ensure the continuing safety of food packaging under present-day conditions.

A tour of a supermarket to check out product packaging would soon impress anyone with the importance of paper and paperboard in food packaging. An inventory of the packaging materials thrown away in our household garbage each week would do the same. Milk, ice cream, orange juice, bacon, biscuits, frozen pizzas, TV dinners—these are just a few of the great variety of food products found in paperboard packaging. This type of packaging has a long proven record of safety resulting from the industry's close compliance with government regulations and food industry guidelines for the microbiological quality and allowable components of the paperboard.

As with any food packaging material, it is important that food board not compromise safety by the migration of hazardous chemical substances or the introduction of bacteria, fungi, or other harmful microorganisms from the packaging. In most cases, of course, the finished packaging will have a barrier coating or be laminated with other materials so that the food does not directly contact the base paperboard sheet. However, in the handling of packaged food, particularly by the consumer, it is possible that contaminants from the base sheet might get into the food. For that reason and for general safety reasons, it has long been required that food board meet certain rather strict microbiological and chemical safety standards.

Any changes in papermaking practices that might have an adverse impact on the quality and safety of food-grade paperboard are obviously of concern to papermakers as well as to others. One such change in the United States is the result of the industry's mandate to increase greatly the recycling of recovered paper, particularly post-consumer waste. While the U.S. Food and Drug Administration has a food-additive regulation that, with certain provisions, allows the use of pulp from reclaimed paper and paperboard fibers in food packaging *(1)*, long-established guidelines have called for the use of virgin pulp only for certain grades of food board. For example, the 1991 version of the U.S. Public Health Service/Food and Drug Administration standards for the fabrication of single-service milk containers *(2)* requires the use of "paper or paperboard made from clean, sanitary virgin chemical or mechanical pulp or from "broke and trim" of such paper and paperboard..." The term "broke and trim" may include "unprinted trim from the converting process" but "does not include post-consumer wastes."

Virgin pulp generally is not heavily contaminated with microorganisms, and the bacterial content of paperboard made from such furnishes can usually be held within the established safety guidelines without too much difficulty. On the other hand, recovered paper, especially post-consumer waste, may be heavily contaminated. What effect this will have on the microorganism content of paperboard is uncertain. It may necessitate a reevaluation of the present guidelines for microbiological quality.

Another reason for a reexamination of these guidelines is increased public concern about the general safety of our food supply due to some recent events. The safety of our food is

something most of us have long taken for granted. We have put our trust in government agencies charged with ensuring that the food we eat is not contaminated with harmful substances or organisms. Recently, however, several highly publicized cases of food poisoning by hamburgers from fast-food restaurants have occurred. In addition, there have been network television reports on sanitation problems in poultry processing plants and newspaper stories on the shortcomings of restaurant inspections by local health authorities. All of this has led to questioning just how safe our food supply really is. While these events are unrelated to paperboard food packaging, they do add to the importance of reevaluating any possible sources of microbial contamination.

The "Dairyman's Standard"

Milk was one of the first liquid products to be packaged in paperboard containers. Even before that development, the use of paper caps on glass milk bottles had become common. Public health authorities, of course, have long required milk going to the consumer to meet very strict bacterial specifications. Thus it was only natural that one of the earliest microbiological standards to be established for food board was for its use in single-service milk containers.

This so-called "Dairyman's Standard" is essentially the same as that which must still be met by milk producers today. The standard *(2)* requires that paper stock used in single-service containers and closures "shall meet the bacteriological standard of not more than 250 colonies per gram as determined by the disintegration test." The sampling and test procedures must be in substantial compliance with those described in the latest edition of *Standard Methods for the Examination of Dairy Products (3).* The paper sampling and bacterial plate count procedures described in TAPPI Test Method T 449 om-90, "Bacterial examination of paper and paperboard," are accepted for evaluating milk carton stock and other food board.

Historical background

A review of the history of the development of the "Dairyman's Standard" microbiological guidelines for food board should be useful in deciding on the need to revise the present standards and test methods. A good summary of this history was provided by DeLong in a 1955 TAPPI Monograph on the microbiology of pulp and paper *(4).* Much of the information presented here comes from that source. While this information is nearly 40 years old, there have been relatively few changes in the test methods and bacterial guidelines since then.

Paper caps used with glass bottles were the first paper products employed in milk packaging, and concern about these as possible sources of bacterial contamination arose as early as 1930 *(5).* In the late 1930s, the dairy industry began making substantial use of paper milk cartons with paraffin wax coatings. This growing use of paperboard milk containers led Sanborn and Breed, two scientists at the State Agricultural Experiment Station in Geneva, NY, to begin testing the bacterial content of paperboard samples. They found that the bacterial content was generally quite low *(6, 7).* Their work led to the adoption of a standard in 1939 by the U.S. Public Health Service under the Milk Ordinance and Code. The standard set a maximum level of 250 bacterial colonies per gram of disintegrated paperboard and specified that no coliform bacteria (i.e., bacteria of fecal origin) be present. Reportedly, the first standard proposed had been a maximum of 500 colonies per gram but was later lowered to 250 *(8).*

In 1945, Sanborn drafted a sanitary code that he suggested should be established for paperboard food packaging materials *(9).* Consultations with public health authorities and paperboard manufacturers brought revisions, and a revised version of the sanitary code was published in 1948 *(10).* This code continued to use the bacterial plate count for evaluating the sanitary quality of finished paperboard, although there were doubts about whether this really was a good measure.

In 1947, the Biological Control Committee of the American Paper and Pulp Association published a guide for papermakers that incorporated many of the same principles as the earlier sanitary codes and methods. However, this guide, which was called "Sanitary Practices and Procedures Applicable to the Pulp and Paper Industries," did not give a specific bacterial plate count for determining the sanitary quality of paper or paperboard.

The consensus of the committee apparently was similar to the views expressed by Tanner *(8, 11),* a bacteriologist at the University of Illinois. In his view, paper as manufactured then was devoid of any bacteria of sanitary significance. He claimed that pathogenic bacteria would not survive the papermaking operations. In his microbiological studies of paper samples, he had found no coliform bacteria, only harmless aerobic sporeformers. Thus Tanner felt that arbitrary bacterial plate count numbers were meaningless as standards for determining the sanitary quality of paper. It was much more important to determine the types of bacteria present.

Despite all the differences of opinion, however, the 250 colonies per gram maximum bacterial plate count still survives as the standard for milk carton stock and other food board. When the initial studies that resulted in this standard began, good sampling procedures had not been developed and the methods for doing the plate counts on paper and paperboard samples were not considered very reliable *(4).* Suitable aseptic sampling procedures using sterile tools and sample holders were worked out in the late 1930s, but the early ways of dispersing the paper or paperboard samples were still not satisfactory. Methods of dispersion that were tried included shaking in water, grinding with sand in a sterile mortar, low-speed food mixers, malted milk mixers, and propeller-type mixers. About 1940, however, the first Waring blenders, with their high-speed motors and sharp-edged cutting blades, became available. These high-shear mixers made it possible to disintegrate and disperse the paper samples properly for bacterial plate counts.

These sampling and disintegration techniques, combined with fairly standard bacterial plate count procedures, became

the basis for a TAPPI Tentative Standard, which was the forerunner of a TAPPI Test Method. The current version, as mentioned earlier, is TAPPI Test Method T 449 om-90, "Bacteriological examination of paper and paperboard." This TAPPI method was drafted as a Tentative Standard in 1940 and adopted as an Official Standard in 1956. The method as used today is, with only minor modifications, essentially the same as used then. And the maximum allowable bacterial plate count of 250 colonies per gram of paperboard is also still the same.

Discussion

It has long been an accepted principle that when paper or board leaves the machine, it generally contains very few microorganisms. The vegetative cells of all bacteria are normally killed by the heat and steam in the dryers. However, certain species of bacteria form endospores that are highly resistant to heat, chemical microbicides, and ultraviolet and ionizing radiation. These spores are released when the bacteria are exposed to conditions that cause lysis of the vegetative cells. The surviving free spores then remain dormant until external conditions are favorable to germination and development into vegetative cells.

Thus it is spore-forming bacteria that cause most of the problems in meeting bacterial colony count limits. While the vegetative cells of these spore-formers are usually destroyed in the papermaking operations, the spores they release can survive in the paper or board. Then, when the paper samples are disintegrated in water and tested for bacterial content, the spores germinate and show up in the bacterial count. Since the spores are highly resistant to most chemical agents used to control microorganisms on the wet end of the paper machine as well as to the heat in the dryers, it is difficult to reduce the spore count in the finished paper. Certain chemical agents do have sporicidal activity, but even these must generally be used in relatively high concentrations to be effective. However, the spore-forming bacteria that contribute to the count have commonly been found to be aerobic species, such as *Bacillus subtilis,* that have not been considered pathogenic or of sanitary significance.

Since the currently used food board sanitary guidelines and test methods were developed, many changes have taken place in papermaking, food packaging, and microbiological test methods. These developments make it necessary to question whether test methods and standards similar to those of the "Dairyman's Standard" are still appropriate for evaluating the microbiological quality of food-grade paperboard.

Does a total bacteria count really measure the sanitary quality of paperboard? Is it necessary to keep the total count to an arbitrary figure, such as 250 colonies per gram? Should new test methods be developed for assessing the microbiological quality of food board? What effect will recycled fiber have on meeting the present standard and on the types of organisms that might be found in the finished paperboard?

These are just a few of the questions that should be addressed before any revision or updating of the current historical microbiological guidelines for food board is made.

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