for comment on problems of interpretation, compliance, and enforcement.

The use of citizen committees, and regular meetings with civic bodies such as city councils, chambers of commerce, and trade associations can also be the means for projecting public health concerns and goals.

In all of our public health activities today, it is in our professional interest to share responsibility with the community. As public health workers, we cannot guarantee a healthy community unless the community is interested in accepting, demanding, and when necessary, enforcing the standards that insure good practice. In all areas of environmental health practice, we are seeking a transfer of learning, and subsequently an acceptance of responsibility for good health practice by the citizens, by industry, and by business. Our interests have broadened to include all aspects of man's environment. More than ever before our position requires leadership and planning. Our techniques must emphasize consultation and education as well as enforcement. Thus as this association enters its second half century, it does so with the knowledge that the horizon for professional performance has never been broader, nor have the opportunities for the environmental health scientist ever been greater.

THE MICROBIOLOGICAL SIGNIFICANCE OF FOOD PACKAGING MATERIALS

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Principal among the trademarks of an advanced society is the continuous availability to its members of a nutritionally adequate and otherwise wholesome food supply. Only in a milieu which supplies this essential to a majority of the population can we secure the not unmixed blessings of technological and cultural progress. We have achieved our high level in the maintenance and protection of public health through the devices of law and education primary to the accomplishment of the objectives of a democratic society. Attainment of the goal of adequate and safe nutrition demands a careful and continuous surveillance of our food supply from its source in the agricultural industry through each step in its inexorable march into the gullet of the ultimate consumer.

Investigations of communicable disease transmission, control of spoilage, transportation and protection of perishables, pesticide management and dozens of other facets of this engaging field provide an impressive body of literature upon which we draw to make prudent judgments and exercise adequate control. The more specialized problems which arise as new food processing and distribution techniques develop, have likewise received their share of attention. Frozen foods, vending, radiation sterilization and other mileposts in the evolution of the food industry, have generated appropriate investigations.

In this body of information one is impressed not by the scarcity of publications on food packaging which are legion, but rather by the relatively few publications of relevance to its microbiology.

The Microbiology of Packaging

The microbiological significance of packaging resides in a very simple relationship; it is in direct contact with its food contents. Thus, if food packaging does have a microbiology, it is a priori significant, assuming our aim is to preclude exogenous organisms from food. If this is our goal it makes very little sense to exercise sanitary control over the endless details of production, processing, dispensing and handling of food while remaining indifferent to the condition of the container in which it is finally packed and presented to the consumer.

The first essential then is to establish whether packaging can make a significant microbial contribution to food i.e., does it have a meaningful microbiology? Let us look at the bacteriologically important events in the production of some common packaging materials. Perhaps the most universally employed packaging are variants of paper and paperboard. Many aspects of the complex process which converts cellulose fibers into a finished food package bear on the microbiological picture.

Beginning with the fiber slurry from which it is made, the microbial population of paper is highly variable. It may range from a few or a few hundred per gram up to hundreds of thousands, sometimes millions depending upon the type of pulp, its

1Presented at the 50th Annual Meeting of the INTERNATIONAL ASSOCIATION OF MILK AND FOOD SANITARIANS, INC. October 22-25, 1963 at Toronto, Canada.
source, temperature and time of wet storage, recycling of water, etc. In the manufacturing process a water suspension of pulp flows onto a moving felt or wire and thence to a battery of drying rolls in a continuous web. The sheet may be of a single type of pulp and uniform throughout or it may be a laminate of several layers, often differing one from another in composition. In addition to fiber, various additives are often incorporated into the pulp. Rosin size, starch, alum and wet strength agents may be added to the wet pulp to control the characteristics of the finished sheet. Additional inocula may accompany these additives. For example starch and casein are excellent microbial media and may contain enormous numbers of microorganisms.

The next stage of manufacturing is that of drying in which the wet web begins its passage over a number of drying rolls. There may be as few as twenty, or over a hundred depending upon the size of the machine. Roll temperatures are variable; about 275°F would be an average temperature. Probably the maximum temperature which a paperboard of appreciable caliper would reach during the drying process is about 200°F. As one would expect, a substantial microbial kill is effected, particularly on the surface; the insulating properties of the board protects somewhat the more interior organisms. The surviving microbial population is not uniformly distributed throughout the sheet.

In many instances subsequent additions to the sheet are made at the size press or at the calendar stack. These operations are near the so-called dry end of the paperboard machine. Starches, clays, moisture and other surface treatments occur at these points. Usually additional drying is accomplished after the size press; additions at the calender may or may not be subject to subsequent drying. The microbes which paperboard will contain then are those which may have been able to survive the high temperature stages in the process, and those which are subsequently brought to the sheet by surface treatments later in the process of paperboard manufacture.

At various stages of manufacture antimicrobial factors other than heat are often brought to bear. Principal among these are preventive sanitation and chemical slimicides. Since papermaking is a continuous process, it is not feasible to shut down an operation for frequent cleanups. These must await shut down for maintenance reasons. While this is not necessarily true of all systems feeding into the machine, pulp beaters, chests, etc., cannot be casually emptied and cleaned. Here microbial control is more often accomplished by slimicide addition. The manufacturer of food packaging grade paper must limit his slimicide addition to those which comply with the Food Additives Amendment. This precludes the use of certain excellent control agents not consistent with food associated use.

Auxiliary systems are somewhat more amenable to control by preventive sanitation as they are often designed in duplicate and parallel facilities. While one starch system is on stream for example, the other may be sanitized and microbial control effected without recourse to sanitizing agents.

Rarely is paper converted into a formed food package in the same plant as that in which it is made. Though sometimes coating with plastic may be accomplished at the paper mill. Paper is shipped by rail or truck in large rolls to a converting plant for the final steps in the manufacture of food containers. A converting plant will usually carry out the printing, blanking, forming and coating, though not necessarily in that order. Of these operations only coating or impregnation can have an appreciable sanitizing effect.

For purposes of convenience we may consider the final package to be of three different types; uncoated, waxed or plastic coated. In the uncoated type, the converting process merely creates a geometric shape and usually provides no effective surface treatment. In this instance the microbiological quality of the end product will be largely dependent on that of the paper as it entered into the conversion process and the extent to which it has been protected from contamination during conversion. Where wax coating or wax impregnation is accomplished in the converting plant it can be considered a sanitizing step by virtue of the heat of the wax treatment. Secondly, wax impregnates paperboard, immobilizing organisms in situ as well as acting as a surface barrier. In general a waxed container provides a food contact surface of very low bacterial count. Of course, contamination may occur subsequent to waxing where a quench of water or refrigerated air is used to harden the wax quickly or where there is excessive exposure to the environment and manual contact incidental to assembling and packaging the units for shipment. Plastic coatings may be applied either to the paper web or to the formed package. Regardless of where it may be accomplished, coating is usually simultaneously sanitizing in its effect since a heat treatment is involved.

**Subsurface Microorganisms**

As indicated earlier, the process of papermaking while inherently antimicrobial, nevertheless does permit organisms to survive both internally and on the surface of paperboard. What kind of a microbial population do we have and are organisms transferred from the interior of the board from which a container is made to the food contents? The internal...
microbial population of board is almost invariably found to be comprised of spore formers. Perhaps a few other thermodurics survive; we have never investigated this point. However we have been able to demonstrate, using commercially available board that internal organisms can and do under some circumstances contaminate food contents. One procedure has been as follows: Samples of commercially available paperboard are milled to the desired depth using a high speed end mill and a drill press with an adjustable stop. It is possible to remove a portion of the paperboard leaving the remainder of the fibers virtually undisturbed. Following X-Ray sterilization inocula can be introduced into any plane. We employ bacterial spores suspended in a volatile solvent since we wish to avoid the effects of added moisture. Inoculated samples are placed in the top of a screw top test tube containing a liquid medium. Upon inversion of the tube, medium is in contact with the undisturbed surface opposite the inoculated milled depression. Migration through the intact surface of the paperboard can be detected by the usual methods. Tagged microorganisms have also been used. We use a variety of Bacillus subtilis which produces a brown pigment when grown on a tyrosine containing medium. This distinguishes this organism from other paperboard spore formers. Secondly, we have employed Bacillus cereus tagged with Fe$^{57}$. Iron appears to be the isotope of choice since bacilli retain most of the iron assimilated and it can be detected in subsequent progeny through several generations.

Our experience thus far indicates the sub-surface paperboard microbe to be immobilized until a liquid phase within the board is established. At that time depending upon temperature, nutrient, agitation, etc., organisms will demonstrate their viability and grow in all directions from the point of origin. When uncoated paperboard is in contact with the liquid nutrient, migration occurs rather quickly, often in less than two days. The position of the organism with respect to the surface may affect the threshold of contamination though it does not appear to be of great significance. Coatings which remain intact appear to retard migration to the surface. Plastics, such as polyethylene and vinyl, appear to act as semi-permeable membranes, allowing liquid to move to the interior strata. So long as these coatings remain intact, they are impervious to penetration by growing microorganisms. Probably the weakest point bacteriologically in these packages would be a cut edge i.e. raw paper exposed to liquid food. Though such papers are treated to resist the moisture, the cut edge is a breach in the plastic barrier and microbes migrate readily through it.

Wax appears to act somewhat differently in that it impregnates the board and immobilizes the organisms. The rate of migration of sub surface organisms may be increased by such factors as agitation, bonding and abrasion. In general abuses which are inimical to the integrity of the board and/or coating will hasten the movement of organisms from board into the contents of the containers.

We have also carried out some experiments in which we have inoculated paperboard as it is produced on the machine at several cross section levels. Results from these experiences follow the same pattern as previously observed in the laboratory.

We conclude that microbial migration does take place from any of several levels of uncoated paperboard at room temperature and incubator temperature. The rate at which this takes place is, of course, temperature dependent. The establishment of a liquid phase within the board is essential to bacterial migration. Some coatings so long as they remain intact retard the movement of microorganisms from board to the food. Board which is variously abused will permit a more efficient movement of organisms either because of increase in liquid permeability or disruption of surface coatings.

As was noted above the surface of a food package may be able to contribute appreciable bacterial counts depending upon the extent to which it is exposed to the atmosphere or comes in contact with microbe-bearing materials. One aspect of this problem which we have presently under investigation is that of establishing the significance, if any, of static charge to the incidence of contamination from airborne sources. In the past decade we have witnessed a vast increase in the use of plastic materials in food storage, handling, dispensing and packaging. A characteristic shared by many of the plastic materials is their tendency to accept and hold a substantial static charge. Our investigations are aimed toward the quantitative determination of the relationship of this charge to airborne contamination and to evaluate the significance of static charge during manufacture, storage and use. While the study is by no means complete, certain of the preliminary findings appear interesting. It is apparent in certain cases that while the predominating charge on a surface will be either negative or positive, the distribution of the charge on the surface will assume a pattern. Sometimes these patterns are strikingly similar to lightning streaks and where a charge may be let us say, predominately negative, we will find islands of positively charged areas. To the degree to which surface distribution of airborne contaminants can be imputed to static charge, they will not be uniform over the entire surface. Secondly, the intensity of charge will depend on frictional characteristics of the machinery which handles packaging and on such variables such
as temperature and humidity. Time is also an important factor. Generally speaking static charge levels tail off with time. Under uncontrolled conditions, the charged surface will very quickly develop a substantially higher contamination level than the normal control. We are presently conducting some controlled experiments within a closed cabinet in which we can add various bacterial and other particulate contaminants to surfaces upon which we have developed charges by an electrostatic generator. While these data are only preliminary, we are quite convinced that the degree of contamination of a plastic surface with airborne particulate matter is in direct relationship to the surface charge.

PERSPECTIVE
Quite apart from health considerations, competition, sharpened by a need to present to the purchaser an attractive display, has played its role. Pre-packaging is so universal today, even unprocessed commodities are often presented as a purchase unit. We have long since passed the era of cracker barrel distribution of bulk commodities at the retail level. Packaging then serves functions additional to that of protection.

We can expect future demands for extended shelf life of perishable foodstuffs will require parallel developments in sanitary packaging. Already feasibility studies in which paper packaging is sterilized and aseptically filled have reached the marketing phase. Packaging has not yet reached the limit of its ability to contribute to the needs of a hungry world.

COMMITTEES
INTERNATIONAL ASSOCIATION OF MILK, FOOD AND ENVIRONMENTAL SANITARIANS

COMMITTEE ON RECOGNITION AND AWARDS
(1 year appointment)

OBJECTIVES
This committee is charged with the responsibility of implementing those objectives of the Association concerned with (1) recognition of individual milk, food and environmental sanitarians whose achievements have contributed greatly to the public health and welfare of their communities, and (2) recognition of those members of the Association who have, through distinguished service, contributed greatly to the professional advancement and growth and reputation of the International Association of Milk and Food Sanitarians, Inc.

The Committee receives and reviews nominations for the annual Sanitarian’s Award, and has full responsibility for the selection of the recipient. The Committee also receives and reviews recommendation on candidates for the annual Citation Awards, and counsels with the Executive Board relative to the selection of the recipients. It is also responsible for handling all matters pertaining to the presentation of awards, publicity and other related items.

MEMBERS
Charles E. Walton, Chairman, City Health Department, City Hall, Laramie, Wyoming.
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Donald K. Summers, 1542 Buchanan Street, Novato, California.

COMMITTEE ON MEMBERSHIP
(1 year appointment)

OBJECTIVES
To make every effort to increase the membership of the organization by bringing to the attention of all qualified persons the advantages of belonging to the International Association of Milk and Food Sanitarians, Inc., and to interest state milk and food sanitarians’ organizations in the advantages of affiliation with the Association.

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