

Journal of

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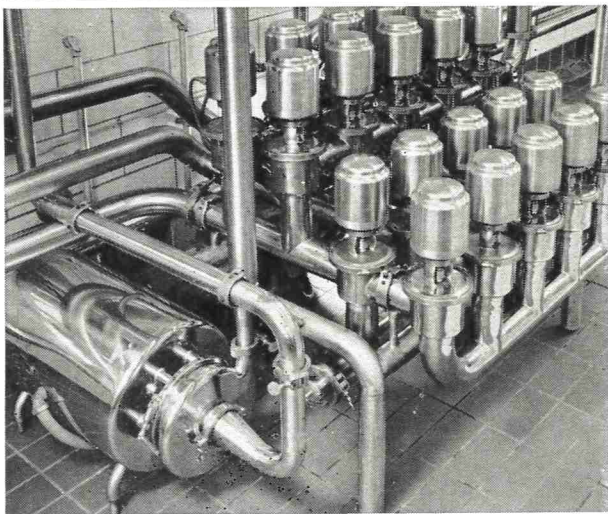
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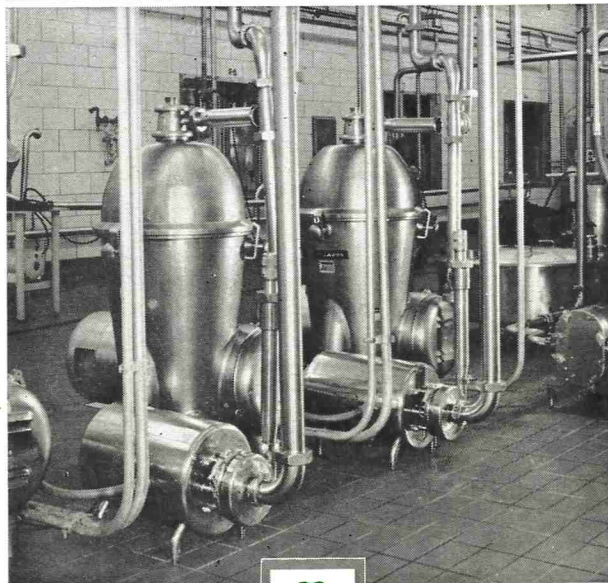
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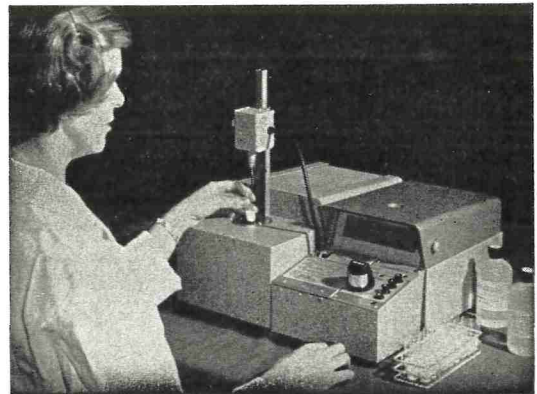
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Journal of

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INCLUDING MILK AND FOOD SANITATION

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International Association of Milk, Food and Environmental Sanitarians, Inc.

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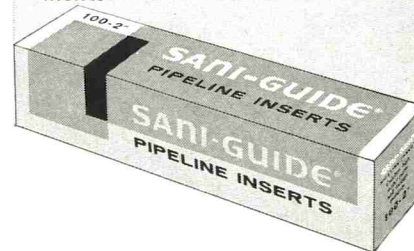


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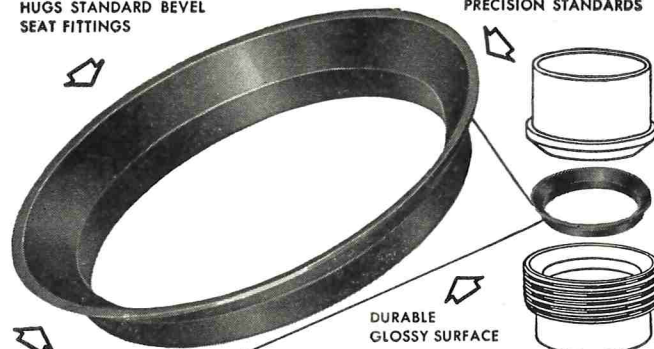
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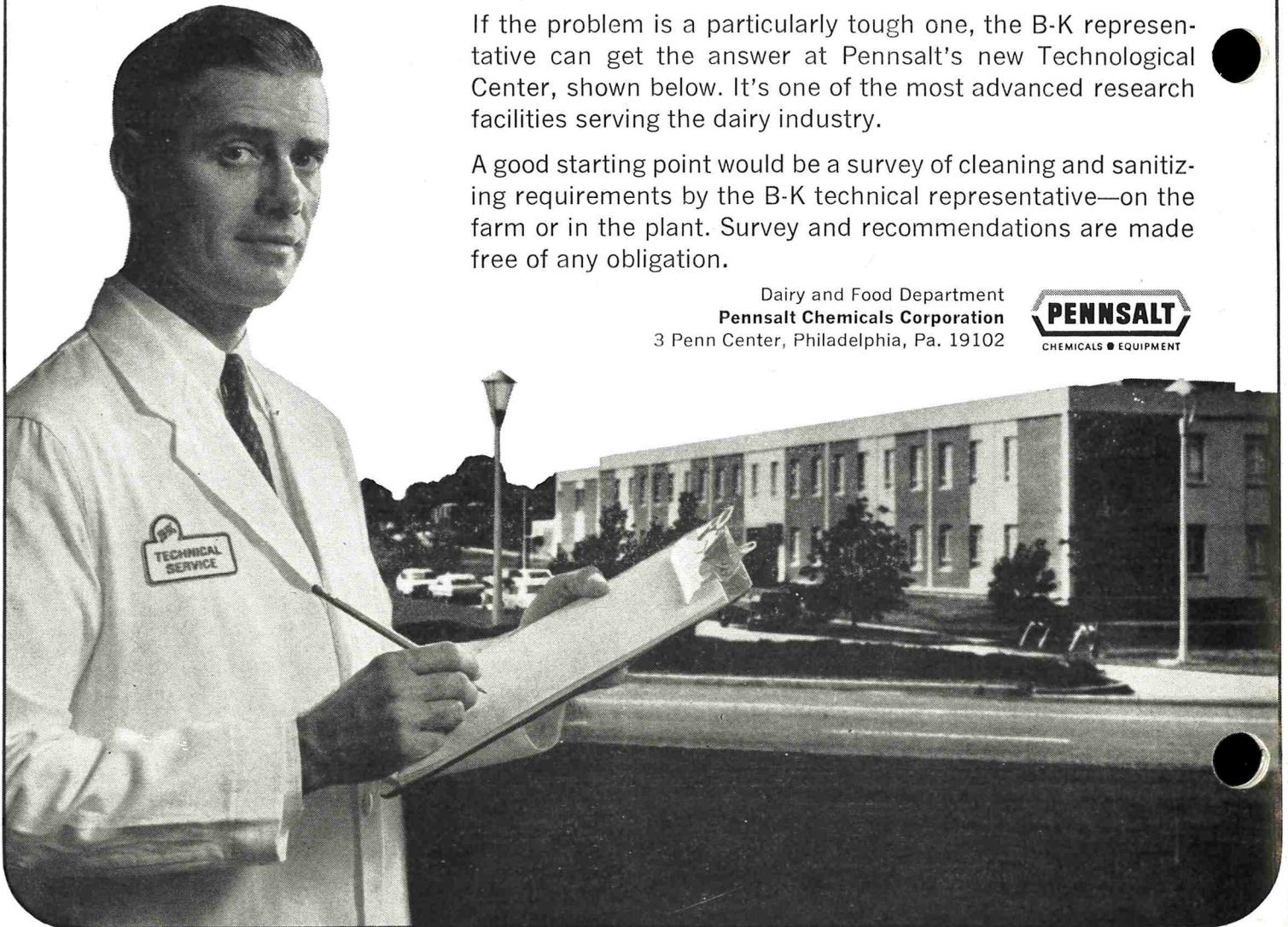
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THE AIR POLLUTION STORY IN A METROPOLITAN AREA¹

WALTER E. JACKSON

*Department of Public Health
Philadelphia, Pa.*

Many metropolitan areas are presently concerned with the mounting number of problems being created by our increasingly polluted atmosphere. This concern is warranted on the basis of the effect that air pollution has on the economic, biologic, and sociologic aspects of a community.

Economically, polluted air places a real, though sometimes intangible, burden on our society. Most of us have encountered some of the direct effects of air pollution. Dust or soot will soil laundry and dirty our homes. In heavily polluted areas, curtains must be laundered and walls and ceilings must be washed or painted at frequent intervals. The American public spends about \$3 billion a year in laundry and cleaning bills. People living in large cities with dirt laden atmospheres pay a considerable portion of this expense.

Air pollution has a marked effect on our urban environment. Exposed surfaces deteriorate faster in cities than in rural areas. This is partly due to sulfur compounds which corrode every kind of building material, including stone. The cost of corrosion of metal by rust has been estimated by the paint industry to total \$7½ billion a year. More than 300 million gallons of paint used by Americans each year cannot keep pace with this blight. Haze reducing visibility decreases the amount of healthful sunlight and increases the need for artificial light. Thus, it is realized that polluted air can be a factor in the deterioration of property value or other forms of community blight, which make necessary the cost of urban renewal.

Rural areas of this country have also been affected. Damage suits have resulted from pollution emissions which have caused severe injury to farm animals and farm crops. Damage to farm crops in various areas of the country, including the northeastern United States, amounts to more than one million dollars each year as a direct result of air pollutants.

In many industries, including the foundry, chemical and utility industries, the cost of air pollution control equipment is a significant percentage of the capital investment and operating expenses. About \$300 million is being invested by industry each year in the United States for air pollution control and research.

Although the price of pollution control is high, the cost of neglect is higher still. Authorities have estimated that polluted air costs each American between \$10 and \$65 annually. On this basis, Philadelphia's bill would be between \$20 million and \$130 million per year.

Along with the increase in industrialization and population density, there has been an increase in the occurrence of air pollution episodes having fatal consequences. Air pollution has been a direct factor in the numerous deaths occurring in communities like Meuse Valley, Belgium; London, England; Denora, Pennsylvania, and New York City. The occurrence of these severe air pollution episodes illustrates that fatal consequences can result from the short term exposure to high levels of air-borne contamination.

On more frequent occasions, pollutants have concentrated sufficiently to cause eye irritation, the reduction of sunlight, pungent odors or a combination of such offenses to our senses. Such temporary episodes have been classified as nuisances, since no lasting health damage is readily apparent. Likewise, pollutants exist in the air which are not readily detectable by human senses. The long term exposure to low concentrations of these substances is of increasing medical concern, since there is a growing amount of evidence which indicates a positive correlation between certain non-detectable but common air pollutants and some specific diseases. Such ailments as chronic bronchitis, asthma, emphysema, and lung cancer are among the most common.

The foregoing introduction has outlined some of the reasons for my belief that there is an urgent need for action to combat the pollution of our atmosphere in all metropolitan areas. This will undoubtedly require the combined efforts of local, regional, state, and federal government agencies, as well as the positive contributions of well-informed industrial and community leaders.

The sources of pollution that can be found in any metropolitan area can be attributed to all segments of the community. Control efforts are usually initiated on the basis of an obvious effect that these emissions may have on people or personal property. Thus, one may classify a category of air pollution problems which would refer to the situation where a specific source has released some obvious or detectable pollution which results in a definite nuisance or some other effect in the community adjacent to

¹Presented at the 52nd Annual Meeting of the INTERNATIONAL ASSOCIATION OF MILK, FOOD AND ENVIRONMENTAL SANITARIANS, INC., Hartford, Conn., September 14-17, 1965.

that source. A smoking stack which soils laundry is a typical example of this type of problem. There is an equally important category of air pollution problems which must be considered and dealt with by a community with a comprehensive air pollution control program. This category includes those sources which may be emitting pollution that is not readily detectable in that there is no direct correlation between these emissions and an observed effect. The automobile is a good example of this type of problem since emissions from an individual car will be of no concern. There may, however, be a very drastic change in air quality resulting from the accumulative effect of pollution emissions from hundreds or thousands of these widely-spread individual sources.

As an important guide to any community's effort toward controlling pollution emissions, some indication of the order of magnitude and the relative contribution of each of the various sources is helpful. A listing of the types of sources and the relative contribution from each can be obtained by means of a source inventory or survey within the community. The data can be presented in a form of charts which indicate these relative magnitudes of contribution.

In the northeastern United States, the major contributor to the air pollution problem can be classified as fuel combustion processes. This is logical when considered from the point of view that the combustion processes represent a community's major use of the atmosphere as a raw material and a waste disposal medium. By supplying oxygen for supporting the burning processes, the air supplies a raw material and, as a receptor for the noxious products of combustion, the atmosphere must be used as a waste disposal medium.

A combustion process can be conducted without the visible emission of pollution which is usually referred to as smoke or soot. However, visible emissions often result from the mechanical breakdown of the combustion equipment which obviously wastes fuel and is not an economical practice. A failure on the part of operational personnel can result in a similar occurrence. In a combustion process where there is no problem with inadequate combustion and all the heating value is being derived from the fuel the visible emission may be the non-combustion portion of the fuel or the ash which must be removed by control equipment. The control equipment is installed as an auxiliary to the combustion equipment. In one installation in the city of Philadelphia, the company spent approximately \$200,000 to remove the seven tons of flyash released to the atmosphere each day.

In addition to the visible emissions from these large combustion sources, there are, of course, the

invisible but equally important gaseous emissions such as carbon monoxide, sulfur dioxide, and oxides of nitrogen. Of major concern, is the problem of sulfur dioxide concentrations in many urban communities. The removal of sulfur as an impurity of the fuel before it is burned appears to be the most feasible method of controlling this emission at the present.

Open burning of refuse creates enormous quantities of pollution which can be adequately controlled by properly-designed incinerators. The handling of dusty materials and dusty processes can be controlled by appropriate changes in handling procedures. The production of petroleum or chemical products can likewise result in objectionable pollution emissions. For the most part, these emissions can be controlled to an acceptable reasonable degree by the application of: (1) good equipment design; (2) proper equipment maintenance; (3) good operational procedures on the part of responsible employees; or, if all the above are inadequate, (4) the installation of a device or system for controlling the emissions.

Domestic sources are usually a significant portion of the problem in any community. Proper operation and maintenance of home heating equipment and privately-owned automobiles must be emphasized in any comprehensive program. The burning of domestic refuse or leaves in open fires results in approximately fifty times the amount of air pollution that would be produced by a properly-designed municipal incinerator for the handling of an equal quantity of refuse. A comprehensive program must, therefore, inform and contact all segments of the community. In the City of Philadelphia, the Air Pollution Control Section within the Department of Public Health, has the primary responsibility for carrying out this program. Authority was granted in the Philadelphia Home Rule Charter and the Air Pollution Code of 1949 for the establishment of Philadelphia's Air Pollution Control program.

To most effectively deal with the types of problems indicated previously, the Section is divided into several operational units. The activities of our engineering unit stress the preventative aspect of air pollution control. Plans must be approved before certain types of equipment may be installed. This insures adequate control of sources when they are in the design stage, rather than after they are built and causing neighborhood nuisances. All combustion, incineration, and process equipment must be approved by the engineering unit prior to their installation within the City.

Our engineering staff works closely with industry in determining the engineering principles whereby emissions can be controlled or where suitable alter-

nate operations can be used to eliminate a problem. Whenever it becomes necessary to perform testing of specific pollution sources to determine if they comply with the Air Pollution Code, the engineering unit directs the testing program in cooperation with the Environmental Health Laboratory.

The laboratory also gives technical assistance with data collection during industry surveys and plant inspections, and conducts routine sampling and analysis of the air over Philadelphia.

Our investigations unit is involved in nearly two thousand specific investigations of complaints from citizens each year. Field investigators patrol our city twenty-four hours a day, seven days a week, looking for excessive pollution emissions. We use radio cars to assure rapid investigation of problems when they occur. The inspectors provide immediate correction of many faulty operations through assistance and instruction to the operating personnel. They also check combustible gas and gasoline leakage which could create explosion or health hazards.

Consultative services, in the form of office conferences, play an important role in the achievement of greater compliance with the Code. About 200 such conferences are held each year. In many instances, education and persuasion fail to bring results and legal action must be taken.

So that we can accurately and continuously measure our progress in improving the quality of the air over Philadelphia, thirteen sampling stations are located throughout the City. Data collected at these stations gives us an indication of how air pollution varies geographically within our community. Hourly, daily, and seasonal levels of pollution are also measured. In addition, this data are used in studies designed to correlate community activity, weather conditions and health, with air pollution levels. Such correlations, which are already underway or being planned, are an important tool in guiding the long-range goals of the Section.

In the past the Division of Environmental Health has assigned sanitarian personnel to specific air pollution control activities. It is our opinion that sani-

tarians with a limited amount of specialized training can provide significant services to an air pollution control program. The reporting of observed air pollution emissions from both stationary and vehicular sources and the development of public information material are areas in which sanitarians can play a vital role. The Division of Environmental Health of the City of Philadelphia plans to increase its utilization of sanitarians in the expanded air pollution control program.

Since 1956, in addition to the correlation of numerous smoke and special problems, the Section was instrumental in bringing about 160 major control installations which have resulted in the daily removal of approximately 85 tons of particulate matter formerly discharged to the atmosphere and the daily treatment for odors of an amount of air equivalent to that breathed by 2.1 million people.

Increased emphasis has been given to air pollution control throughout the country by the passing of the Federal Clean Air Act in 1964. Under this legislation, communities which have a planned and workable program are eligible for receipt of federal support and up to two federal dollars for each local dollar in cost of the air pollution control program. We feel that this has been an important factor in dealing with the problem on a national basis and Philadelphia's program has been increased within the last year with the assistance of the Clean Air Act's appropriations. Our annual budget is \$360,000 or approximately 18 cents per capita.

Although additional research in this field would be helpful in shedding further light on the health and economic effects of polluted air, we already have sufficient information which indicates that something must be done to combat this problem. Likewise, the technology for controlling pollution emissions is sufficiently well-advanced. There is an urgent need for additional legislation at all governmental levels and the provision of adequate enforcement agencies for dealing with the air pollution problem by local, regional or state governments.

CDC SHORT COURSE ON EPIDEMIOLOGY AND CONTROL OF SALMONELLOSIS

The Communicable Disease Center in Atlanta, Georgia, will present a course, "Epidemiology and control of Salmonellosis," June 6-10, 1966. Control of salmonellosis will be emphasized. Current information and immediately useful techniques related to control will be delineated.

This course is designed especially for sanitarians, engineers, and veterinarians; however, it is also of interest to other members of the public health team involved in the epidemiology and control of salmonellosis. Course content will include the status and surveillance of salmonellosis in

the United States; a review of the bacteriology of salmonella; sources and reservoirs of salmonellae; epidemiology of salmonellosis; and controls related to animal feeds, the farm environment, rood processing, and food service.

There is no charge for this course or the training materials which will be distributed. Travel and living costs are the responsibility of the applicant. For application forms and information, write: Chief, Training Branch, Communicable Disease Center, Atlanta, Georgia 30333.

PESTICIDES AND THE FOOD SUPPLY

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SUMMARY

The use of chemical pest control agents undoubtedly constitutes a calculated risk; nonetheless, the proper use of these agents results in benefits which, at the present time, far outweigh the known potential hazards. Considerable care must be exercised in the selection, storage, and use of pesticide chemicals and in the disposition of the empty containers. Since virtually all pesticides are more or less toxic to man and cumulative and potentiation characteristics are not well defined, regulation through registration and the establishment of residue tolerances is essential. Scientists recognize that the adequate production and preservation of food and fiber and the protection of human health require the use of chemical pesticides. Federal, state, and local health agencies and the food and chemical industries are striving through research and residue surveillance to show the effect of pesticides on human beings and to provide alternative means of pest control. Until these chemical agents are replaced by less toxic means of control, the use of pesticides will continue. As in any scientific venture, the benefit-hazard ratio in the use of pesticides may never be completely established, but we must act on the best available evidence.

The production of an abundance of high-quality nutritious food for mankind has always had its share of problems. For many years, these were essentially microbiological in nature and were concerned with production and processing sanitation to prevent spoilage and foodborne illness. Recently, however, the increased use of chemicals in agricultural practices has resulted in a new problem—residues in food.

The publication *Silent Spring* (9) focused attention on pesticides—their beneficial and harmful characteristics; their effects on the balance-of-nature, the fish and wildlife population, the food supply, and domestic animals; and their total impact on man. Many questions were posed, but they could not be answered with any degree of accuracy. Consequently, to the concerned and confused public, the problems associated with pesticides became as important as those of antibiotic residues in milk, radionuclides in food, the relationship of animal fat to cholesterol level in man, and community air and water pollution.

Although recent papers in the scientific literature have called attention to the general environmental problems associated with pesticides (10, 36, 56), a re-

view of the food phase of the problem is appropriate (8) since about 90% of man's pesticide intake is through the food chain.

CLASSIFICATION OF PESTICIDES

Pesticides may be classified in terms of use and as chemical compounds. Pesticides used to control insects are referred to as insecticides; similarly, rodenticides are used to control rats, mice, and other rodents; herbicides, to destroy unwanted vegetation; soil sterilants, to destroy undesirable plant seed and insect life in the soil; fungicides to prevent and control plant diseases; and fumigants to prevent and control insect and like infestations in stored grain.

Pesticides are chemically classified as chlorinated hydrocarbons, organic phosphates, carbamates, miscellaneous organics, and inorganic compounds. These classifications often signify little in terms of use since a compound may be employed to control several kinds of pests. Literature is available on the chemical composition and classification of pesticides both from manufacturers' and government agencies (23, 42, 81).

SALE AND USE OF PESTICIDES

By 1964, more than 60,000 formulations, representing approximately 900 chemical agents, had been registered for use in the United States, and the estimated sales of synthetic organic pesticides by primary producers amounted to about \$426 million (75).

Actual figures are not available for other pesticides, but the total supply is estimated at about \$500 million with a gross weight of about 1 billion pounds (75). DDT was the most commonly used pesticide and accounted for 12.4% of the total production.

REGULATION AND CONTROL OF PESTICIDES

The United States Department of Agriculture (USDA) is responsible for the control of pesticides under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act. The Food, Drug, and Cosmetic Act assigned the responsibility for safety of foods to the Department of Health, Education, and Welfare (DHEW) and the Secretary thereof delegated this responsibility to the Food and Drug

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Administration (FDA). An interdepartmental agreement was formalized in April by the USDA, Department of Interior (DI), and DHEW to coordinate their activities relating to the registration of pesticides and the establishment of tolerances (22). Although the USDA retains administrative responsibility for the Federal registration of pesticides, the FDA and the Public Health Service (PHS), of the DHEW, and the DI are charged with joint responsibility for the review of applications for pesticide registration with regard to their safety for man, fish, and wildlife, prior to registration by the USDA.

To be sold in interstate commerce, a pesticide must be registered with the USDA. In applying for registration, the manufacturer must submit information about the product as to intended use, efficiency of use, directions for use, chemical composition, and toxicological data (77). If, on the basis of data submitted, the USDA finds that no residue remains on food, the pesticide will be registered on a "no residue" basis. If the pesticide does leave a residue and is proposed for use on food crops and animals, the manufacturer must file a petition for tolerance with the FDA, in addition to the application for registration with USDA. This petition must present additional data on toxicity, the tolerance requested, evidence that proper use of the pesticide will not leave a residue in excess of the tolerance, and description of an analytical method for detecting the pesticide at the tolerance level. The FDA can then establish a tolerance on crops or animals as petitioned, whereupon the USDA will grant registration of the pesticide. Registration of the pesticide and establishment of tolerances do not preclude future review and change (77). Each registration must be renewed every 5 years. Official FDA tolerances for raw agricultural products are published annually (58).

Tolerance levels are normally set at 1/100 of the amount found to produce toxicity symptoms in experimental animals, but never higher than necessary to accomplish pest control according to the recommended use of the pesticide. If a compound is found too toxic to permit a residue, the FDA will establish a "zero tolerance" (77). Both "no residue" and "zero tolerance" are modified as analytical methods become more sensitive (77). One example of this is the "zero tolerance" in milk. For practical purposes FDA had previously considered the "effective zero", or actionable level, to be 0.1 ppm of DDT in whole milk, simply because 0.1 ppm was the lower limit of detection of the official method of analysis (1). More recently FDA has stated that in the future any milk containing 0.05 ppm, or above, of DDT, or 0.01 ppm, or above, of any one of a number of other chlorinated hydrocarbons, such as

dieldrin and endrin, would be subject to seizure (16).

Because of its unique position in the feeding of infants, the elderly, and the sick, milk is not considered in the broad category of raw agricultural products. While tolerances as high as 10 ppm have been set for many pesticide residues on various fruits and vegetables, milk and its products are currently required to have a zero pesticide residue concentration. Considerable controversy has occurred as a result of the zero requirement for milk. The Food and Nutrition Board of the National Academy of Sciences (NAS) has recommended that a reasonable tolerance for pesticides be considered in milk (77), and the FDA has stated that they will consider petitions to set tangible tolerance levels in milk for any pest control agent (46).

Recently the "no residue" and "zero tolerance" concepts have been studied by a committee sponsored by the NAS. Although no immediate changes are anticipated, this committee has recommended changes in the basic considerations in the registration and regulation of pesticide chemicals. The most pertinent of these changes involves the abandonment of "no residue" and "zero tolerance" in favor of the more readily definable terms, "negligible" and "permissible" residue levels (63).

NECESSITY FOR CONTROL

The mere fact that food and drug laws treat pesticide residues as food adulterants is reason enough to consider such products objectionable. Pesticides, moreover, are not only necessarily toxic to the pests they are intended to control, but many of these agents are also toxic to man and warm-blooded animals. The toxicities of the various pesticides have been studied extensively (2-5, 13, 30, 33, 35, 62, 82). Admittedly, these compounds are quite toxic at high concentration or dosage levels. Some examples of accidental or intentional misuse of pesticides causing illness or death as reported in the literature are the accidental ingestion of relatively large quantities of pesticides by children, excessive exposure of applicators to dusts and sprays through both ingestion and absorption, careless handling of pesticides, thoughtless disposal of the so-called "empty" containers, and intentional poisonings or suicides (14, 24, 25, 32, 38, 41, 55, 57, 67, 85). In the absence of long-term toxicity studies, it cannot definitely be said that the minute residues normally found in contaminated food, are harmful to man. Actually there is evidence to the contrary (34, 87). However, of most concern is the less obvious, more subtle and potentially cumulative effect of low-level, long-term exposure of man to the various pesticide chemicals, individually and collectively (20, 66). These effects

assume a status of more importance when certain characteristics of chemical pesticides are considered.

Chlorinated hydrocarbons are fat-soluble, and most of them tend to accumulate in the fatty tissue of man and animal. The extent of such accumulation and the danger therefrom over a long period of time is not known. DDT and perhaps many other pesticides are rather universally distributed in nature as evidenced by their presence even where applications have probably not been made (70). DDT and DDE concentrations in human body fat in Canada have been estimated to be 3.1 to 7.6 and 7.7 to 20.4 ppm, respectively (64). Estimated DDT in the body fat of the general population in the United States averages about 12.0 ppm, while that of residents of England and Germany is considerably lower (77). These data may reflect differences in food consumption habits in these countries, since it has been shown that in the United States abstainers from meat retain about half as much DDT as that retained in the general population (34). More recent data, accumulated from a somewhat larger population, indicate a slightly lower DDT concentration in human body fat in this country (37). DDT once stored in the body fat is metabolized and released very slowly, as shown by Huddleston, et al. (39). These investigators found that dairy animals feeding on pasture that had been given a single application of 2 pounds of DDT spray per acre initially secreted milk containing 3.77 ppm and, at the end of 1 year, produced milk containing 0.53 ppm (39). These data have been validated for both milk and meat by Kartashova (43) and Gannon, et al. (26). Recent studies indicate that other chlorinated hydrocarbon insecticides are metabolized in a similar manner (29).

Organic phosphate and carbamate pesticides are generally metabolized by both man and animal into compounds that are currently believed to be relatively nontoxic. Although none of the organic phosphate pesticides appear to remain as such in man or animal for any appreciable period of time, absorption of these agents is probably more hazardous than ingestion. Studies indicate that the poisoning of pesticide applicators by organic phosphates is usually through adsorption (31). Residues of certain of these agents have been found in milk as a result of ingestion by the animals; however, more persistent residues in higher concentrations have been found to result from dusting and spraying of animals (11, 61, 65).

Certain combinations of organic phosphate insecticides have exhibited the characteristic of potentiation or synergistic action (60). This phenomenon results in a much more pronounced effect than could be explained by the additive effects of the two or more individual agents. Potentiation has been re-

ported to result from interference by one of the agents involved with the normal metabolism and detoxification of the other compound or compounds (17). Thus, intoxicating activities of the additional compound or compounds are allowed to proceed more or less uninhibited. Synergistic action may occur among other chemical species of pesticides or perhaps between pesticidal agents and other environmental chemicals, as indicated by observations with carbamate insecticides and organic thiocyanates (18). Consequently, although the consumption by human beings of drugs and other chemical entities together with pesticide residues in food may not be cause for great concern, such relationships are certainly a fertile area for concentrated investigation.

Whether or not synergistic action occurs among chlorinated hydrocarbon pesticides has not yet been established. Early investigations by insect bioassays of combinations of these agents produced conflicting data (77). Recently it has been shown that the concentration of dieldrin in rat tissue decreased in direct proportion to the amount of DDT contained in the DDT-dieldrin supplement fed to the rats (69). Such data may suggest an antagonistic action between these agents.

Decomposition of pesticides by the metabolic activities of man and animal might be responsible for a portion of the acute toxicity and the more subtle potential effect. The intermediate and end products of all pesticidal agents are not known. Many of these may exhibit an acute toxicity which is equal to or greater than the parent compound, as in the case of heptachlor epoxide, produced by the metabolism of heptachlor (68, 88). On the other hand, DDT is metabolized to the nontoxic entity, DDE (45). Metabolic modification of pesticides is not limited to animal and man. Lichtenstein and Schultz (50, 54) contend that plants also convert certain of the insecticides to their corresponding epoxides. Soil conditions, sunlight, air, and rain are also responsible for the decomposition of pesticides into new compounds that are often as toxic as their parents (51-54).

Heptachlor epoxide, dieldrin, and endrin exemplify still another potential danger, carcinogenicity, since they contain an epoxide grouping in their molecule and certain other compounds having the epoxide structure have already been shown to be carcinogens (47). Recent investigations of a number of epoxides indicate however, that only certain species of diepoxides are carcinogenic (83). None of the monoepoxides tested (presumably those compounds more closely related to heptachlor epoxide, dieldrin, and endrin) were found to produce carcinoma in rats. The investigators caution, however, that this work is only preliminary and further study is needed.

Since neither heptachlor epoxide, dieldrin, nor endrin were included in the study, it would be unwise to conclude at this time that these insecticides are not carcinogenic. Recent reviews on insecticides as potential carcinogens have been prepared by Durham and others (17, 21, 59).

Investigators, in their assessment of the biological problems in wildlife, have raised the question of sublethal effects of residual insecticides and have presented some evidence with respect to the subtle activities of such agents. Evaluation of the detrimental effect of pesticides on wildlife has been previously concerned with mortality, or the determination of the numbers and percentages of fish, birds, or mammals that died following the application of a toxicant. However, of equal concern is the morbidity the animals suffer. What effects these toxic agents have on growth, reproduction, mutagenesis, or other biological processes are not fully determined. In chronic toxicity studies with quail and pheasant fed 0.14 mg of certain chlorinated hydrocarbon insecticides daily for 2 months, Dewitt has shown that eggs of reduced hatchability were produced and the resulting chicks were subject to high death rates (15). Additional evidence indicates that pesticide residues do cause genetic changes (7, 12, 73).

HOW FOOD IS CONTAMINATED

Food products undoubtedly contain some pesticide residues (77). These contaminants enter the food supply in a number of ways. Crops may be contaminated by direct application, by uptake from the soil and water, or by accidental means such as fall-out or drift from applications to adjacent fields. Lichtenstein, et al. (50, 54) have shown that translocation of pesticides from soil to plants does occur and that certain vegetables tend to concentrate the agents. Evidence also indicates that many of the chlorinated hydrocarbons persist for long periods of time in soil and plant debris (86). Residue concentrations in cereal grains are at times increased by fumigation of storage bins and containers.

Residues in milk and meat may result from direct application to the animal or from the animal's ingestion of residue in feed and water, inhalation of the toxic vapors, and, to some extent, absorption, inhalation, and ingestion from applications to the animal's housing. Waste disposal, runoff from agricultural areas, and direct application of pesticides to water for the control of undesirable aquatic vegetation and marine life often result in the contamination of fish and shellfish (19).

All foods may inadvertently be contaminated during production, in the processing plants, and in the home. Consequently, all food materials provide a

continuous, though extremely limited, source of these potentially hazardous agents.

EFFORTS TO SAFEGUARD FOOD

In July 1964, the Federal Committee on Pest Control (FCPC), was established by the Secretaries of USDA, Department of Defense, DI, and DHEW consisting of two members and two alternates from each of the four Departments to coordinate inter-departmental efforts in accordance with the recommendations of the President's Science Advisory Committee in its report "Use of Pesticides" (77). The FCPC provides a continuous review of all direct uses of pesticides by the Federal Government and insures that the Federal programs will be conducted with maximum safety, effectiveness, and economy. Following review, FCPC recommends procedures to achieve the desired results while preventing or minimizing undesirable effects. The Committee recognizes the statutory duties of each Department, and its recommendations are not intended to limit statutory responsibilities. In addition, the Committee's responsibilities extend to pest control programs in which the Federal Government participates through planning, development, supervision, or financing. Furthermore, it coordinates government information, monitoring, and research on pesticides through special subcommittees.

In its initial program of development and evaluation of pest control agents, the USDA realized very early the possibility of harm from residues in food. Consequently, around 1940 this agency began to evaluate the hazards involved (72). USDA studies, including feeding experiments, have contributed valuable information regarding recommended uses, amounts and frequencies of application, and persistence of residues on crops and in meat and milk. Perhaps the most valuable general service provided by this department is the publication annually of recommended uses and the amount and frequency of application of various pest control agents (74).

The USDA is frequently called upon to apply pest control in the field. All of the large eradication and control programs, such as gypsy moth and Japanese beetle, are the responsibility of this department. Quarantine and control designed to reduce the number of pests, and thus decrease chemical pesticide applications, are additional functions. More recently, USDA scientists have been successful in the limited development of alternative pest control procedures, such as radiation sterilization of male insects and the use of sex attractants (73).

The PHS is directly responsible for protecting the public health from hazards of pesticide use. Since 1940, human and animal experiments have been car-

ried out to determine the effect of pesticides on physiological functions (76). In its program the PHS has investigated the uptake, retention, and excretion of chlorinated hydrocarbons, including buildup in body fat; the effect on the organism of residues as shown through short-term feeding trials; and the overall toxicity effect of many pest control agents (30, 71, 77). Methods have been developed to detect toxic residues in air, water, milk, other food, and body tissue. Valuable data have resulted from surveillance of the environment, studies of the exposure of pesticide applicators and workers in chemical plants, and epidemiological investigations of pesticide incidents in homes, factories, and communities (47).

The last and perhaps the most important phase of the work of the PHS is communication. All of the information that can be collected from PHS research and the work of others is made available to state and local health personnel and representatives of universities and industry by means of short courses, consulting services, bulletins, and training in analytical procedures and techniques (79, 81).

Many of the analytical methods used today were developed by the FDA. It has established more than 2,400 separate tolerances for over 125 chemicals and has maintained a constant surveillance of food in interstate commerce to enforce the existing tolerance regulations (76). For example, in 1962 more than 25,000 food samples were analyzed (46). Obviously not all contaminated food can be detected and removed from human consumption, but as the result of the efforts of this agency, the incidence of illegal pesticides in food and the average concentrations of residues in contaminated samples are on the decline (44). Food producers and processors are apparently becoming more conscious of the potential hazards of pesticide residues in food and are making every effort to minimize such contamination.

The DI has the responsibility of protecting the natural outdoor environment from large accumulations of pesticides. Department scientists are seeking to learn more about the effect of pesticides on fish, birds, and other wildlife and to reduce the hazard in this portion of the human food chain. Considerable research is in progress toward the development of alternative pest control agents, both insecticides and herbicides (22).

Not all work concerned with pesticides is being done by the Federal Government; agricultural experiment stations, universities, many state and local health departments, and state departments of agriculture are involved in research, surveillance, training, and regulatory activities. Although much of this work is being supported by Federal funds, the states themselves are spending large sums of their own

money in support of these programs.

This discussion would not be complete without including the contributions of industry. The tremendous amount of developmental work by the pesticide manufacturer is responsible for many of the efficient pesticide agents and must be recognized. It has been estimated that the manufacturer spends an average of 5 years and \$2 million in the development of a single pesticide and reportedly is able to put only 1 of 30 on the market (27). Industry is constantly striving to improve these materials, to perfect relatively safe replacements for the more potentially hazardous agents, and to develop methods of analysis. It spends an estimated 1.7% of sales receipts to investigate potential health hazards of new products before these products are offered to the public (6).

ANALYTICAL METHODS

The ultimate control of pesticide residues in food depends upon the development of an efficient surveillance program. The major concern in such a program is the analytical methods used to detect and measure pesticide residues. Analysis of food for pesticide residues is fraught with difficulties. As indicated previously, 60,000 formulations representing more than 900 chemical agents were registered for use as of 1964. These formulations represent all of the chemical species previously listed. Residues must be detected and measured in concentrations of 10 to 0.01 ppm. Food products are of a complex chemical nature, usually difficult to sample, often requiring preservation, and generally difficult to prepare for analysis without loss or destruction of the agent in question. Consequently, the ideal analytical method for an efficient surveillance program would be a rapid screening procedure capable of yielding sensitivity in the area of 0.01 ppm of any of the potential pesticide residues, regardless of chemical species, from a crude extract of the food in question. Obviously such a method does not exist. Methods of analysis available today are long and laborious; are useful for a single pesticide, small groups of pesticides, or a single chemical species; are not completely specific; lack required sensitivity; or require expensive instrumentation and intelligent and well trained operators. Undoubtedly, the time required for analysis is the greatest problem in devising a realistic sampling system and thus an efficient surveillance program. Methods of analysis available consist of chemical colorimetric and titrametric procedures; biological assay methods; gas, paper, and thin-layer chromatography; and combinations of gas chromatography and spectroscopy or electrometric titration (28).

PREVENTING CONTAMINATION

The utilization of analytic methods on food materials is for the most part an after-the-fact control procedure. While it has been reported that techniques exist for the removal of pesticide contamination from processed food materials (40), investigation has shown that normal procedures followed in the manufacture of milk products are virtually ineffective in removing pesticide residues (48, 49). Consequently, the aim of food producers and processors is to supply food products as low in pesticide residue concentration as possible. A number of publications on the safe handling and use of pesticides are available (76-78, 80, 81, 84). In general, pesticide contamination of food can be minimized by following the recommendations of Federal and state regulatory agencies, observing the manufacturer's instructions on the label, guarding against careless application, and carefully selecting animal feed materials.

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FIRST ANNUAL REPORT OF CALIFORNIA FOOD PROTECTION AND TOXICOLOGY CENTER

The Food Protection and Toxicology Center at the University of California at Davis, activated on January 1, 1965 has completed its first year of operation and has issued its first annual report, reviewing its accomplishments and outlining its plans for the future. The report describes the objectives and progress of the Center. As a specialized research and training unit, it is concerned with all phases of the environmental science but particularly with the hazards associated with the application of chemicals in producing raw and processed foods, the naturally occurring toxicants and effective agents associated with foods as well as other aspects of food quality.

Several projects involving new areas of research were initiated during the Center's first year of operation. These included a project to determine the relative potency of certain chlorinated hydrocarbon pesticides on the central nervous system; the impact of synthetic organic toxins on soil microorganisms; poultry production and processing practices resulting in the presence of salmonella; and an expanded investigation of certain factors in the hazard of botulism, particularly in prepacked foods.

Other research projects under development include a study of the increasing environmental levels of toxicant residues and possible adverse effects of chronic exposure to humans; use of toxicological agents and the metabolism of these toxicants by microorganisms and animals; the isolation, distribution, and toxicity of natural poisons in food and their

significance in human and animal health; nutritional studies on selected phenolic compounds to improve foods; and a study of the biological and economic implications of pesticide contamination through water drainage.

The Center has the further major objective of producing a greatly increased output of scientists trained in the related disciplines of environmental sciences. Broadly speaking, the Center is concerned with developing new research information, establishing curricula, improving communication within the scientific community, and eventually with improving man's environment.

One of the most important steps taken at the Center during the year to minimize chemical and microbiological hazards to man was the establishment of the Information and Documentation Service. This vital activity will enable the Center to: conduct research on improved techniques for the accumulation and handling of information necessary to the Center's research and training activities; disseminate this scientific information not only to the Center staff but the scientific community at large; develop broad uses for the information by Center-sponsored lectures, seminars and conferences; and to train documentation experts in the environmental sciences. A special working library is being developed and collections being sought include specialized reference works and periodicals, industrial and government publications and reports.

EFFECT OF pH OF PLATING MEDIUM ON ENUMERATION OF PASTEURIZATION-RESISTANT BACTERIA IN MILK¹

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SUMMARY

Plating media of different pH were studied as to effects on enumeration of pasteurization-resistant bacteria in milk. After heat treatment, thermophilic bacteria were more tolerant of pH levels above rather than below 7, and maximum mean thermophilic counts were obtained at pH 7.5. There were some exceptions, but usually the pH levels that yielded the highest counts also produced the largest and most easily discernible colonies. Pure cultures of thermophilic bacteria grew over a much wider range of pH before than they did after laboratory pasteurization. Results indicate that, although seemingly adequate for enumeration in raw milk, the medium pH currently recommended for the standard plate count may not be satisfactory for the determination of the maximum viable bacteria population of pasteurized milk.

Reappraisal of certain bacteriological methods has directed attention to tests for specific groups of bacteria which might serve as indices of milk contamination. Pasteurization-resistant bacteria have been considered as such an index of unsanitary production practices. The most common procedure for determining the viable population of milk, both raw and commercially-pasteurized, is the agar plate method as described in *Standard Methods for the Examination of Dairy Products* (2). This procedure, also recommended for determining the thermophilic bacterial count of laboratory-pasteurized milk, calls for the use of a plating medium of pH 6.9 to 7.1.

The literature lacks comprehensive studies related to the influence of pH of the plating medium upon the enumeration of thermophilic bacteria in milk. Coolidge, as cited by Fay (3), believed that the appearance of pin-point colonies formed by thermophilics was associated with the reaction of the plating medium. The same sample of milk plated on two media at pH 6.6 and 7.3 resulted in counts of 15,400 and 317,000 per ml, respectively. Wilson et al. (7) plated 22 raw milk samples and 23 pasteurized milk samples on Yeastrel Milk agar adjusted to pH levels

of 6.0, 6.8 and 7.6. They reported that, for both raw and pasteurized milk, a medium reaction of pH 6.0 was too acid. For raw milk, a medium of pH 6.8 was more favorable than one of pH 7.6, but for pasteurized milk, a medium of pH 7.6 was more desirable.

Nelson (5) studied the effect of media pH upon growth of pure cultures of *Escherichia coli*, *Pseudomonas aeruginosa*, *Streptococcus durans*, *Micrococcus pyogenes* var. *aureus* and *Bacillus subtilis* before and after heat treatment. In general, the unheated cultures grew on solid media over a much wider pH range than did the heated cultures. Heat-treated *S. durans* gave a maximum count when the plating medium was adjusted to pH 6.5 to 8.0, while the unheated control gave a maximum count from pH 5.6 to 9.0.

The present study was undertaken to determine the effect of plating medium pH upon the enumeration of pasteurization-resistant (thermophilic) bacteria in milk.

EXPERIMENTAL METHODS

Except for certain indicated modifications, the methods employed were those outlined in *Standard Methods* (2). To reduce the time required for preparing replicate plates, 1.0 ml and 10.0 ml pipettes graduated in tenths of a milliliter were used for delivery of 0.1 ml and 1.0 ml quantities.

Six samples each of bulk-cooled grade A milk, can-cooled manufacturing grade milk and blended bulk and can-cooled manufacturing grade milk were examined. A standard plate count at 32 C was determined for each sample before laboratory pasteurization. A "complete immersion" laboratory pasteurization technique as described by Thomas et al. (6) was employed. Samples were pasteurized at 62.5 C for 30 min. Less than 5 min was required for the sample to reach pasteurization temperature. Immediately following pasteurization, samples were cooled in ice water.

Following pasteurization of each milk sample, a single series of dilutions was prepared. The required number of replicate plates was prepared for each sample dilution. Duplicate plates of each dilution were poured with each of five Plate Count agars (1) adjusted to final pH levels of 6.5, 7.0, 7.5, 8.6 and 9.1. Grade A milk samples were plated by using Plate Count agars adjusted to additional pH levels of 5.6 and 8.0.

All media were prepared from the same lot of dehydrated basal medium. Except for the variation in pH, the media were identical in composition and method of preparation. A Beckman Model 96 potentiometer was used for all pH determinations. Ten-percent solutions of NaOH or HCl

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TABLE 1. AVERAGE DISTRIBUTION OF THERMODURIC BACTERIA IN EIGHT SAMPLES OF MILK^a OBTAINED WITH MEDIA CONTAINING VARIOUS BACTERIOLOGICAL PEPTONES

| Bacteriological peptone | Average thermoduric count ^b /ml | Distribution of bacteria (% of total) | | | |
|-------------------------|--|---------------------------------------|---------------|------------|--------------|
| | | Arthrobacters | Microbacteria | Micrococci | Streptococci |
| Bacto-Tryptone | 95,000 | 13.6 | 1.7 | 77.9 | 6.8 |
| N-Z-Amine Type AS | 150,000 | 1.8 | 5.3 | 70.1 | 22.8 |
| N-Z-Amine Type YT | 130,000 | 13.1 | 4.9 | 55.7 | 26.3 |
| Edamin | 100,000 | 7.3 | 5.4 | 87.3 | 00.0 |
| HY-Case SF | 140,000 | 12.3 | 7.0 | 49.1 | 31.6 |

^aPasteurized at 62.5 ± 0.1 C for 30 min.

^bPlates incubated at 32 C for 48 hr.

were used in adjusting the pH of all media prior to autoclaving. The final pH of each medium was determined at a temperature of 45 C just before plating in accordance with Standard Methods (2). Storage, melting and tempering did not cause the final pH of any medium to vary by more than 0.1 pH unit from the level to which it had been adjusted.

Milk samples showing either a wide variation or no variation in thermoduric count, when plated at the various pH levels at 32 C for 4 days, were selected for study of the bacterial types encountered. Immediately after the colonies were counted, representative colonies from suitable plates were picked by a random method (4) and inoculated into tubes of sterile litmus milk. After incubation at 32 C for 3 to 5 days, a loopful of milk from each tube was streaked onto a plate containing Plate Count agar plus 0.25% non-fat milk solids. Surface colony characteristics were noted on the streaked plates after 72 hr at 32 C.

To assure the isolation of pure cultures, a single colony picked from each streak plate was inoculated into a tube containing 5 ml of sterile litmus milk. The reaction was noted at intervals during a 14-day period at 32 C. Slants inoculated from the litmus milk tubes were incubated at 32 C for 24 hr; smears were prepared from the slants, Gram stained and examined microscopically.

A preliminary classification of the isolates into genera was based upon cell morphology, Gram staining characteristics, reaction in litmus milk and colony characteristics. Additional cultural and biochemical testing of representative isolates verified classification into genera and, in some cases, into species.

Four isolates, representative of the predominant genera of thermoduric bacteria found, were selected for study of the effect of pH of the plating medium upon the growth of pure cultures before and after laboratory pasteurization. The selected isolates were classified as *Microbacterium lacticum*, *Micrococcus varians*, *Streptococcus* sp. and *Arthrobacter* sp. Stock cultures were prepared by inoculating sterile litmus milk with representative colonies from agar slants and then incubating the milk at 32 C for 24 hr. One ml of each culture was added to 100 ml of sterile reconstituted skim milk containing 10% non-fat milk solids. After thorough mixing, 10 ml of the inoculated skim milk were transferred to a sterile test tube for laboratory pasteurization. A second portion of the nonpasteurized, inoculated skim milk was refrigerated at 3.3 to 4.4 C for 24 hr before laboratory pasteurization. The pasteurized and nonpasteurized cultures were plated and incubated in the manner previously outlined

for pasteurized samples of raw milk. Plate Count agars adjusted to pH 5.6, 6.5, 7.0, 7.5, 8.0, 8.6 and 9.1 were used; duplicate plates were incubated at 32 C and were counted after 2, 3 and 4 days.

RESULTS

The effect of plating medium reaction upon the average arithmetic thermoduric plate count of 18 milk samples is shown in Figure 1. The maximum mean count was obtained with Plate Count agar adjusted to pH 7.5. Insufficient data were obtained to include counts on a medium of pH 8 in Figure 1, but the limited data available indicate that average counts with a medium of pH 8 would at least equal those obtained with a medium of pH 7.5. No discernible colonies were produced with any of the samples with Plate Count agar at pH 5.6. Of the various media mentioned in Figure 1, only that of pH 7.5 produced average thermoduric counts that did not increase when plates were incubated beyond 2 days. Limited data would suggest similar results with media of pH 8.0. The mean 4-day thermoduric count obtained at pH 8.6 was equal to the 2-day count obtained at pH 7. Mean colony counts obtained with Plate Count agars at pH 6.5 and pH 9.1 were comparable to but considerably lower than counts obtained with media of intermediate pH.

The distribution of thermoduric bacteria in nine samples of milk obtained with Plate Count agar at various pH levels is presented in Table 1. The proportionate share of the mean colony count attributable to micrococci tended to decrease as pH of the medium was increased. The greatest number of micrococci, however, was obtained with a medium of pH 7.0. In contrast to the trend shown by micrococci, the percentage of the mean colony count attributed to streptococci increased at each pH level as the plating medium pH progressively increased from 6.5 to 9.1. The highest average streptococcus colony count was obtained at pH 7.5. The counts

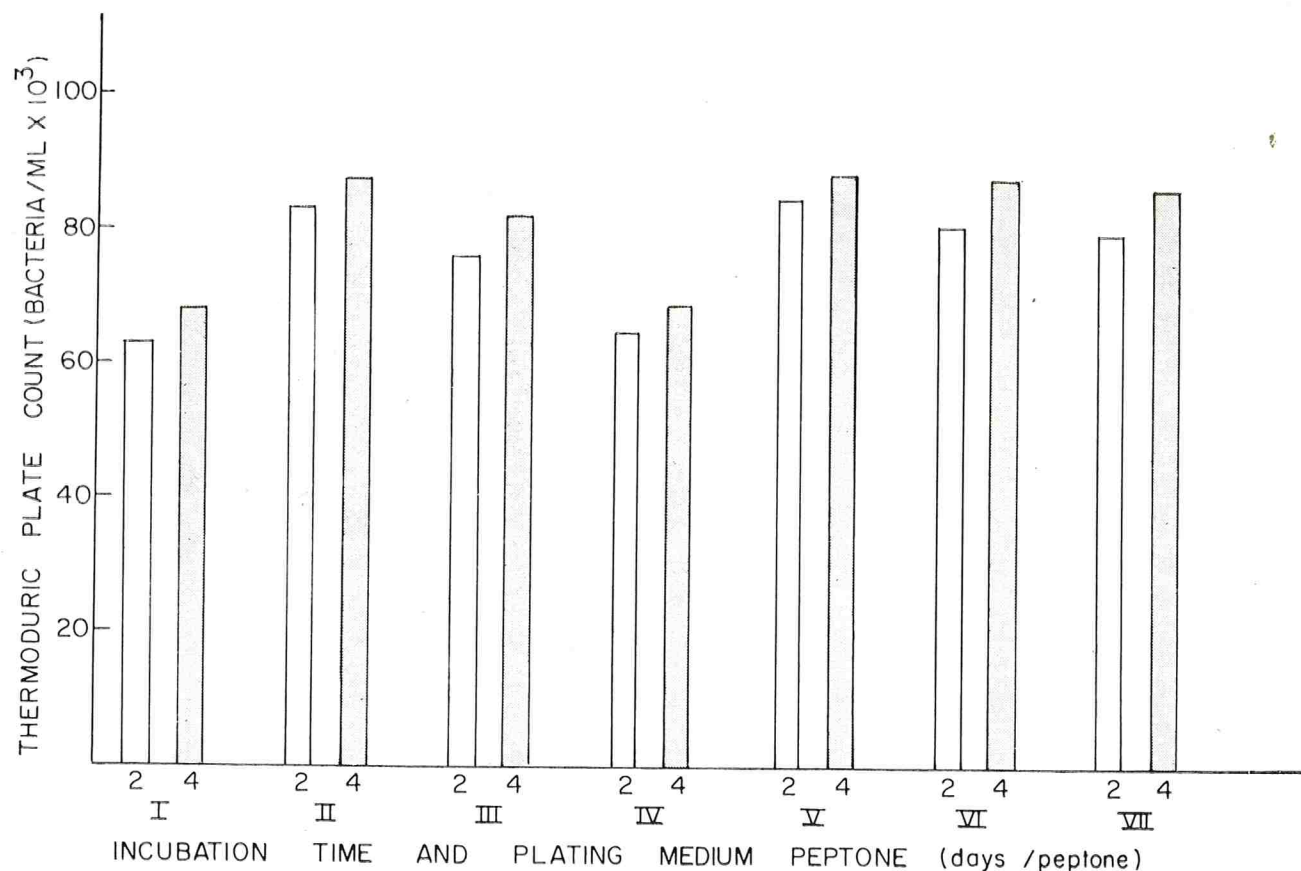


Figure 1. Mean thermoduric plate counts (32 C) of 26 milk samples obtained with media containing various bacteriological peptones: I, Bacto-Tryptone; II, N-Z-Amine Type AS; III, N-Z-Amine Type YT; IV, Edamin; V, Soy Peptone Powder; VI, N-Z-Case; VII, HY-Case SF.

obtained at pH 8.6 and 9.1 were more than double the count of streptococci obtained with a medium of neutral reaction.

Arthrobacters accounted for approximately equal portions of the counts obtained with media of pH 7.0 and 7.5. However, colony development by these bacteria was restricted at pH 8.6 and entirely absent at pH 9.1. The number of microbacteria isolated from samples included in Table 1 was inadequate to demonstrate the effect of the medium pH upon their ability to produce colonies. The limited data suggested, however, that growth of microbacteria that survived pasteurization was favored by the higher pH media.

In addition to influencing the thermoduric plate count, the pH of the plating medium influenced the size of individual colonies. Although there were some exceptions, colony size generally was largest with those media yielding the highest count for a particular sample. This was especially true for samples containing appreciable numbers of streptococci and microbacteria. Although the thermoduric colony count for certain samples was not influenced substantially by variations in pH, levels above pH

7 usually produced the largest and most easily discernible colonies.

The effect of plating medium pH upon the plate count of a pure culture of *Arthrobacter* sp. before and after laboratory pasteurization is shown in Figure 2. The unheated culture produced colonies equally well over a range of pH 6.5 to 8.6. However, the laboratory pasteurized culture showed a definite preference for a medium of pH 7.0 and colony counts were depressed substantially above and below this level. Incubation of plates beyond 48 hr failed to change the results shown in Figure 2.

An unheated culture of *M. varians* showed essentially the same degree of colony development over a range of pH 6.5 to 9.1 as shown in Figure 3. With a pasteurized culture of this organism, however, the maximum 48-hr colony count was obtained at pH 8 with noticeably decreased colony production on media below or above pH 8. Extending the plate incubation period to 96 hr permitted colony development at pH 7.5 and 7, but the counts were considerably less than those obtained at pH 8.

Figure 4 shows that an unheated culture of *Streptococcus* sp. gave essentially the same degree of colony development over a range of pH 6.5 to 9.1.

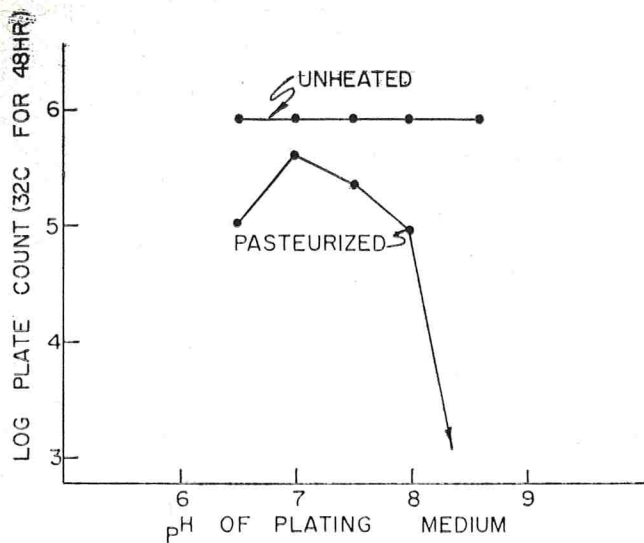


Figure 2. Effect of pH of Plate Count agar upon the plate count of a culture of *Arthrobacter* sp. before and after laboratory pasteurization.

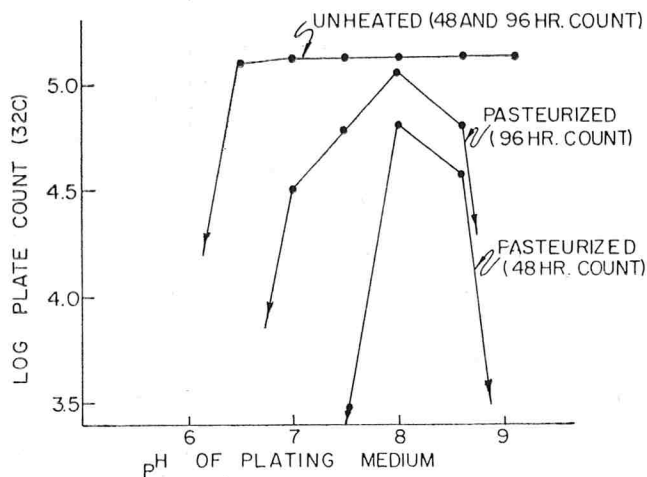


Figure 3. Effect of pH of Plate Count agar upon the plate count of a culture of *Micrococcus varians* before and after laboratory pasteurization.

A laboratory pasteurized culture of this organism failed to produce countable colonies at pH 6.5, and colony development increased from pH 7 to 8.6.

Unheated cultures of *M. lacticum* gave essentially the same colony count with Plate Count agar at levels of pH 6.5 to 8.6. The colony counts for pasteurized cultures were considerably less at pH 6.5 than at pH levels of 7, 7.5, 8 and 8.6. Colony productivity by this organism was substantially enhanced by laboratory pasteurization.

Colony size, as well as colony count, was influenced by pH of the Plate Count agar. Although colony counts for pasteurized cultures of *M. lacticum* did not differ appreciably at pH levels of 7 to 8.6, colonies produced at pH 7 were generally less than 1 mm in diameter after incubation at 32 C for 3

days. With pH levels of 7.5 to 8.6, colonies averaged about 2 mm in diameter after incubation at 32 C for 3 days.

DISCUSSION

The current edition of Standard Methods (2) recommends a pH of 7.0 ± 0.1 for the plating medium used in determining the Standard Plate Count of raw, commercially pasteurized and laboratory pasteurized milk. Results of this study, however, have indicated that a pH of 7 for Plate Count agar is suboptimal for colony production by most thermophilic bacteria.

As a rule, maximum thermophilic counts were obtained with Plate Count agar adjusted to pH 7.5 and 8. The reason for the higher counts at these pH levels can be explained partially by the increased growth of the thermophilic streptococci. As the pH of the plating medium was progressively raised from pH 6.5 to 9.1, the portion of the mean colony count attributable to streptococci also increased. However, at levels above pH 8 and, in some cases, above pH 7.5, the growth of certain other thermophilic bacteria was inhibited, as evidenced by a decrease in total colony count.

Thermophilic bacteria of the genus *Arthrobacter* evidently were primarily responsible for decreases in count obtained at levels above pH 7.5. Of all the thermophilic bacteria isolated in this study, only those of the genus *Arthrobacter* showed a definite preference for a medium of pH 7 to 7.5. There were some indications that certain of the thermophilic micrococci preferred a neutral medium rather than

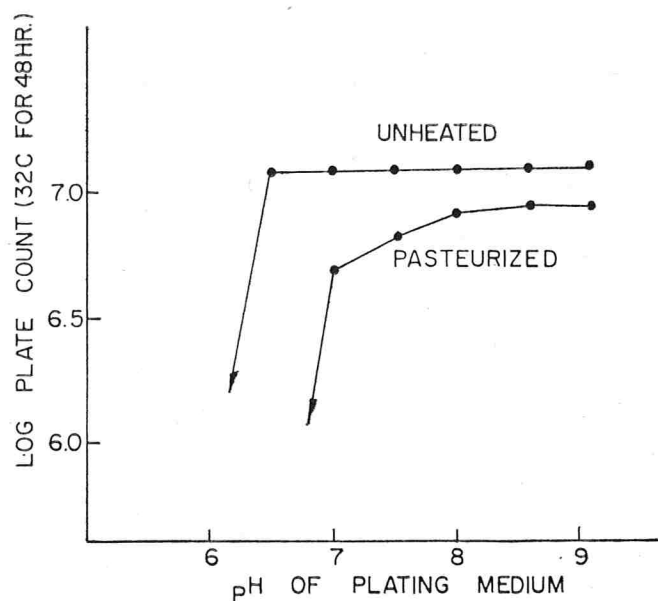


Figure 4. Effect of pH of Plate Count agar upon the plate count of a culture of *Streptococcus* sp. before and after laboratory pasteurization.

an alkaline one. However, this group of bacteria exhibited no definite preference, and colony productivity often was as great at pH 7.5 to 8.6 as at pH 7.

An increase in the thermoduric plate count was usually obtained when the reaction of the plating medium was elevated from pH 7 to pH 7.5. On the other hand, lowering the pH to 6.5 almost always resulted in a substantial decrease in thermoduric count from that obtained at pH 7. With a level of pH 7 as the basis, the average increase in count obtained at pH 7.5 was considerably less than the average decrease in count obtained at pH 6.5. This observation offers further support in favor of the use of a slightly alkaline medium for obtaining a more nearly maximal thermoduric count of milk.

That the pH of the plating medium influenced the size of individual colonies as well as the number of colonies appearing on the medium should not be overlooked. As noted earlier (6), the accuracy of a plating procedure is determined, not only by its ability to recover the maximum number of viable bacteria in a product, but also by its ability to produce distinct and easily countable colonies. As a general rule, the pH level displaying the highest thermoduric colony count for a particular sample also produced colonies of the largest size. This relationship held true especially for those samples containing thermoduric streptococci. The thermoduric count for some samples was not influenced appreciably by variations in pH of the plating medium. For these samples, however, the most easily discernible colonies were usually produced at levels above pH 7. This was most noticeable with samples containing microbacteria.

The results indicate that thermoduric bacteria subjected to laboratory pasteurization are more exacting in their pH requirements for growth than they were before pasteurization. Unheated cultures of a strain of *M. varians*, for example, gave essentially the same count with Plate Count agar at pH levels from 6.5 to 9.1 after 2 days of incubation. After being subjected to laboratory pasteurization, however, this strain did not produce colonies at 2 days of incubation with Plate Count agar of pH 7 and 9.1 and yielded a pronounced maximum count at pH 8.

These observations generally agree with those of Nelson (5). After studying the effect of sub-lethal heat treatment on several bacteria of a non-thermoduric nature, he concluded that unheated cultures

grew over a much wider pH range than did the heated cultures. The only exception in the present study were the results obtained with a strain of *Microbacterium lacticum*. Colony productivity by unheated cultures of this organism was definitely inhibited on Plate Count agar at pH 9.1. After the cultures were subjected to laboratory pasteurization, however, colonies were produced quite well at pH 9.1. No explanation can be offered for this occurrence, but it seems logical that the process of heating altered the character of the organism so as to render it more tolerant to the higher pH. This points out the apparent need for additional work with respect to the effects of heat upon the physiological characteristics of thermoduric bacteria.

As mentioned previously, the current edition of Standard Methods (2) recommends that the plating medium used for the enumeration of bacteria in milk have a pH of 7.0 ± 0.1 . This standard applies for the examination of both raw and pasteurized milk. Results of this study have indicated that a pH level of 7, although adequate for the enumeration of bacteria in milk before pasteurization, is sub-optimal for maximum colony production by some of the thermoduric bacteria after these have been subjected to pasteurization. This should be considered in the preparation of media for the enumeration of bacteria in pasteurized products and in experiments concerned with the effect of heat upon microorganisms in dairy products.

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EFFECT OF PSEUDOMONADS AND ACHROMOBACTERACEAE ON GROWTH OF STAPHYLOCOCCUS AUREUS^{1, 2}

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SUMMARY

Pseudomonas and *Achromobacteraceae* cultures, mostly from foods, were tested for their effect on the growth of *Staphylococcus aureus* 196E in Trypticase Soy Broth at different temperatures (10 to 30 C) and with different ratios of effectors to staphylococci in inocula. Most cultures inhibited the staphylococcus, with inhibition becoming greater with decreasing proportions of *S. aureus* in the inoculum and decreasing temperatures of incubation, but inhibition usually was not as great as had been found with most coliform and lactic acid bacteria. Only a few of the *Pseudomonas* cultures could keep numbers of *S. aureus* below 5×10^6 cells per ml, even with an initial ratio of effectors to staphylococci of 100 : 1 and a low incubation temperature, although most cultures of *Pseudomonas* and *Achromobacteraceae* delayed the attainment of these numbers. Especially effective in inhibition of *S. aureus* were strains of *Pseudomonas striata* and *P. mildenbergii* or *convexa*, and a culture of *Alcaligenes viscolactis*.

At 15 C *Pseudomonas fluorescens*, *Alcaligenes faecalis*, and *Achromobacter xerosis* stimulated *S. aureus* enough during early growth to hasten the attainment of hazardous numbers of staphylococci by several hours. At 15, 25 and 30 C most cultures, however, delayed the growth of *S. aureus*, and all kept maximal numbers of staphylococci below those reached by the coccus growing alone, although numbers usually were less by only about one- to two-thirds.

Most strains of two *Pseudomonas* species affected *S. aureus* similarly, and the effects of eight species of effectors on two strains of *S. aureus* were, for the most part, similar.

Previous work by DiGiacinto and Frazier (1) had indicated that most of the coliform bacteria tested and lactic acid bacteria as reported by Kao and Frazier (3), inhibited the growth of *Staphylococcus aureus*, with greater inhibition as the incubation temperature was lowered toward 10-15 C and as the proportion of staphylococci in the inoculum was decreased. Some of the lactic acid bacteria, however, stimulated growth of *S. aureus* during early hours of incubation. Present work was with some of the gram-negative, nonsporeforming, nongasforming rods commonly found in foods.

Graves and Frazier (2) reported that most cultures of the *Pseudomonas-Achromobacter* group stimulated *S. aureus*, according to spot-plate tests, but some were inhibitory, *Flavobacterium* and *Alcaligenes* being most inhibitory. On spot plates Oberhofer and Frazier (5) found that *Pseudomonas* cultures from chicken and meat, together with *P. aeruginosa*, *P. fragi*, and *Alcaligenes viscolactis*, had no apparent effect on growth of *S. aureus*, whereas two strains of *Pseudomonas fluorescens* were somewhat inhibitory. Troller and Frazier (7) concluded that a *Pseudomonas* culture inhibited *S. aureus* by outcompeting it for nutrients. Peterson, Black, and Gunderson (6) reported that naturally occurring mixed populations of mesophiles and psychrophiles in precooked frozen foods repressed added staphylococci during thawing at different temperatures. Presumably *Pseudomonas-Achromobacter* bacteria were involved.

MATERIALS AND METHODS

A few of the 28 effector cultures tested were from stock culture collections, but most were isolated from foods. The 19 *Pseudomonas* cultures represented species tentatively identified as *P. fluorescens*, *P. aeruginosa*, *P. fairmontensis* (strain R35), *P. effusa* (S82), *P. striata* (F2, R39), *P. mildenbergii* or *P. convexa* (A24, B63, F72), and *P. incognita* or *P. rugosa* (A47). Strain F11 was not identified. The *S. aureus* cultures were strain 196E, an enterotoxigenic strain from G. M. Dack, and strain W-1, a nonenterotoxigenic mastitis strain from J. B. Wilson. All effector cultures were tested for their effect on *S. aureus* when grown with it on Trypticase Soy Agar spot plates at 15, 30, and 37 C. Also effector cultures were grown with *S. aureus* in Trypticase Soy Broth at different temperatures and with different initial ratios of effectors to staphylococci, and growth of the staphylococci was followed. A third transfer, grown in the broth for 12 hr at 30 C, was used as inoculum. In all experiments the inoculum of staphylococci was about 2×10^8 cells per ml, and inocula of effectors were 2×10^2 , 2×10^4 , or 2×10^6 cells per ml. Trypticase Soy Broth was chosen to represent a complete medium, favorable to growth of both staphylococci and effectors, and in this way resembling most raw foods.

Counts of *S. aureus* during the course of growth were made by means of Mannitol Salt Agar spread plates, with incubation for 48 hr at 30 C. All dilutions were in sterile 0.1% peptone solution.

RESULTS

Spot plates. None of the *Pseudomonas*, *Alcaligenes*, *Achromobacter*, or *Flavobacterium* cultures

¹Published with approval of the Director of the Wisconsin Agricultural Experiment Station.

²This investigation was supported in part by Public Health Service Research Grant EF-00282 from the Division of Environmental Engineering and Food Protection.

³Present address: Department of Soils, College of Agriculture, College, Laguna, Philippines.

TABLE 1. INFLUENCE OF EFFECTOR BACTERIA ON GROWTH OF *S. aureus* 196E IN TRYPTICASE SOY BROTH AT 25 AND 30 C AFTER 8 HR, AND AT 18 C AFTER 24 HR, WITH INITIAL EFFECTOR TO COCCUS RATIO OF 1 : 1

| Cultures | Source | No. of <i>S. aureus</i> ^a /ml x 10 ⁶ | | |
|----------------------------------|----------------|---|------|------|
| | | 30 C | 25 C | 18 C |
| <i>S. aureus</i> 196E (alone) | — ^b | 53.0 | 13.0 | 14.0 |
| <i>Pseudomonas aeruginosa</i> | — | 39.0 | 5.9 | 14.0 |
| <i>Pseudomonas fluorescens</i> | — | 25.0 | 3.5 | 8.3 |
| <i>Pseudomonas</i> A8 | beef | 45.0 | 4.2 | 4.9 |
| <i>Pseudomonas</i> A24 | beef | 2.7 | 2.0 | 8.3 |
| <i>Pseudomonas</i> B63 | beef | 23.0 | 1.9 | 11.0 |
| <i>Pseudomonas</i> F2 | fish | 19.0 | 5.8 | 8.2 |
| <i>Pseudomonas</i> F11 | fish | 23.0 | 6.5 | 16.0 |
| <i>Pseudomonas</i> F72 | fish | 41.0 | 5.9 | 8.3 |
| <i>Pseudomonas</i> R35 | milk | 42.0 | 2.8 | 3.9 |
| <i>Pseudomonas</i> R39 | milk | 58.0 | 3.9 | 6.4 |
| <i>Pseudomonas</i> S82 | chicken pie | 12.0 | 4.6 | 5.4 |
| <i>Alcaligenes viscolactis</i> | — | 10.0 | 0.9 | 1.6 |
| <i>Alcaligenes faecalis</i> | — | 20.0 | 1.2 | 16.0 |
| <i>Alcaligenes</i> P142 | peas | 31.0 | 2.9 | 6.7 |
| <i>Achromobacter xerosis</i> | — | 58.0 | 0.4 | 7.0 |
| <i>Achromobacter</i> M80 | milk | 43.0 | 3.0 | 2.9 |
| <i>Flavobacterium capsulatum</i> | — | 56.0 | 0.6 | 7.7 |

^aInitial number for *S. aureus* 196E (alone) and for *S. aureus* and each effector was 2×10^4 per ml.

^b— indicates previously identified stock cultures.

tested affected the growth of *S. aureus* 196E on spot plates at 15, 30, or 37 C.

Growth in broth. Table 1 shows the influence of effector cultures on the growth of *S. aureus* in broth after 8 hr at 25 and 30 C, and after 24 hr at 18 C, with equal initial numbers of effector and staphylococcus. Of 19 *Pseudomonas* cultures (11 are shown in the table), only one, strain A24 (which resembles *P. convexa*), markedly repressed the growth of *S. aureus* at 30 C. At 25 C all were inhibitory, and at 18 C all were moderately inhibitory except *P. aeruginosa* which had no effect, and an unidentified strain (F11) which was stimulatory. The four *Alcaligenes* cultures (3 in table) inhibited at 30, 25, and 18 C, except that *A. faecalis* stimulated somewhat at 18 C. *Achromobacter xerosis* and *Flavobacterium capsulatum* stimulated at 30 C, but otherwise all four *Achromobacter* cultures (2 in Table)

and one *Flavobacterium* inhibited *S. aureus*.

By the 72nd hr at 18 C and the 24th hr at 25 and 30 C, all 19 *Pseudomonas* cultures had inhibited *S. aureus*, but in most instances numbers were reduced to only about one-third to two-thirds of numbers of *S. aureus* growing alone. At 18 C, by the 72nd hr, *P. fluorescens* had caused no decrease in final numbers, and only two pseudomonads, A24 and R35, had markedly inhibited the staphylococcus.

Of cultures in the other genera, only *Alcaligenes viscolactis* had held down numbers of staphylococci appreciably (85%) after 24 hr at 30 C. This culture and the others held down numbers of cocci most effectively at 25 C, where numbers of cocci were lower than in the control by about 99.5% with *A. viscolactis*, by about 85% with *Alcaligenes faecalis*, *Achromobacter xerosis*, and *Flavobacterium capsulatum*, and by about 56 to 77% with the others. The exception was *Achromobacter* P15, which was most effective at 18 C. At 18 C by the 72nd hr most of the cultures had repressed *S. aureus* to only about one-third to two-thirds of its population when growing alone.

Eight cultures, representing the four genera, were studied for their effect on growth of *S. aureus* by means of detailed growth curves at 10, 15, and 22 C and with ratios of effectors to staphylococci in inocula of 1 : 100, 1 : 1, and 100 : 1. In general, inhibition increased with increasing proportions of effector bacteria in the inocula and with decreasing temperature, but inhibition was not as great as with the other bacteria studied.

Again special attention was paid to the time required to reach 5×10^6 staphylococci per ml, a number approximating the minimal number of *S. aureus* organisms assumed by DiGiacinto and Frazier (1) to be necessary for appreciable enterotoxin production. Only one of the eight test organisms, *Pseudomonas* A24, kept numbers of staphylococci below 5×10^6 cells per ml with inoculum ratios of 100 : 1 and 1 : 1, as shown in Table 2. These numbers were exceeded eventually in the presence of the other seven test organisms, regardless of temperature or inoculum ratio. Similar results also were obtained in other tests at 18, 25 and 30 C. Table 2 shows the delay or hastening of the attainment of 5×10^6 staphylococci per ml with the eight cultures. Except for *Pseudomonas* A24, delay was for 1.3 to 5.5 hr at 22 C. At 15 C, however, *P. fluorescens* and *Alcaligenes faecalis* caused *S. aureus* to reach 5×10^6 cells per ml 2.2 to 4.4 hr sooner than when growing alone, when inoculum ratios were 1 : 100 and 1 : 1, and *Achromobacter xerosis* shortened the time 4.4 hr at a 1 : 100 ratio. Otherwise at 15 C delays were, for the most part, considerable, some for as long as 9 to 23 hr. There was no stimulation at 10 C, and

TABLE 2. TIME IN HOURS FOR *Staphylococcus aureus* TO REACH 5×10^6 CELLS PER ML WHEN GROWN WITH EFFECTOR ORGANISMS IN TRYPTICASE SOY BROTH AT 22, 15, AND 10 C, AND WITH INITIAL RATIO OF EFFECTOR TO COCCUS OF 1 : 100, 1 : 1, OR 100 : 1

| Effector organism | 22 C | | | 15 C | | | 10 C | | |
|------------------------|---------|-------|----------------|---------|-------|---------|---------|-------|---------|
| | 1 : 100 | 1 : 1 | 100 : 1 | 1 : 100 | 1 : 1 | 100 : 1 | 1 : 100 | 1 : 1 | 100 : 1 |
| <i>P. aeruginosa</i> | 11.5 | 11.5 | 14.5 | 45.8 | 52.4 | 64.4 | 93.6 | 102.0 | 172.8 |
| <i>P. fluorescens</i> | 11.3 | 11.3 | 12.0 | 37.1 | 37.1 | 45.2 | 93.6 | 96.0 | 100.8 |
| <i>Pseudomonas</i> A24 | 11.5 | 16.3 | — ^a | 61.1 | — | — | 175.2 | — | — |
| <i>Pseudomonas</i> R39 | 12.5 | 12.5 | 15.5 | 43.6 | 51.8 | 57.8 | 93.6 | 96.0 | 109.2 |
| <i>A. viscolactis</i> | 13.0 | 13.0 | 14.0 | 50.2 | 53.5 | 56.1 | 91.2 | 100.8 | 121.0 |
| <i>A. faecalis</i> | 12.0 | 12.0 | 12.0 | 39.3 | 37.1 | 43.1 | 81.6 | 92.4 | 115.2 |
| <i>F. capsulatum</i> | 13.5 | 13.5 | 13.5 | 41.5 | 41.5 | 50.2 | 87.6 | 87.6 | 103.2 |
| <i>A. xerosis</i> | 12.0 | 12.0 | 13.0 | 37.1 | 42.5 | 49.1 | 96.0 | 96.0 | 112.8 |
| <i>S. aureus</i> | 10.0 | | | 41.5 | | | 81.6 | | |

^a— = a population of 5×10^6 *S. aureus* per ml was not attained.

S. aureus usually was delayed from reaching hazardous numbers for a number of hours, especially when ratio of effectors to staphylococci was 1 : 1 or 100 : 1.

A comparison of the eight selected cultures at 10, 15, 18, 22, 25, and 30 C, with an initial ratio of effector to coccus of 1 : 1, showed that most inhibition of the coccus was obtained at 15 C with the pseudomonads, except for *P. fluorescens* which was best at 25 C. *Alcaligenes* cultures had the greatest effect at 18 to 22 C; *Flavobacterium capsulatum* was best at 22 C, and *Achromobacter xerosis* at 10 or 15 C.

A comparison of strains of *Pseudomonas* species showed that three of five other strains of *P. mildenbergii* or *P. convexa* resembled strain A24 in being markedly inhibitory toward the staphylococcus at 18 and 25 C; however, they were not inhibitory at 30 C. All five strains of *P. striata* were markedly inhibitory at 18 and 25 C, but not at 30 C.

A comparison of the effect of the eight selected cultures on the enterotoxigenic *S. aureus* 196E and the nonenterotoxigenic *S. aureus* W-1, made at 30 C with an effector to staphylococcus ratio in the inoculum of 1 : 1, showed mostly general agreement with the two strains, except with *A. xerosis* and *F. capsulatum* which stimulated strain W-1 more than strain 196E.

DISCUSSION

The representatives of the genus *Pseudomonas* and the family *Achromobacteraceae* tested were, in general, less inhibitory toward *S. aureus* than the coliform bacteria were shown to be by DiGiacinto and

Frazier (1), and than most of the lactic acid bacteria as reported by Kao and Frazier (3). This is contrary to expectations, because the psychrophiles, and in particular low-temperature pseudomonads, are believed to play an important role in the repression of *S. aureus* at temperatures below those of the room, and to cause changes in foods that make them unfit to eat before numbers of staphylococci become significant. Of the 17 *Pseudomonas* cultures isolated from beef, fish, milk, and chicken pot pie, 14 came from these foods incubated at 15 C or below, and 10 from foods held at 5 C. All 19 of the pseudomonads in 1 : 1 ratio inhibited *S. aureus* within 8 hr at 18 and 25 C, but only 12 kept numbers below 5×10^6 cocci per ml at 25 C, and only 5 within 24 hr at 18 C. Only one repressed *S. aureus* that much in 8 hr at 30 C. The commonly found *P. fluorescens* was not an effective inhibitor, nor were the *Achromobacteraceae* tested. Of course if the foods are held at near the minimal temperature for growth of *S. aureus*, the psychrophilic pseudomonads usually will be able to repress the staphylococcus.

Tests should be made on the special types of *Pseudomonas* and *Achromobacter* reported by Lerke, Adams, and Farber (4) to be concerned with the spoilage of fish.

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ASSOCIATION AFFAIRS

RAY B. WATTS HONORED BY OHIO STATE UNIVERSITY

Ray B. Watts, Chief, Division of Sanitation, Ohio Department of Health, has been presented the Merit Award In Milk Sanitation by the Ohio State University Department of Dairy Technology.

Ray Watts was honored in recognition of "his outstanding contributions to Public Health and to Milk Sanitation in Ohio, for engendering the spirit of cooperation and understanding between all facets of the Dairy Industry in respect to milk control needs, and for providing leadership in educational programs designed to improve the professional status of the Sanitarian." The Award was presented by Dr. I. A. Gould, Chairman of the Department of Dairy Technology, at the 33rd Annual Dairy Industry Conference Banquet, February 9.



Ray B. Watts is presented the Merit Award in Milk Sanitation by Dr. I. A. Gould.

A native of Connecticut, Ray Watts has been engaged in milk and food sanitation work in Ohio since 1939. In 1949, he became associated with the Ohio Department of Health and he was named Sanitarian in Charge of Milk and Food Protection in 1951. He assumed his present position with the Department in 1964.

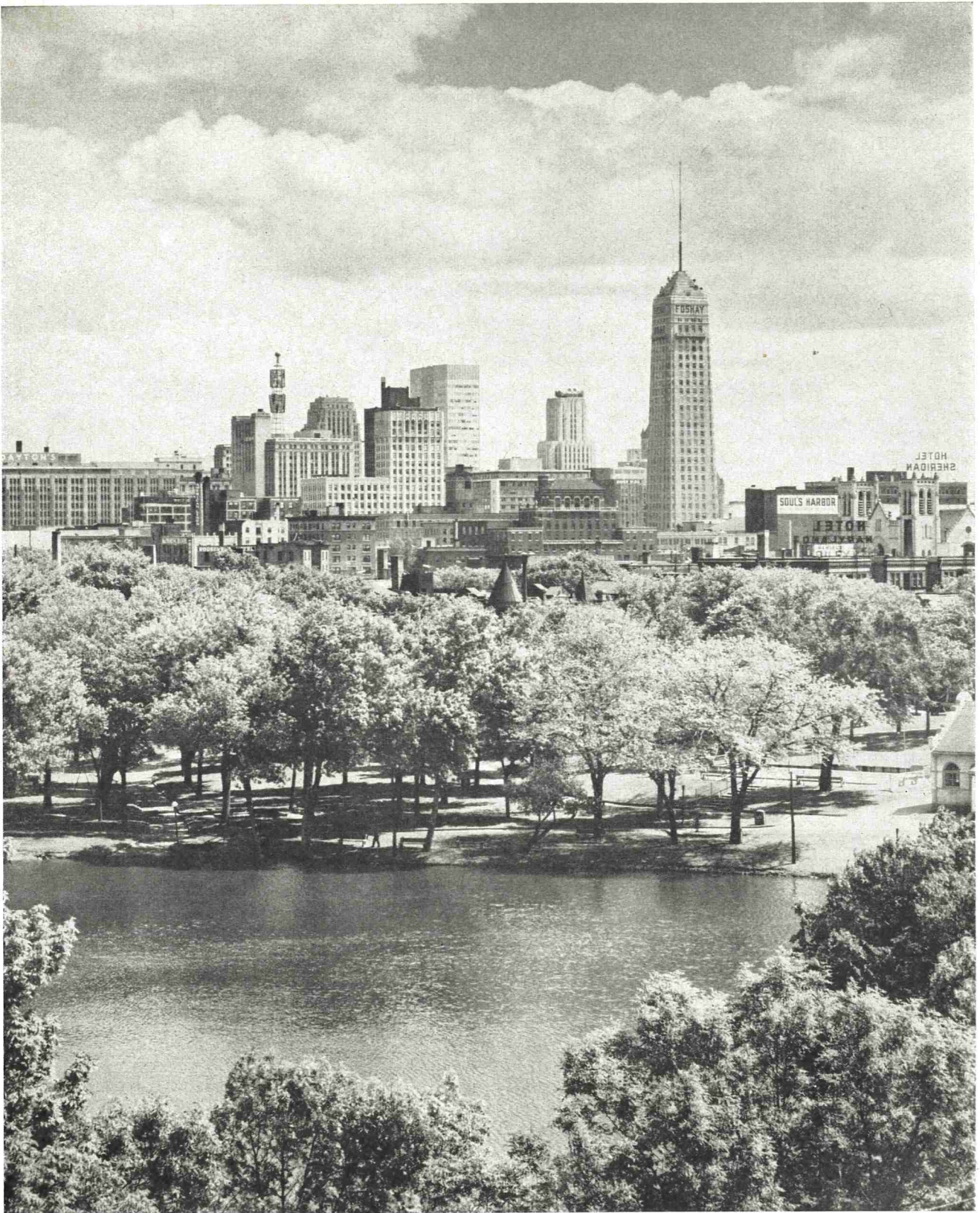
DALE R. COOPER RECEIVES MERLE BAKER AWARD



Left to Right: Dr. Merle P. Baker; Dale R. Cooper; E. G. Haupt, President Iowa Milk Sanitarians Association.



1966 Officers of the Iowa Association of Milk Sanitarians, left to right: H. E. Hansen, Sec'y.-Treas.; E. H. Wegeman, Retiring President; E. G. Haupt, President; C. W. Yeager, Jr.; Vice-President; D. E. Hagedon, 2nd Vice President.



Skyline of Minneapolis business district with Loring Park and lake in foreground. This is one of the 22 lakes and lakelets within the city limits.

PROGRAM
FIFTY-THIRD ANNUAL MEETING
INTERNATIONAL ASSOCIATION OF MILK, FOOD AND ENVIRONMENTAL SANITARIANS, INC.
 In Cooperation with
THE MINNESOTA SANITARIANS ASSOCIATION
AUGUST 15-18, 1966

Hotel Radisson

Minneapolis, Minnesota

REGISTRATION

Monday, August 15—1:00 P.M.-5:00 P.M.

Tuesday, August 16—8:00 A.M.-6:00 P.M.

Registration Fee \$5.00

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Milk Breaks: C. MARKUSON

SUNDAY, AUGUST 14, 1966

1:30-5:30—Executive Board Meeting, Directors' Suite
 8:00-11:00—Executive Board Meeting, Directors'
 Suite

MONDAY, AUGUST 15, 1966

1:00-5:00—Registration, Convention Lobby

SPECIAL MEETINGS

8:00-12:00 Noon—Executive Board, Directors' Suite
 1. Report on Local Arrangements
 2. Report of Executive Secretary
 3. Report on Sanitarians Joint Council
 1:30-5:00—Executive Board, Directors' Suite
 1. Report of Journal Management Com-
 mittee
 2. Regular Agenda
 1:30-5:00—Individual Committee Meetings (See
 Bulletin Board)
 7:00-8:30—Affiliate Council Meeting

AGENDA FOR COUNCIL MEETING

1. Review history and purpose of the affiliates.
 2. Report from IAMFES Executive Board as to how affiliates can best serve the Association.
 3. Discussion of membership dues.
 4. Discussion of greater recognition for the affiliates.
 5. Discuss ways and means of providing a more effective affiliate newsletter.
 6. Discuss ways of improving communications between IAMFES and affiliate secretaries.
 7. Discuss possible improvements in Journal of Milk and Food Technology.
- 7:00-10:00—Executive Board, Directors' Suite
1. Committee Chairmen and Committee Members
 2. Meet with Past Presidents
 3. Report of Affiliate Council Chairman

TUESDAY, AUGUST 16, 1966

8:00 a.m.—REGISTRATION

MORNING—GENERAL SESSIONP. R. ELLIKER, *President-Elect*, Presiding

9:30 a.m.—INVOCATION

9:35 a.m.—WELCOME

The Hon. ARTHUR NAFTALIN,
Mayor of City of Minneapolis

9:50 a.m.—PRESIDENTIAL ADDRESS

F. E. UETZ, *President*10:15 a.m.—SANITATION AND STERILIZATION
REQUIREMENTS FOR SPACE EX-
PLORATIONJOSEPH J. McDADE, Project Engineering
Division, Jet Propulsion Laboratory, Pasa-
dena, California11:00 a.m.—THE SANITARIAN'S CONTRIBUTION
TO SPACE SANITATION—PRESENT
AND FUTUREV. W. GREENE, School of Public Health,
University of Minnesota, Minneapolis,
Minnesota

11:45 a.m.—NOMINATIONS, 1966

TUESDAY, AUGUST 16, 1966**AFTERNOON—MILK SANITATION SECTION**S. M. NOLES, *Presiding*

1:30 p.m.—Door Prize Drawing

1:45 p.m.—SANITATION PROBLEMS IN UTILI-
ZATION OF AMERICAN DAIRY PRO-
DUCTS OVERSEASGEORGE W. WEIGOLD, Dairy Society In-
ternational, Washington, D. C.2:30 p.m.—SIGNIFICANCE AND CONTROL OF
AIR-BORNE CONTAMINATION IN
MILK AND FOOD PLANTSDENNIS HELDMAN, Department of Agri-
cultural Engineering and Food Science,
Michigan State University, East Lansing,
Michigan

3:15 p.m.—Break

3:30 p.m.—EFFECTIVE TESTING PROCEDURES
FOR EVALUATING PLANT SANITA-
TIONE. L. SING, Quality Control Laboratory,
Mayflower Farms, Portland, Oregon4:15 p.m.—REPORT ON THE NEW TWELFTH
EDITION OF *STANDARD METHODS
FOR THE EXAMINATION OF DAIRY
PRODUCTS*WILLIAM G. WALTER, Department of Bot-
any and Microbiology, Montana State
University, Bozeman, Montana**TUESDAY, AUGUST 16, 1966****AFTERNOON—FOOD AND ENVIRONMENTAL****SANITATION SECTION**J. H. FRITZ, *Presiding*

1:30 p.m.—Door Prize Drawing

1:45 p.m.—LATEST DEVELOPMENTS IN AUTO-
MATIC DISHWASHINGW. M. PODAS and S. B. CRECELIUS, Re-
search and Development Department,
Economics Laboratory, Inc., St. Paul,
Minnesota2:30 p.m.—SANITARY ASPECTS OF FLEXIBLE
PACKAGING MATERIALS FOR
FOODSD. T. MAUNDER, Metal Products Division,
Continental Can Company, Chicago, Illi-
nois

3:15 p.m.—Break

3:30 p.m.—SANITATION PROBLEMS IN FOOD
VENDING MACHINESS. H. HOPPER, Department of Public
Health, Indiana University Medical Cen-
ter, Indianapolis, Indiana

4:15 p.m.—SANITARY ASPECTS OF AN AUTOMATED RESTAURANT SYSTEM
 NORMAN N. POTTER, Research Division, American Machine and Foundry Company, Springdale, Connecticut

TUESDAY EVENING, AUGUST 16, 1966

7:30-9:30 p.m.—EVENING DISCUSSION GROUPS.
 These discussion groups are for the benefit of our members who have special questions or problems which they wish to discuss informally with others. Selected individuals have agreed to answer questions and otherwise assist in discussions.

7:30 p.m.—EQUIPMENT STANDARDS AND SANITARY REQUIREMENTS FOR MILK TRANSFER SYSTEMS, PIPELINE MILKERS AND BULK TANKS
 DICK B. WHITEHEAD, *Moderator*, M. W. DEAN, W.M. MUDGE, W.M. PICKAVANCE

7:30 p.m.—MILK SANITATION — LABORATORY AND MILK PROCESSING
 J. J. JEZESKI, *Moderator*, PETER PATRICK, DICK BRAZIS, H. E. RANDOLPH, W. K. MOSELEY

7:30 p.m.—FOOD AND ENVIRONMENTAL SANITATION
 V. W. GREENE, *Moderator*, S. H. HOPPER, ROBERT HUNT, R. S. GEISTER

WEDNESDAY, AUGUST 17, 1966

MORNING—GENERAL SESSION

A. N. MYHR, *Presiding*

8:15 a.m.—Door Prize Drawing

8:30 a.m.—WATER QUALITY ACT OF 1965—IMPACT ON THE DAIRY AND FOOD INDUSTRY
 H. G. HARDING, Research and Development Division, National Dairy Products Corporation, Glenview, Illinois

9:15 a.m.—THE FDA AND FOOD SAFETY
 J. P. DURHAM, Food and Drug Administration, Minneapolis District, Minneapolis, Minnesota

10:00 a.m.—Break

10:15 a.m.—Door Prize Drawing

10:30 a.m.—Annual Business Meeting
 1. Report of Executive Secretary
 2. Report of Secretary-Treasurer
 3. Committee Reports
 4. 3A Symbol Council Report
 5. Report of the Committee on Inter-Association Cooperation
 6. Report of Resolution Committee
 7. Old Business
 8. New Business
 9. Election of Officers
 Announcements

WEDNESDAY, AUGUST 17, 1966

AFTERNOON—MILK SANITATION SECTION

W. C. LAWTON, *Presiding*

1:30 p.m.—Door Prize Drawing

1:45 p.m.—EVALUATION OF SCREENING TESTS FOR ABNORMAL MILK
 D. S. POSTLE, Department of Veterinary Science, University of Wisconsin, Madison, Wisconsin

2:30 p.m.—MASTITIS—WHAT CAN WE DO ABOUT IT?
 KERMIT J. PETERSON, Department of Veterinary Medicine, Oregon State University, Corvallis, Oregon

3:15 p.m.—Break

3:30 p.m.—FARM EQUIPMENT SANITATION PROBLEMS — MILKING MACHINES, BULK TANKS AND TANK TRUCKS
 H. V. ATHERTON, Department of Animal and Dairy Science, University of Vermont, Burlington, Vermont

4:15 p.m.—USDA SANITARY STANDARDS FOR MILK FOR MANUFACTURING PURPOSES
 FLOYD FENTON, Standardization Branch, U. S. Department of Agriculture, Washington, D. C.

WEDNESDAY, AUGUST 17, 1966

AFTERNOON—FOOD AND ENVIRONMENTAL SANITATION SECTION

W. J. DIXON *Presiding*

1:30 p.m.—Door Prize Drawing

1:40 p.m.—DISSEMINATION OF MICROORGANISMS FROM HUMANS
 JOHN A. ULRICH, Mayo Clinic, Rochester, Minnesota

- 2:20 p.m.—SANITATION IN MEAT AND POULTRY PROCESSING PLANTS
R. S. GEISTER and A. C. MAACK, Quality Assurance and Production Departments, Swift and Company, Chicago, Illinois
- 3:00 p.m.—Break
- 3:10 p.m.—SANITATION IN PROCESSING OF POTATO PRODUCTS
CARROLL E. DESPAIN, Engineering and Sanitation Division, Idaho Department of Health, Boise, Idaho
- 3:50 p.m.—PREPARING LOCAL HEALTH DEPARTMENTS TO COPE WITH FOOD-BORNE DISEASE OUTBREAKS
ROBERT DALTON, Section of Environmental Health, State Department of Health, Lansing, Michigan
- 4:30 p.m.—SANITATION PROBLEMS RELATED TO PRODUCTION OF MAPLE SYRUP
J. C. KISSINGER and C. O. WILLITS, Eastern Utilization Research & Development Division, U. S. Department of Agriculture, Philadelphia, Pennsylvania

WEDNESDAY EVENING, AUGUST 17, 1966

- 6:00-6:50 p.m.—Reception
- 7:00 p.m.—ANNUAL AWARDS BANQUET
F. E. UETZ, *Presiding*
INVOCATION
INTRODUCTIONS
Master of Ceremonies, J. C. OLSON, JR.
PRESENTATION OF AWARDS
1. Past President's Award
2. Citation Award
3. Honorary Life Membership
4. Sanitarian's Award*
- INSTALLATION OF OFFICERS
ENTERTAINMENT
Courtesy of the Minnesota Sanitarians Association
*The Sanitarian's Award is sponsored jointly by the Diversey Corporation, Klenszade Products, Division of Economics Laboratory, Inc., Olin Mathieson Chemical Corporation, and Pennsalt Chemicals, Inc. and is administered by the International Association of Milk, Food and Environmental Sanitarians.

THURSDAY, AUGUST 18, 1966

MORNING—GENERAL SESSION

J. C. OLSON, JR., *Presiding*

- 8:30 a.m.—Door Prize Drawing

- 8:45 p.m.—MILK, FOOD AND WATER-BORNE VIRUSES—EVALUATION OF HEALTH HAZARDS
R. B. READ, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio
- 9:30 a.m.—LATEST DEVELOPMENTS IN BOTULISM RESEARCH
E. M. FOSTER, Department of Bacteriology, University of Wisconsin, Madison, Wisconsin
- 10:15 a.m.—Break
- 10:30 a.m.—PROGRESS IN SALMONELLA SURVEILLANCE AND CONTROL
ALBERT R. MARTIN, Salmonella Surveillance Unit, Communicable Disease Center, Atlanta, Georgia
- 11:15 a.m.—STAPHYLOCOCCI IN FOOD PROCESSING
J. J. JEZESKI, Department of Dairy Industries, University of Minnesota, St. Paul, Minnesota

ENTERTAINMENT

ENTERTAINMENT FOR THE LADIES

TUESDAY, AUGUST 16

- 9:30 a.m.—11:30 a.m.—Bus tour of St. Paul and Minneapolis—Courtesy of Minnesota Sanitarians Assoc. Luncheon at the Famous Diamond Jim's—Courtesy of Sepko Chemicals, Inc.

WEDNESDAY, AUGUST 17

- 9:00-11:30 a.m.—Tour of Betty Crocker's new expanded kitchens.—Courtesy of General Mills, Inc.

MEN AND WOMEN

MONDAY, AUGUST 15

Renew acquaintances

TUESDAY, AUGUST 16

- 9:00 p.m.—Informal get together—Refreshments
Courtesy of Minnesota Sanitarians Assoc.

WEDNESDAY, AUGUST 17

- 6:15-7:00 p.m.—Cocktail Hour—Courtesy of Norris Dispensers, Inc.
7:00 p.m.—Banquet
Entertainment—Courtesy of Minnesota Sanitarians, Assoc.

MEN

THURSDAY, AUGUST 18

- 1:30 p.m.—Tours to Laboratories and Plants in the Minneapolis-St. Paul area.
(Details to be supplied later)

HOMER G. YOUNG DIES SUDDENLY



Homer G. Young died suddenly January 15, 1966, after being stricken by a massive hemorrhage of his central nervous system.

Born on a farm near Saltsburg, Pennsylvania in 1912, he attended Pennsylvania State University specializing in various agricultural and dairy courses. For more than 30 years he was employed by the Isaly Dairy Company in Pittsburgh, Pa., in the position of Fieldman and Farm Inspector.

As a Certified Pennsylvania Approved Inspector, Homer served for many years as the Corresponding Secretary for the Dairy Sanitarians Association of Western Pennsylvania and as Secretary-Treasurer of the Pennsylvania Dairy Sanitarians Associations. He was chosen as the fieldman representative on the Northeast Milking and Milk Hauling Committee for Dairy Farms and was an active industry member of the Farm Practices Committee of the Allegheny County Health Department. In 1958, Homer was voted the most outstanding Field Sanitarian in the State at the Pennsylvania Dairy Sanitarian's Convention at Pennsylvania State University.

In recent years he was a leading figure in working with the many complicated problems facing the dairy industry such as pesticides, antibiotics, water adulteration, mastitis control, bulk tank installations and specifications, water contamination, the U.S.P.H. Standards. Homer's rare combination of dedication, interest and ability, his recognized contributions in the areas of farm sanitation, quality control, and producer relations, and his devotion to the dairy industry, earned him national prestige in his life's work.

COMMENTS ON ASSOCIATED ILLINOIS MILK SANITARIANS MEETINGS

Jim Meany, Secretary of the Associated Illinois Milk Sanitarians, offers the following observations concerning the annual and interim meetings of the Illinois group which should be of interest to other affiliates.

"Our meetings are well attended. Quite frequently our annual meeting in December at a Chicago hotel coincides with what is generally the first blizzard of the year. However, attendance averages in excess of 200. The Spring Conference is held the 1st or 2nd Monday in May usually at a resort type location—the last three years at Pheasant Run Lodge, a palatial motel with fine accommodations including "Bourbon Street" a la New Orleans and a beautiful indoor-outdoor pool. Attendance at the Spring meeting is excellent with an average of slightly less than 200.

"Our meetings are one day sessions with about five speakers handling current topics. The Annual Meeting has business affairs discussed immediately following lunch. At the Spring meeting luncheons we may have professional entertainers or a noted speaker discussing a topic far afield from milk sanitation. It will be of interest to know that at three of the last six Spring meetings, as our luncheon speaker we have had men of the cloth—one a Baptist minister, one a Presbyterian minister and the last a Catholic priest who was a prisoner in Red China. All three were excellent and most impressive and well received by our group.

"One year we had a professional pickpocket as the entertainment! Watches, wallets and pens missing all over the place. One fellow even had his suspenders lifted! All were returned in due time, fortunately."

MICHIGAN ASSOCIATION ANNUAL MEETING



Left to right, H. L. Thomasson, Executive Secretary IAMFES; Ray Minert, Chairman IAMFES Section; John Fleming recipient of the Sanitarian of the Year Award; Robert Lyons, new President of Michigan Association of Sanitarians, and Sam Stephenson immediate Past President.

NEWS AND EVENTS

TRAINING COURSE ON FOOD-BORNE DISEASE CONTROL

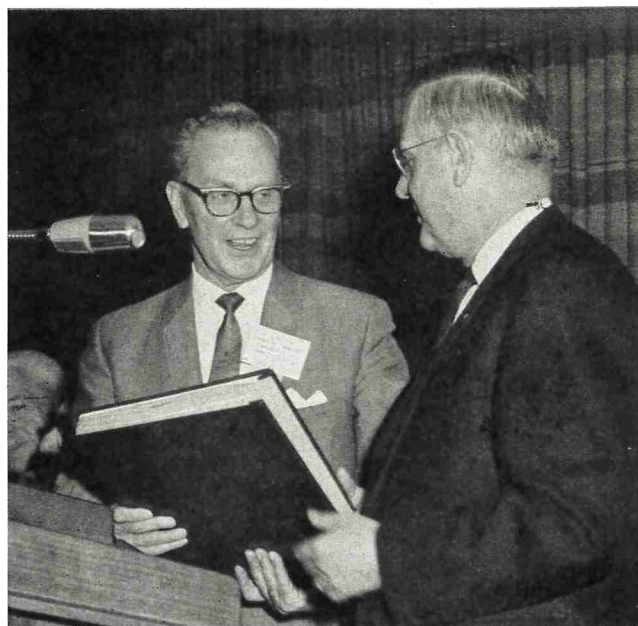
A two-day training course on the epidemiology and control of food-borne diseases was held at Michigan State University, East Lansing, on March 1-2, 1966. The course was sponsored by the Michigan Department of Public Health in cooperation with the Communicable Disease Center Training Branch of Atlanta and the USPHS Regional Office in Chicago.

The program, essentially for health officers and sanitarians in the Michigan area, was designed so that each local health department would be fully prepared to investigate any food-borne disease outbreak within its jurisdiction. Subjects discussed covered the epidemiology of various food-borne diseases, aids in outbreak investigations and sample collection, interpretation of laboratory data, news releases, interrelation between agencies and with industry and other factors.

Each local health department represented was also given a field kit containing all necessary equipment for the collection of food samples under investigation. The kit included a manual containing extensive data and reference material on food-borne diseases. Prominent among this material was a copy of

the IAMFES "Procedures for the Investigation of Food-borne Disease Outbreaks."

Much of the work of organizing the program and layout of the field kits was done under the supervision of LaRue L. Miller, Chief of the Section of Environmental Health, Michigan Department of Public Health.



MEMORY BOOK TO RETIRING PRESIDENT

To the retiring President of Dairy and Food Industries Supply Association, Fred M. King of Wyandotte Chemicals Corporation, a memory book containing memorabilia of two dynamic years of leadership is presented by DFISA Board Chairman Paul K. Girton of Girton Manufacturing Company. Presentation occurred March 24 in San Francisco.

W. A. DEAN, JR., JOINS DFISA STAFF

The Dairy and Food Industries Supply Association, Inc., has announced the addition of William A. Dean, Jr., to its technical staff. Formerly engineer with Bowman Dairy Co. of Chicago, he is an outstanding industry personality and for more than 15 years has been the Milk Industry Foundation representative to the Sanitary Standards Sub-Committee of the Dairy Industry Committee.

Bill Dean will collaborate with the DFISA Technical Director in implementing the DFISA role in the 3A Standards program. Temporarily he will work from his Chicago residence in the development



La Rue L. Miller (left) receives congratulations from Bob Dalton (MDPH) for a successful conference.

of new tentative 3A standards. In this activity he will be serving as acting secretary of the DFISA Technical Committee. Should task committee meetings become necessary, Bill will arrange for sessions in the Chicago area, handling the record of such activity accordingly.

Mr. Joseph S. Cunningham, Executive Vice President of DFISA stated: "We are of the opinion that Bill's contribution to the Association will materially provide us with additional resources by which we can move forward in a continuing effort to help improve the total effectiveness of the 3A Standards program, as well as to accomplish our selfish interest of identifying DFISA as an industry leader in the development of uniform sanitary standards for dairy — and perhaps eventually — food processing equipment."

SEMINAR ON USE OF RADIOISOTOPES AND RADIATION IN DAIRY RESEARCH

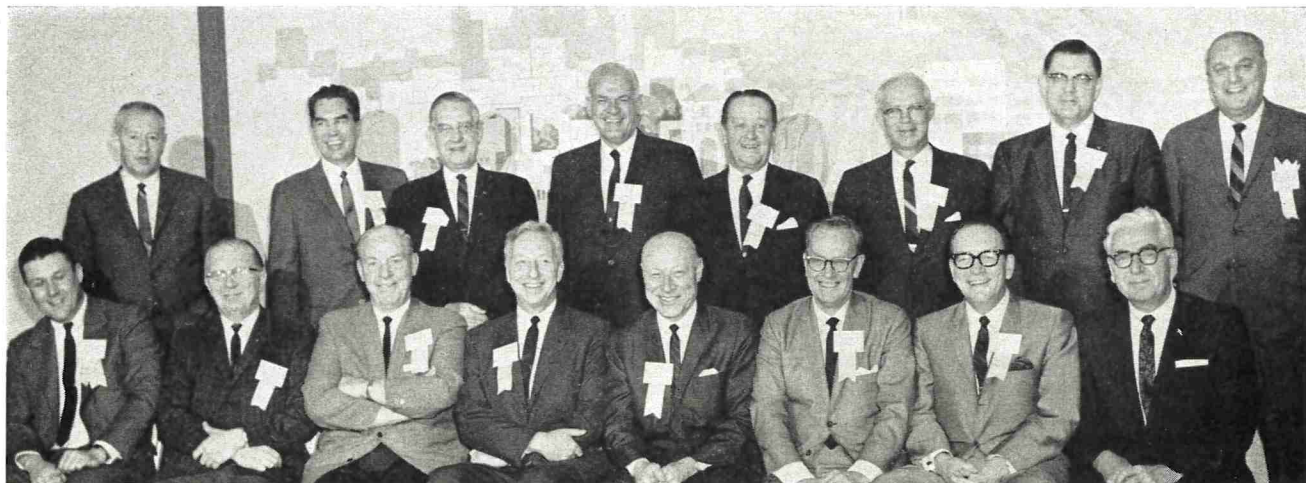
The International Atomic Energy Agency in cooperation with the International Dairy Federation

has announced a Seminar on the use of radioisotopes and radiation in dairy science and technology. The Seminar will take place in Vienna, Austria, July 12-15, 1966.

The purpose of the Seminar is to diffuse information on the current status of application of nuclear techniques and their future potentialities for the dairy industry. It will be concerned with the use of radioisotopes and radiation for research and their practical application in dairy science and technology, as related to the handling and processing of milk and milk products. It will include discussion of isotopic procedures for the study of milk and cheese fermentation; automatic monitoring or control systems for milk processing; evaluation of sanitation of surfaces exposed to milk or milk products; and the efficiency and operational characteristics of processes for the removal of radioisotopes from milk.

Participation in the Seminar will be based on submission of a Participation Form in a prescribed manner. Information on the forms and on the Seminar may be obtained from the Joint FAO/IAEA Secretariat for the Seminar, Kärntner Ring 11, Vienna I, Austria.

DFISA BOARD OF DIRECTORS—1966



Sixteen members of the 18-man Board of Directors of Dairy and Food Industries Supply Association are shown following their March 25 meeting in San Francisco. Seated, left to right, are Frank M. Schwartz, Vitafreze Equipment, FMC Corporation; Ralph F. Anderson, Anderson Bros. Mfg., Co.; George A. M. Anderson, The King Company; John J. Weldon, Bessire & Co., Inc.; George L. Huffman, Ex-Cell-O Corporation, Packaging Equipment Group; Fred M. King, Wyandotte Chemicals Corporation; Joe Larson, Sparta Brush Co., Inc.; and Roy E. Cairns, Waukesha Foundry Company. Standing, left to right,

are James H. Brunt, Jr., Hackney Bros. Body Co.; D. G. Colony, Manton-Gaulin Manufacturing Company, Inc.; Paul K. Girton, Girton Manufacturing Company; M. Carter Strickland, Smith-Lee Co., Inc.; Edward K. Walsh, American Can Company, Milk Container Division; Gordon A. Houran, The DeLaval Separator Company; Arthur A. Rogers, C. E. Rogers Company; and D. H. Carter, Kelvinator Division, American Motors Corporation. Not present at the time picture was taken were Hunt Hamill, Krim-Ko Corporation, who had attended an earlier Board meeting in San Francisco; and R. B. Wilhelm, Owens-Illinois, who was prevented by illness from attending.

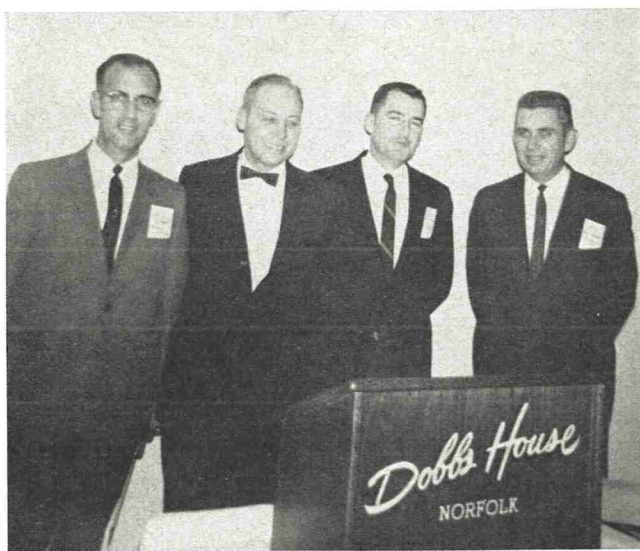
DAIRY TECHNOLOGY AND FIELDMEN'S MEETINGS IN VIRGINIA

Dairy plant tours and a milk flavor evaluation clinic were the main features at the February meetings of the Eastern and Western Sections of the Virginia Dairy Technology Society at Norfolk and Roanoke. High school students and counselors took part in the plant tours and participated in the milk clinics as guests of the Society.

The purpose of the student-career nights was to create greater interest among high school students to pursue college training in dairy technology. Following the tours, society members and guests par-



Dr. R. B. Redfern (white coat at right) conducting milk flavor evaluation clinics for Dairy Technology Society members and guests.



Program participants at Eastern Section of the Virginia Dairy Technology Society (left to right) W. R. Mabe, Farmers Creamery, Fredericksburg, Virginia, President of Eastern Section; Dr. R. B. Redfern, Pine State Creamery, Raleigh, N. C.; Dr. James R. Nichols, Head, Department of Dairy Science, V.P.I., Blacksburg, Virginia; and M. W. Jefferson, Virginia Department of Agriculture, Richmond, Virginia, Program Chairman.

ticipated in milk flavor evaluation clinics conducted by Dr. R. B. Redfern, Director of Production, Pine State Creamery, Raleigh, N. C.

At the evening meetings Dr. Redfern briefly discussed the many precautions necessary to produce and maintain good uniform flavor in milk. Dr. J. R. Nichols, Head of the Dairy Science Department at V.P.I., outlined the economic importance of the Virginia dairy industry and stressed the need for highly-trained people to fill the many job opportunities that are presently open to dairy technology graduates.

A record attendance of 93 Dairy Fieldmen attended the annual conference at Virginia Polytechnic Institute, Blacksburg, on March 3 and 4, 1966. Topics covered in the 2-day conference included: Maintaining A Positive Attitude In A Negative Atmosphere; Liquid Manure Handling; Manufacturing Milk Housing and Facilities; New Ideas About Dairy Cattle Feeding; Why Cows Fail To Conceive; and progress reports on Virginia's Abnormal Milk Screening Test Program and Pesticide Research.

One of the highlights of the program was a conducted tour through the Corning Glass plant, located at Blacksburg, which manufactures specialty glass products including the pipeline used on farms and in dairy plants.

STUDY FOOD SERVICE EMPLOYEE EDUCATION IN SOUTH CAROLINA

Research to determine the effectiveness of educational television networks to teach better food sanitation practices to restaurant workers will be undertaken soon in South Carolina. A grant of \$115,080 has been made available by the U. S. Public Health Service's Division of Environmental Engineering and Food Protection. If found useful, ETV may be used in other States to help reduce the estimated 1,000,000 cases of foodborne illness occurring annually in the United States.

Three South Carolina agencies will cooperate in the project: the Educational Television Commission, the Board of Health, and the University of South Carolina. A two-year study by a team of public health workers will use the PHS *Food Service Sanitation Manual* to provide material for a series of eight one-hour video tape programs which will be presented over facilities of the South Carolina Educational Television Network.

Later, tests will be made of the results of the new methods and materials for teaching food sanitation. The completed programs will be shown to restaurant workers in local schools where receivers for the closed-circuit channels are available. The workers will be enrolled through the efforts of 42 State sani-

tarians assigned to the work.

The use of educational television in this aspect of public health work is considered as being both a new approach to the training of food service workers and one holding great promise. An important consideration is the need to reach large numbers of food handlers, although the number of qualified instructors is small. The project team estimates that from 60 to 80 percent of an estimated 50,000 food service workers in South Carolina may be reached by ETV in 38 of the State's 46 counties.

COURSE IN WATER QUALITY INVESTIGATION AND RESEARCH TECHNIQUES

The second course in water quality investigation

and research techniques conducted by the Division of Environmental Health, School of Public Health, University of Minnesota, will be held June 13 - July 16, 1966. It will be given at Duluth, Minnesota and activities will be headquartered at the Lakeside Research Laboratory of the University of Minnesota, Duluth.

The course is open to professional and technical persons who have an interest in water quality measurement and control. Instruction will include formal lectures, laboratory work, and extensive field operations, with the latter centering around Knife River Harbor where a fully equipped 30-foot research vessel is available for the field studies. Persons interested should write to the School of Public Health, University of Minnesota, Minneapolis, Minn. 55455.

SANITATION SEMINAR ON VENDING

Dr. Samuel Hopper (standing), chairman of the Department of Public Health, Indiana University, and vending machine evaluation program consultant to NAMA, explained how the Indiana University Foundation tests and approves vending machines to more than 30 Indiana public health officials at a recent sanitation seminar on vending in Indianapolis.

Highlights of the two-day meeting, which was sponsored by the National Automatic Merchandising Association and the Indiana State Board of Health and hosted by ARA Service of Indiana, included

vending machine demonstrations, practice machine evaluations by the group, a review of the revised U. S. Public Health Service vending code, and a discussion of proposed changes in Indiana vending machine sanitation regulations.

Other speakers participating in the seminar were: David E. Hartley, NAMA public health counsel; J. Richard Howard and Walter Kirk, ARA Service of Indiana; and Karl K. Jones, Indiana State Board of Health.



SUMMER COURSE IN HOSPITAL ENGINEERING

The third course in hospital engineering problems, co-sponsored by the Division of Environmental Health, School of Public Health, University of Minnesota and the American Hospital Association, will be held at the Minneapolis campus of the University, July 18 - August 19, 1966. The course will provide an opportunity to obtain refresher instruction in engineering, sanitation, and maintenance techniques and their underlying principles, with special attention to their relationship to effective planning, administration, and operation of hospitals. The course is not intended to cover the design and construction aspects of hospitals except as these relate to the operational aspects.

The course is open to professional and technical persons engaged in operation and maintenance of the physical facilities of the modern hospital and having some experience with practical problems in the area of hospital maintenance. Full-time registration, in residence, will be expected of all participants. Academic credit can be earned by suitably qualified students who successfully complete the course.

For further information address the School of Public Health, University of Minnesota, Minneapolis, Minn. 55455.

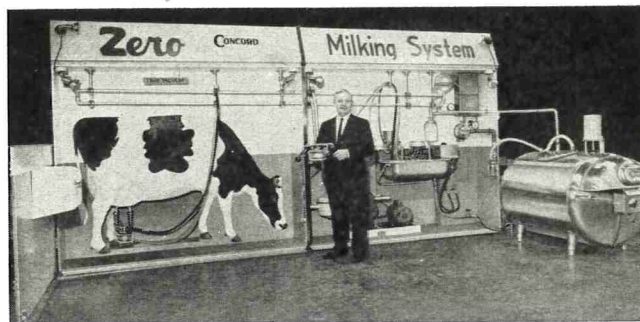
FOOD ENGINEERING SHORT COURSE

A two-day technical meeting on certain aspects of food engineering is scheduled for June 27-28, 1966, at the University of Massachusetts, Amherst. The meeting is sponsored by the University and the American Society of Agricultural Engineers.

At the winter meeting of the Society in December some 80 authorities from the food industry and from food technology departments and engineering colleges discussed the increasing need for trained food engineering and for an expanded research program in this field. The Massachusetts short course is one step in the educational program being undertaken by the ASAE Food Engineering Committee.

The course will consist of four half-day meetings devoted to discussions in such areas as Heat Transfer in Freeze Drying, Pumping of Viscous Mixtures, Irradiation, Steam Injection Heating, Foam Spray Drying, and Waste Management and Disposal. Further information on the meeting can be obtained from the Agricultural Engineering Dept. University of Massachusetts, Amherst.

ZERO INTRODUCES NEW COMPLETE PIPELINE MILKING SYSTEM



Zero display includes milking machine, twin-vacuum pipelines, "push-button" self-cleaning and sanitizing system.

The Zero Concord Twin-Vacuum complete pipeline milking system has been put on the market by Zero Manufacturing Co. of Washington, Missouri, well-known manufacturer of Zero completely automated vacuum bulk milk coolers. The new system is totally different from conventional milking systems because it operates on a new, scientific principle of twin-vacuum. While conventional milking systems operate with air-injection at the milker units, the Zero Concord system utilizes two separate vacuums, each doing an entirely different job. One vacuum in the air line connected to the vacuum pump milks the cows. The other vacuum in the milk line connected to the vacuum bulk tank, moves the milk, siphoning it quickly through the milk line into the bulk tank.

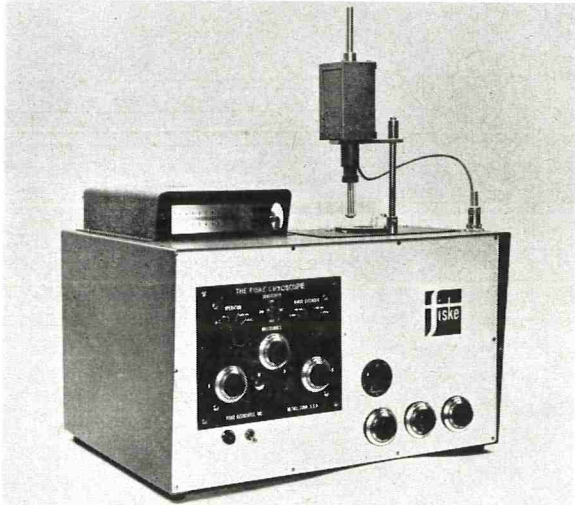
Combined with its completely automated vacuum bulk milk cooler, Zero offers a completely automated pipeline and bulk tank milking system marketed by a single manufacturer. This system does the entire job milking the cows, moving the milk through the pipeline into the bulk tank and cooling and storing the milk ready for pick-up.

Zero's new Twin-Vacuum principle offers several advantages, according to the manufacturer. The vacuum in the milk line siphons the milk in a solid column through the milk line into the vacuum bulk tank. This prevents air agitation and foaming of the milk, a cause of rancidity, and keeps air-laden bacteria and odors out of the milk. As vacuum moves the milk from the milker units instead of air injection, there is no vacuum fluctuation. The Zero Concord gives absolute uniform and low vacuum at each individual cow. No expensive, hard-to-clean releaser or milk pump is needed with this system as the vacuum operation takes the place of this equipment.

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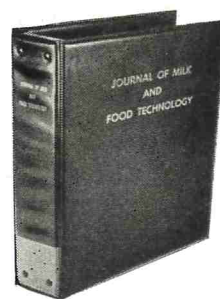
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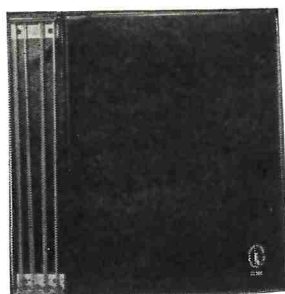
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SURGE

Brand New
ALAMO 30-PLUS



**ROTARY
VACUUM
PUMP**

**MILKING VACUUM
STABILITY...**

The ALAMO 30-PLUS moves over 30 CFM (under vacuum). Sold only with matching motors.

PLUS A Polyurethane Filter protects the pump

PLUS Super-Strong Welded Unitized Base

PLUS Permanently Lubricated rotor bearings

PLUS Self-Adjusting Pulley Tension

PLUS Vertical "Space-Saving" Design

ALAMO Rotary Vacuum Pumps are Also Available in 50 & 75-Plus sizes

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