Public Health Compliance by Manufacturers of Paper for Packaging Perishable Foods*

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IN spite of the fact that nearly all of the mills manufacturing paper and paperboard for the packaging of such perishable foods as milk, cream, and frozen desserts, are continuing to meet public health requirements, there is still some discussion as to the relationship of mill conditions and practices to compliance with public health regulations and standards. The data presented below should help to clarify the situation.

BACTERIOLOGICAL CONDITION OF PAPERBOARD USED FOR MILK CONTAINERS

During the early stages of the present study (1937–1938), approximately 22 mills were engaged more or less actively in the manufacture of paperboard for milk containers. In a few instances the runs made were largely experimental. Some mills discontinued making this board for economic reasons. While many of the plants demonstrated their ability to produce paperboard that meets bacteriological standards, several encountered some difficulty in doing so. Such instances were due to the inadequacy of microbiological control, to temporary difficulties in locating certain focal points of growth within the mill system, or to limitations of the equipment utilized.

Table 1 presents a summary of the bacteriological results on milk container board from representative mills, secured during the past 5 years.

More than 7,500 analyses have been made of paperboard produced by the 22 mills. Most of the mills were able to meet with fair consistency a standard of less than 500 colonies per gram. Several of the largest producers, working toward the manufacture of a board that is essentially free of microörganisms, were in a position to meet a

TABLE 1

BACTERIOLOGICAL ANALYSES OF PAPERBOARD USED FOR MILK CONTAINERS

Colonies per Gram of Disintegrated Paperboard

Media: Old and New Standard Agars. Incubation: 37° C. for 48 hours

No. Mills	Year	Total No. Tests	Percentages Yielding Counts Between 0 and 10	Between 11 and 100	Between 101 and 250	Between 251 and 500	Over 500	Maximum Count Obtained*
14	1937–1938	1,064	15.7	47.3	19.1	9.2	8.7	10,300
7	1939	2,341	40.2	53.9	4.8	0.8	0.3	1,100
9	1940	2,182	46.7	41.2	5.5	1.3	5.3	1,100
6	1941	1,581	76.0	23.3	0.7	0	0	140
3	1942†	276	69.6	27.9	2.5	0	0	130

* Usually this figure is much higher than the next highest count.
† January to March, 1942.

* Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 499, March 20, 1942.

standard of less than 250 colonies. Since 1939, the majority of the 7 or 8 mills that have continued to make milk container board have experienced little trouble in meeting public health standards. Table 2 shows the results obtained during the past 15 months from 4 of these mills.

TABLE 2

BACTERIOLOGICAL ANALYSES OF MILK CONTAINER BOARD BY DISINTEGRATION METHOD*
Medium: New Standard Agar. Incubation: 37° C. for 48 hours

			Percentages of Counts per Gram of Paperboard					
			Between					*Maximum*
Mills	*Year*	*Total No. Tests*	*0 and 10*	*11 and 100*	*101 and 250*	*251 and 500*	*Over 500*	*Count Obtained*
S	1941	678	89.2	10.8	0	0	0	70
C	1941	197	58.4	39.6	2.0	0	0	130
T	1941	110	28.2	66.3	5.5	0	0	140
Q	1941	529	80.9	18.9	0.2	0	0	130
Combined Count S, C, Q, Jan. to March, 1942		276	69.6	27.9	2.5	0	0	130

* *Standard Methods for the Examination of Dairy Products*, 8th edition, 1941, p. 138.

In order for a mill to achieve strict control comparable with the results shown in Table 2, it is necessary to prevent microbiological growths in the mill system through the use of treatments that are carefully, thoroughly, and systematically applied.

IMPORTANCE OF MICROBIOLOGICAL CONTROL

During the past two decades numerous workers have given considerable attention to the microbiological problems involved in the manufacture and uses of various pulp, paper, and paperboard products. In carrying out these studies, investigators have had advantages in the experiences and research background provided by cellulose microbiology, water works practices, investigations of the slimy fermentations, and by other industries that have encountered similar problems such as the sugar, dairy, food, textile, rubber, leather, and fermentation industries.

An investigation of microbiological and sanitation problems of miscellaneous types of mills and their products was started by the author in 1930. Conditions at plants experiencing troubles due to the excessive development of microörganisms have been studied. It has been demonstrated that the growth and activities of these organisms in mill systems result in economic losses and often in products of inferior quality, due to offensive odors, slime spots, and microbiological growths in paper and paperboard.

Mills that fail to take proper precautions often fail, as well, to manufacture products that are suitable for the packaging of foods. Under conditions of inadequate sanitary and microbiological control, nearly all of the miscellaneous groups of microörganisms that are found in mill systems, raw materials, and water supplies may also be isolated from paper and paperboard products. Effective control of microörganisms by mills is important, therefore, for economic as well as for sanitary reasons.

MICROBIOLOGICAL CONTROL AT MILLS

Studies of the experiences of many mills, including those manufacturing paper and paperboard for food packages, have produced several pertinent facts. The following conclusions may be drawn:

1. The growth of microörganisms in pulp, paper, and paperboard mills can be effectively controlled.

2. Failure of attempts to do so indicates that a mill has not succeeded in locating the focal points of growth, that efficient remedies have not been utilized, or that the treatments used were improperly applied.

3. Microbiological surveys reveal the origin of the objectionable microorganisms, the places in the mill systems where active growth takes place, the extent and methods of growth distribution, the most effective treatments, and precautions that should be employed.

4. The decision as to how far a mill is prepared to go to remedy conditions and avoid future trouble rests with the plant itself. In the case of mills that manufacture miscellaneous grades such as newsprint, wrapping, or boxboard, it is usually sufficient, as well as economically necessary, to establish a type of microbiological control that enables a plant to prevent losses and to meet customer specifications.

In other instances where more efficient control is feasible, desirable, or essential, mills should adhere strictly to programs of prevention which, while similar to the precautions taken for economic reasons, are applied more carefully, thoroughly, and systematically.

5. Microbiological problems are often widely variable among individual mills and groups of mills. Nevertheless, despite variations in local conditions, water supplies, raw materials, processing methods, and microbiological flora, mill problems can be solved quite as effectively as have many similar difficulties in the food, dairy, sugar, textile, and fermentation industries.

6. It is idle to stress as insurmountable such obstacles as the persistence in some mill systems and their products of microörganisms that are resistant to heat and to some chemical reagents. Many plants that have had to contend with abundant development of aggressive, persistent types and varieties of bacteria and fungi, have succeeded, through critical investigation and painstaking effort, in eradicating the sources of such growths and in preventing their further development. Procedures and treatments are available to mills that insist upon getting results.

MICROBIOLOGICAL CONTENT OF PAPER AND PAPERBOARD

In 1931, certain members of the paper and paperboard industry were sufficiently concerned as to the fate of carefully processed foods, packaged in or held in direct contact with paper containing microbiological growths, to request the author to investigate the problem. A method was devised in 1932 for the disintegration of paper and paperboard and the determination of bacterial counts per gram of stock.* Numerous samples of different food container boards were tested. The microörganisms isolated included various types of fungi, coliform bacteria, and putrefactive organisms.

Food authorities and sanitarians showed increasing interest in the microbiological content of wrappers and containers for foods when it was found that certain types of bacteria, yeasts, yeast-like fungi, and molds, occurring on or in packaging materials, were sometimes responsible for or associated with spoilage, deterioration, and objectionable contamination of perishable foods, such as butter, meats, fish, bread, and eggs.(1) When the industry attempted to package such perishable and easily contaminated foods as milk, cream, and ice cream in paper containers, public health officials, quite naturally, demanded reliable information as to the bacteriological and sanitary condition of these containers and of the paperboard from which they are made. In response to a general request for information and data, both mills and converting plants have coöperated in programs of research. This work has as its object the attainment and

* Unpublished Report, issued August 18, 1932.

TABLE 3

BACTERIOLOGICAL ANALYSES OF PAPER AND PAPERBOARD PRODUCTS BY DISINTEGRATION METHODS

Media: Old and New Standard Agars. Incubation: 37° C. for 48 hours

Classes of Products Paper or Paperboard for	No. of Plants	Total No. Tests	Percentages of Counts per Gram of Paper or Paperboard Between									
			0 and 100	101 and 500	501 and 1,000	1,001 and 5,000	5,001 and 10,000	10,001 and 50,000	50,001 and 100,000	100,001 and 200,000	200,001 and 500,000	500,001 and 1,000,000
Milk bottle caps, hoods and closures	12	1,856	93.30	5.61	0.65	0.38	0	0.06	0	0	0	0
Milk containers	24	7,153	88.00	9.00	1.44	1.42	0.13	0.01	0	0	0	0
Liquid tight containers	10	501	86.20	13.80	0	0	0	0	0	0	0	0
Food wrappers	6	242	65.30	31.80	1.70	0.40	0	0.40	0.40	0	0	0
Other types of food containers; trays, pails, cups, etc.	13	201	59.20	16.90	17.40	6.50	0	0	0	0	0	0
Bulk fiber cans	6	1,115	54.00	32.10	6.60	5.70	0	1.60	0	0	0	0
Tubing	8	166	44.00	28.30	17.50	10.20	0	0	0	0	0	0
Miscellaneous uses	14	321	10.30	13.40	6.20	12.80	3.10	18.40	10.90	9.00	14.30	1.60

maintenance of high standards of bacteriological quality and sanitation.

In the course of the investigation of methods suitable for determining the bacteriological content of paperboard, seven or eight disintegration devices including pulpers, churns, shredders, ball mill types, food and beverage mixers were employed. Two specially modified mixers(2) have given particularly satisfactory results. A critical review and investigation of disintegration procedures and other methods for the examination of paper, paperboard, and products made therefrom, including milk-bottle caps, hoods, closures, cups, fiber cans, and containers have been carried out by a Committee on Standard Methods for the Examination of Dairy Products of the American Public Health Association. Microbiological methods resulting from these studies are included in *Standard Methods for the Examination of Dairy Products,* Eighth Edition (1941). Interpretations of bacteriological counts and standards for these products are also given.

Table 3 presents some of the analytical results that have been obtained at this laboratory on various classes of paper and paperboard products. A summary of the bacteriological results secured on paper containers used for perishable foods, is reported elsewhere.(3)

When it was found that the bacteriological condition of the original paper or paperboard determines, in general, the bacteriological condition of the fabricated product, nearly all of the mills involved actively coöperated with public health officials by investigating and establishing programs of microbiological control with consistency and critical thoroughness. Mills studied their flow diagrams and operations in order to determine and control all sources of microbiological contamination and points of growth build-up. Many mills installed bacteriological laboratories and employed trained workers for the purpose of obtaining

information as to the number and types of microörganisms present, their significance, and methods of eradication. They found, as other industries have, that certain microbiological problems are so complex that definite correlations between control procedures and the microbiological results secured are not always apparent. However, the solutions to some of the more important problems are sufficiently complete to enable mills to produce good results. Research on a comprehensive and critical scale is still in progress.

Ground wood mills have discovered that the fermentation type of flora, characteristic of these mills, consists of many species that are rather readily killed by heat and chemicals so that, even when pulp suspensions have a relatively high bacterial content, it is frequently possible to reduce appreciably the number of bacteria in the paperboard produced. Ground wood pulp, being rich in nutrients available to microörganisms, requires proper treatment and care during manufacture, handling, and storage. Many mills are today making paper and paperboard of suitable quality with a high ground wood content, used for food wrappers, containers, milk-bottle caps, and closures.

Other types of mills have to contend with groups of microörganisms that are usually essentially different from those found in ground wood mills. This is the case with mills that utilize mainly bleached and unbleached chemical pulps. These plants may start out with a clean, sanitary pulp, containing few microörganisms, but unless suitable remedies and preventive measures are properly applied, the stock will not remain in this condition.

High counts are often due to the persistence of spore-bearing bacteria and other heat-resistant types and to the neglect of adequate preventive measures.

While it is true that, as microbiological control procedures increase in effectiveness, the flora of paper and paperboard tends to become restricted to a relatively few heat- and dryness-resistant types of bacteria, the problem is not as simple as this statement suggests. For example, the presence in stock of gelatinous masses of microbiological growth or "slime" is sometimes a direct cause of high counts in paperboard. It has been demonstrated that miscellaneous groups of microorganisms, embedded in such masses, are afforded a certain amount of protection from the lethal effects of heat and chemical reagents. As previously stated, procedures and treatments for controlling the various types of microbiological growths are available to and utilized successfully by mills that insist upon getting results.

EFFECT OF CALENDER WATER ON PAPERBOARD COUNTS

The influence of calender water on the bacteriological content of a sheet is a good example of a source of growth that is controllable. Paper is often calendered at the end of the paper machine after it is formed and dried. In this process, the paper or paperboard passes between cast-iron rolls to increase surface smoothness and gloss. During the operation the sheet is usually moistened with water (sometimes starch solutions or emulsions) from troughs or calender water boxes. Many mills take precautions to keep this water clean and free from bacteriological growth. If the condition of water and water boxes is not properly controlled, calender water develops high counts which raise the bacterial content of the paper or board, nullifying the beneficial effect of the bactericidal treatments that the original pulp suspensions may have received. Bacteria that are objectionable from a sanitation standpoint may be transferred to the sheet in this way.

The data in Table 4 show the effect of bacteriological growths in calender water or solutions upon bacterial counts in finished paperboard.

TABLE 4

INFLUENCE OF HIGH BACTERIAL COUNTS IN CALENDERING SOLUTIONS UPON PAPERBOARD COUNTS

	Average Bacterial Counts Normally Obtained		Average Bacterial Counts per Gram of Paperboard When Water or Solutions Containing Microbiological Growths are Used for Calendering	
Mills	Pulp Suspensions at Machines Colonies per Ml.	Finished Paperboard When Water or Solutions Used are Under Bacteriological Control Colonies per Gram	Calender Water or Solutions Colonies per Ml.	Finished Paperboard Colonies per Gram
B	43	74	Source (a) 27,200	1,150
			Source (b) 88,000	
E	580	164	5,730	660
T	Source (a) 3	31	3,325	637
	Source (b) 77			

COMPLIANCE WITH PUBLIC HEALTH REQUIREMENTS

A number of laboratories have undertaken investigations of the various problems involved in the microbiology and sanitation of paper and paperboard products. Departments of Health have participated and taken an active interest in these developments. The results of this work have provided public health officials with pertinent information and data which have enabled them to promulgate certain regulations and standards. On the whole, the record of the past five years appears to indicate satisfactory compliance with these requirements. According to our observations and experience it also shows benefits both to manufacturer and consumer. The industry should be reminded that public health officials desire to have certain information and data as to products, processes, and practices, insofar as they may, in the judgment of these officials, affect the health and well-being of the consuming public. Departments of Health have every right to demand such information. Thus far, the majority of interested public health authorities have seemed well satisfied with the progress that the mills are making.

Based on the record, it appears clear that mills which make a sincere effort to comply with bacteriological standards have found no difficulty in meeting them.

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