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MILK and FOOD TECHNOLOGY

Official Publication

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



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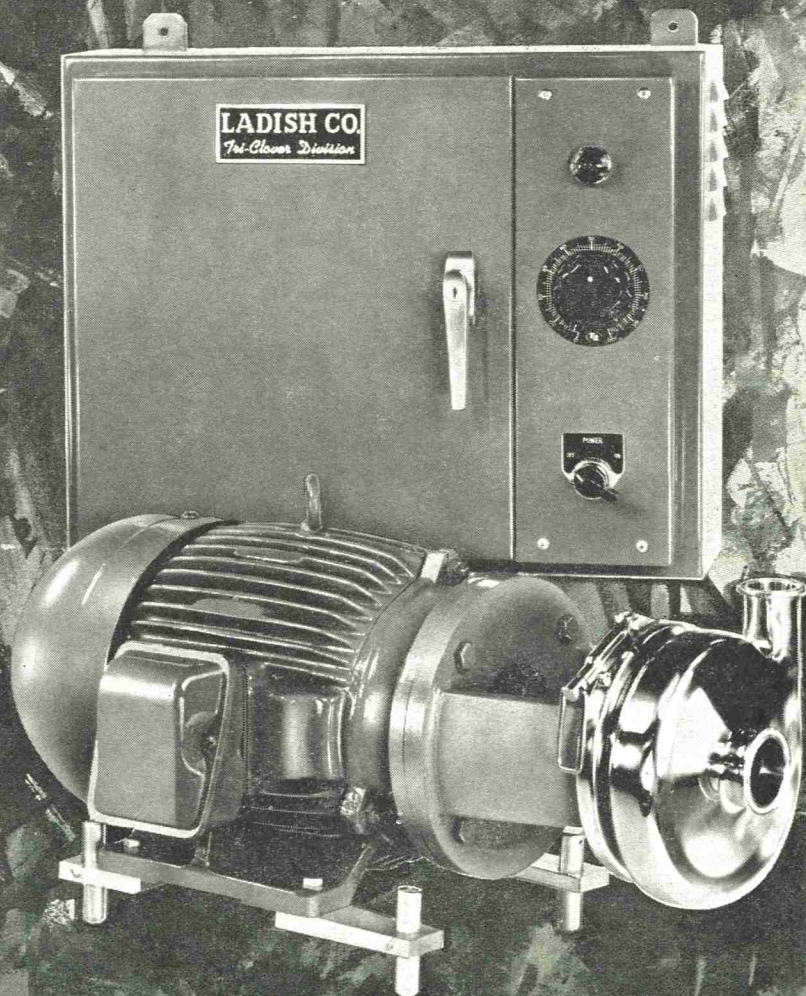
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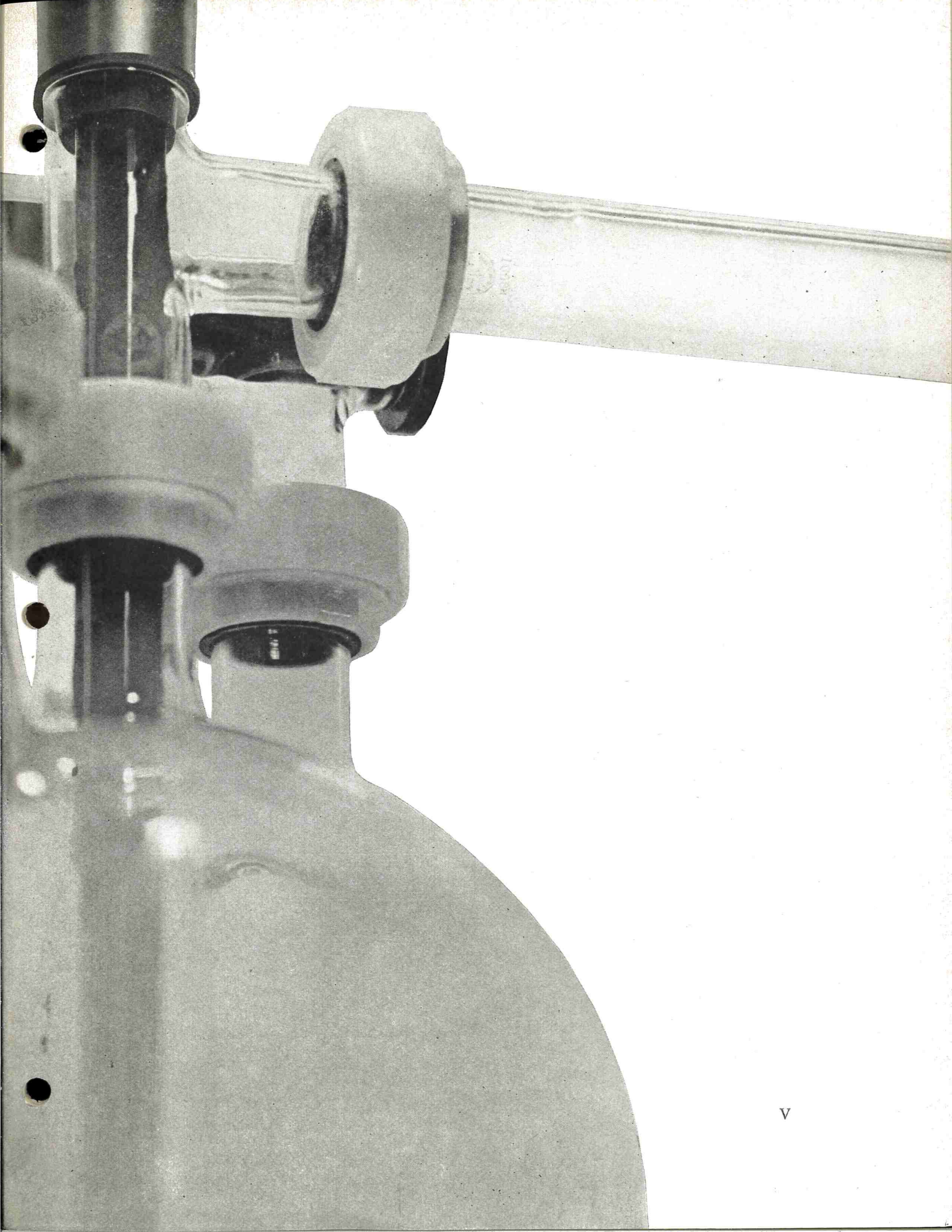
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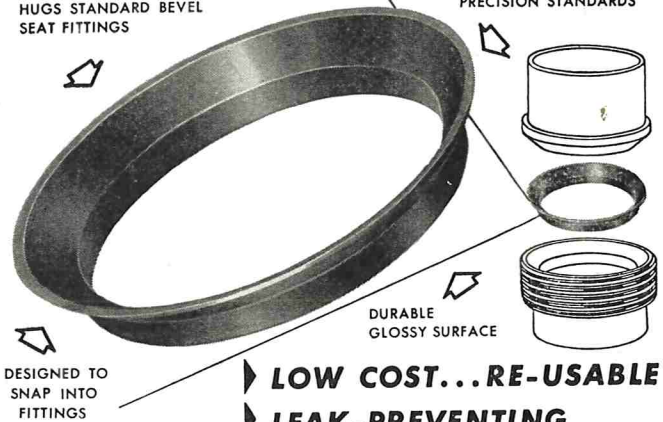
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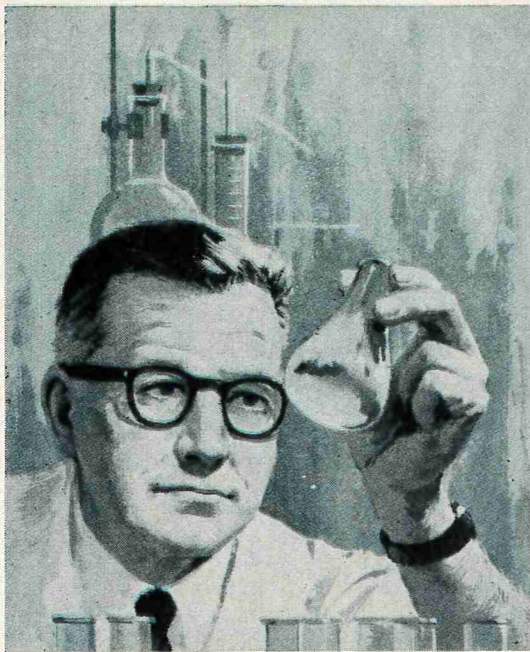
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PRESIDENTIAL ADDRESS¹

A. N. MYHR

*Department of Food Science
University of Guelph
Guelph, Ontario, Canada*

It is my distinct pleasure to extend to you, on behalf of the Officers and the Executive Board, a warm welcome to this 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians. I know that we are all extremely pleased to be here in St. Louis, enjoying the friendly hospitality extended to us by the Missouri Association of Milk and Food Sanitarians. The Missouri Affiliate has done an exceptional job of the mammoth task of attending to all the detailed arrangements so vital to the smooth conduct of a meeting of this kind. To these local sanitarians, we are truly indebted.

During the course of this Annual Meeting we will have the opportunity to increase the breadth and depth of our understanding and knowledge of sanitation science and technology by attending the excellent technical sessions which have been arranged by the Program Committee. We hope too that each person in attendance will take full advantage of the opportunity provided to interchange ideas and information with others, not only for personal improvement but for the enlightenment of your fellow sanitarians as well.

One of the big objectives in holding annual meetings is to aid in improving the professional knowledge of sanitarians, as well as giving our members an opportunity to participate in the affairs of the Association. If you leave this meeting enriched and inspired by the contacts you have made with professional sanitarians, then I would suggest that you attempt to enthuse the membership of your local affiliate with the benefits and stimulation to be derived from attending these meetings.

ELECTIONS

This was the fourth year that our annual election for the offices of 2nd Vice-President and Secretary-Treasurer of the Association was conducted by mail ballot. Our committee of 3 tellers under the chairmanship of Mr. Ray Belknap of Ohio, reported that 806 ballots were cast, 35 of which were spoiled by members who voted for both nominees for the single position of 2nd Vice-President.

¹While this level of response was an improvement

¹Presented at the 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Inc., St. Louis, Mo., August 18-22, 1968.

over previous years, it was still disappointing to note that only about 27% of our membership exercised their franchise. The remaining 63% either did not read the issue of the Journal which contained the ballot or they procrastinated and later forgot about it. The strength and welfare of our Association is so dependent upon the calibre of the Executive Officers that our members cannot afford to be complacent about the nomination and election of the members of the Executive Board.

MEMBERSHIP DUES

Another matter which should be of interest and some concern to you, is the effect the increase of \$3.00 in annual membership dues, (effective January 1st, 1967) had on the Association. The beneficial aspect of this change was the improvement in the financial position of our Association, but this was only because the increase in dues overcompensated for the loss of revenue suffered by the resulting drop in membership when the dues increase first went into effect. Whereas the Direct Membership continued to show gains in 1968, the number of Affiliate Members in International remained substantially the same as in 1967. Thus, there are approximately 1,000 former members in the ranks of our affiliates who are still to be reclaimed following the dues increase.

There is not much doubt that the potentially most effective area to work in reclaiming the drop-outs in the ranks of Affiliate Members is at the affiliate level. I suggest therefore, that each affiliate establish a strong Membership Committee whose terms of reference should be to not only promote increased membership in the affiliate but to reclaim past or lost members of International, as well as to continue to pursue efforts to bring in new members.

Paying for a membership in IAMFES represents more than buying a subscription to the *Journal of Milk and Food Technology*. Being a member of International means supporting the high ideals of those pioneering sanitarians who, some 57 years ago, formed the Association in recognition of the need for organizing and bringing sanitarians together to provide a strong team approach to solving problems associated with insanitary conditions in our society. They and those who followed them, saw the need for more stringent control measures to reduce wasteful

spoilage and spread of diseases through dairy and other foods; to render the air we breathe and the water we drink and swim in free from health-damaging pollutants. They foresaw the need for disseminating scientific information through a journal and other publications to help practicing sanitarians improve their competence and professional status and to help them do a better job. These are some of the major objectives of our International Association today and certainly warrant and justify the active and financial support of every practicing sanitarian who is interested in raising his professional competence and who is engaged in the work of helping to make our environment a healthier and more enjoyable place in which to work and play.

THE JOURNAL

Last year we were somewhat disturbed when we received the news that Dr. J. C. Olson, Jr. was resigning as Editor of the *Journal of Milk and Food Technology*. We were soon to learn, however, that Dr. Olson had demonstrated the same sound judgment and wisdom, in suggesting the person who might succeed him, as he had shown during the years he was our Editor. I feel certain that everyone will agree that his successor, Dr. Elmer H. Marth of the University of Wisconsin has done a most professional job of continuing the excellent editorial standards established for the Journal by Dr. Olson.

During my term as President, I have not heard one written or oral complaint about the content of the Journal. This suggests that a very good balance has been achieved between technical, non-technical, and general interest articles and that the interests of the majority of our sanitarians are being met.

We were deeply shocked and saddened this year to learn of the death of our Associate Editor, Mr. William J. Dixon. Mr. Dixon was a highly respected and esteemed sanitarian, a wise counsellor to his fellow sanitarians, and a wonderful friend. He is going to be sadly missed by all of us who were privileged to know him.

The late Mr. Dixon's main responsibility as Associate Editor was to gather and edit material for the "Association Affairs" and "News and Events" sections of the Journal. Our Executive Secretary, Mr. H. L. Thomasson, has agreed to assume the additional responsibility for preparing items for these sections, while Dr. Marth, our Editor, will be responsible for the research and technical papers as well as some of the general interest or "grass roots" articles.

Upon the recommendation of the Journal Management Committee, the Board approved the institution of a page charge for publication of technical papers in the Journal. This charge will become effective following the determination of printing costs per

page by our Executive Secretary and after authors have been notified of this charge through publication in the Journal. This action was deemed necessary to increase the volume of research material appearing in the Journal and to permit timely publication of papers submitted by authors.

PROFESSIONAL TRAINING

Your Executive Board was pleased to take action this year on a resolution submitted to us by the Indiana Association of Sanitarians emphasizing the need for preparing an acceptable undergraduate curriculum for sanitarians. This important project was referred to our Committee on Professional and Educational Development who, according to their report of last year, have a Sub-Committee which is considering this subject. It is fitting that sanitarians examine and study various curricula which have been developed in schools and colleges that offer training in the field of environmental science to ascertain whether or not these courses of study meet the needs of practicing sanitarians working in various areas of environmental health. We have since learned, through a newsletter from our Wisconsin Affiliate, that the Wisconsin Association of Milk and Food Sanitarians has formed a joint committee on education with their counterpart, the Wisconsin Association of Sanitarians (Affiliate of the National Association of Sanitarians) with the objective of developing a curriculum for a B.S. Degree in Environmental and Public Health. Following their preliminary work in developing the curriculum, the committee further groomed the program in consultation with the Biology Department at the Wisconsin State University at Eau Claire. Planning for the program has now been completed and the course will be offered at the University commencing this September. This is a notable achievement on the part of both of our Wisconsin Affiliate and the National Association of Sanitarians' Affiliate and is a classic example of the benefits to be derived from intersociety cooperation and understanding.

The need for more professionally trained sanitarians in the many specialized fields of environmental health is undisputed. As the rate of national growth and technological advancement increases, problems of the environment become increasingly more important and complicated. We will require a greater number of highly trained sanitarians to meet the needs of the industry and to effectively deal with environmental hazards threatening public health.

This year your Executive Board had the privilege of critically reviewing the very excellent brochure on careers for sanitarians, prepared by the Committee on Professional and Educational Development. This is a promotional brochure being prepared for dis-

tribution to high schools and other interested groups, and outlines the types of work sanitarians perform, job opportunities, educational requirements and so on. It was suggested to the Committee that this material should be made available to the Wisconsin sanitarians to assist them in promoting their course in environmental health at Eau Claire.

NATIONAL MASTITIS COUNCIL

The National Mastitis Council (NMC) is a closely related organization which deserves more support from members of our Association, particularly from those who are milk sanitarians. The Council was originated through the efforts of members of this Association and yet from information received from Dr. John Flake, Secretary of NMC, there are relatively few milk sanitarians in their membership. It was suggested to Dr. Flake that our Journal Editor would be pleased to receive an article, written by a member of the NMC Board of Directors outlining the objectives and current activities of the Council as a means of stimulating interest and participation in the worthwhile programs of the Council.

Our Washington Affiliate passed a resolution at their last Annual Meeting requesting the Executive Board to take steps to have inactive and retiring members on the Board of Directors of NMC replaced by sanitarians actively engaged in milk regulatory work. Accordingly, two such milk sanitarians' names were submitted to their Nominating Committee, one of which was accepted as a nominee. Subsequently, at the Annual Meeting of the Council in Chicago last February, Mr. A. E. Parker of Portland, Oregon, was elected to the Board of Directors as the IAMFES representative on the National Mastitis Council. Mr. Parker has won considerable acclaim for his achievements in regulatory programs for controlling abnormal milk in the Portland milk supply. We are most fortunate to have him represent this Association on the Council.

SANITARIAN'S AWARD

I wish now to inform you of a decision made by the Executive Board concerning the broadening of the rules governing eligibility of sanitarians for the Sanitarian's Award. As you know, the Award to date has been restricted to sanitarians employed at the county or municipal levels. Upon the recommendation of our Committee on Recognition and Awards, and after consultation with and approval by the 3 sponsoring companies, the Board decided to broaden the eligibility for the Sanitarian's Award to include sanitarians employed by State and Federal Governments, and educational institutions.

Some of the reasoning behind the change is that in some years the number of nominees for the Award, submitted yearly by our Affiliates, is not as large as the Awards Committee considers desirable for a meaningful competition. Then, too, it was felt that there are a great many sanitarians employed by the higher levels of government and educational institutions who are making notable contributions and deserve recognition.

In order to rule out the possibility of unfair competition between the above groups of sanitarians, the Sanitarian's Award will be made to each separately on an alternate yearly basis as follows:

"In 1968, and in the even numbered years thereafter, the Award will be made on the same basis as in previous years. In 1969, and the odd numbered years thereafter, the same Award will be made, but the persons eligible will be sanitarians employed by State and Federal Governments, and educational institutions."

We know there are many sanitarians among our affiliates who would be worthy of consideration for the Sanitarian's Award. All that is required is some work on the part of 2 or 3 individuals in each affiliate in gathering and organizing the material required to place the person in nomination. It is only through our conscientious efforts to seek out and nominate all worthy candidates for this Award that we will have maximum assurance that the winner is truly the sanitarian of the year.

EXTENSION OF 3-A STANDARDS

There has been discussion among interested sanitarians over the past few years about the possibilities and feasibility of broadening the application of 3-A sanitary standards to include food processing equipment. Mr. Dick Whitehead, Chairman of our Committee on Sanitary Procedures considers that there are many sanitarians among the IAMFES membership who are sufficiently knowledgeable in the general food area to permit intelligent evaluation of design and sanitary requirements for food processing equipment. I do not know, at this stage, the form this proposed expanded committee will take, but it is possible that the present activities of such committees as the committees on Food Equipment Sanitary Standards and Baking Industry Equipment would be incorporated in the C.S.P. program in the form of sub-committees or in some other way. This would serve to bring about a needed improvement in the coordination of activities of these three IAMFES Committees and through consultation and possible cooperation with outside organizations, a strong new program for improving the sanitary design of food equipment will be realized.

IAMFES-NAS AMALGAMATION

I now wish to direct your attention to a subject which is of paramount importance and interest to members of this Association.

As you will recall, 2 years ago our Association commenced earnest discussions with the National Association of Sanitarians (NAS) to determine the feasibility of merging the members of these two major groups of sanitarians into one strong association. Following the 1966 Annual Meeting in Minneapolis, an IAMFES ad hoc Committee on Inter-association Cooperation was formed with Dr. Paul R. Elliker as Chairman. A similar Committee was appointed by NAS under the chairmanship of Dr. William G. Walter.

These Committees first made a thorough study of the constitutions, procedures, and some of the problems associated with both organizations. A wonderful working relationship was developed between the 2 ad hoc Committees, primarily because members on both sides approached the task in a spirit of harmony, with a minimum of bias and with a good understanding of the problems to be resolved in successfully unifying the 2 Associations.

The approach adopted by the IAMFES-NAS committees, in seeking a satisfactory basis upon which to form a new association of sanitarians, was to attempt to select the best features from the constitutions of both the existing associations and to combine these into a set of by-laws which would be acceptable and would serve the best interests of members in both IAMFES and NAS.

One year later, the original draft of the proposed by-laws had undergone 2 revisions and the 3rd draft was completed in readiness for consideration by members at the respective 1967 Annual Meetings of NAS and IAMFES. The draft was studied by our Executive Board and copies were distributed to the representatives of the Affiliate Council during our Annual Meeting in Florida. A special meeting was also called at that time to obtain the views of other IAMFES members.

Having obtained the reactions and suggested amendments to the proposed by-laws from this Association, our ad hoc Committee (this time under the chairmanship of Dr. W. C. Lawton) resumed meetings with Dr. Walter's NAS Committee. After a series of further revisions, made after consultation with members outside of the Committees, the 7th draft of the proposed by-laws was completed with the intention of distributing copies to the members of both Associations for consideration at their respective 1968 Annual Meetings.

The NAS held their Annual Educational Conference in Washington D. C. in June—about 2 months prior to our Annual Meeting. At some time previous

to their Conference, the NAS Executive Officers had referred the 7th draft to their Executive Committee for critical review. The Executive Committee had many reservations about the 7th draft of the proposed by-laws and made so many revisions which would be contrary to the concepts and expressed views of IAMFES members that no useful purpose would be accomplished by presenting their modified version of the 7th draft to this meeting.

Your Executive Board was very disheartened by this turn of events and I know that the joint IAMFES-NAS committee members who had worked with such sincerity and diligence for 2 years in preparing the by-laws were very discouraged as well.

There is little doubt that the 7th draft would have been favorably received by the majority of IAMFES members. It removed most of the major objections to the 3rd draft as expressed at our last Annual Meeting. The details of the draft will be explained by Dr. Lawton in his ad hoc Committee report to be presented at the business meeting tomorrow morning. (See September, 1968 issue of *JMFT*.)

In order to obtain further information and explanations regarding decisions and final action taken by NAS concerning the proposed merger, an invitation was sent to Mr. Nicholas Pohlit, Executive Director of NAS to meet with our Board at this Annual Meeting. We were pleased that he accepted the invitation and he was on hand for a session with the Board yesterday morning.

He indicated that NAS was still very interested in working towards an amalgamation of IAMFES and NAS. His explanation for the type of drastic revision made in the 7th draft of the proposed by-laws by the NAS Executive Committee was that there had not been adequate communication between the NAS Committee on Unification and the Executive Committee. Thus, when the Executive Committee was requested to review and critically appraise the 7th draft it did so without the benefit of consultation with the Chairman of their NAS ad hoc Committee on Unification. The result was that the Executive Committee unilaterally re-wrote the proposed by-laws for a future new association of sanitarians so they were essentially the same as current NAS by-laws. It is conceivable that if a group of IAMFES members were similarly appointed to critically review the 7th draft, without prior briefing by members who had made a study of the overall problem, they may have reacted in a similar manner.

Concerning prospects for future joint IAMFES-NAS committee meetings in attempting to establish acceptable by-laws for a unified association of sanitarians, your Executive Board made the following decisions:

(a) The present NAS Executive Committee rewrite of the 7th draft of the proposed by-laws is unacceptable as a document to be used as a starting point for further joint meetings for the purpose of developing by-laws for a new association. To do so would be to accept virtual nullification of 2 years of time, energy, and expense involved on the part of the IAMFES and NAS committees as well as others, in evolving the 7th draft.

(b) We have received no concrete indication of the position that the Executive Officers of NAS have taken with respect to the revision of the 7th draft made by their Executive Committee. We therefore, are going to request that NAS convene a meeting of their Executive Officers, Executive Committee and ad hoc Committee on Unification to study the 7th draft in relation to the Executive Committee's amended version of the draft. From this meeting, we would hope to receive a revised draft of proposed by-laws, approved by the various NAS groups mentioned. The new NAS draft would then be studied by our Executive Board and ad hoc Committee to determine prospects for future fruitful discussions toward the establishment of a new association. In

the event that prospects are reasonably good, then our IAMFES ad hoc Committee would be requested to arrange further meetings with the NAS Committee on Unification.

I would like to leave this final thought with you regarding this matter. Before successful progress can be made towards amalgamation, there is going to have to be a change in attitude by people in both Associations. We are going to have to de-emphasize what we have by way of procedures and by-laws in our present organizations and be prepared to make some sacrifices in coming up with a workable formula for the proposed new association of sanitarians. We are going to have to get away from the "we" and "they" philosophy used in union-management type negotiations and think more in terms of "us" (comprising both NAS and IAMFES members) in developing by-laws for a new Association. This was the philosophy adopted by the joint IAMFES-NAS Committee. This same spirit of cooperation and understanding is going to have to spill over into the minds of our respective Boards and membership before any real progress can be made toward forming one new strong association of sanitarians.

PENNSYLVANIA ABNORMAL MILK PROGRAM

The flow of low-quality milk to processing plants has been drastically reduced during the past year because of the success of the Pennsylvania Abnormal Milk Program, it was reported by an Extension dairy specialist at The Pennsylvania State University. Stephen B. Spencer said initial program surveys show that 94% of the Commonwealth's dairy herds are producing milk of good to excellent quality. This figure, he said, is substantially higher than those compiled a year ago.

"The Abnormal Milk Program, formulated by the Pennsylvania Mastitis Council, is essentially a campaign to lower leukocyte levels in milk by regular testing procedures in laboratories and establishing clearly defined roles for dairymen, fieldmen, veterinarians, milking machine servicemen, and county agents," the dairy specialist said. "The State Department of Agriculture's Milk Sanitation Division is the regulatory organization."

In explaining the procedures used in the program, Spencer pointed out that milk samples are collected from all herds

monthly and tested at one of the 85 approved dairy laboratories. If the first test indicates an abnormal amount of leukocytes present, the fieldman observes milking practices and attempts to discover the problem. Within 15 days after the first test, a second one is made. If the count continues to exceed minimum standards, the fieldman asks the dairyman to have his veterinarian visit the farm. From here a program is established to find out if the condition is caused either by health or management or both.

"The results have been gratifying according to initial surveys," the Penn State specialist emphasized. "When the program began, 40% of the dairymen shipping milk to one plant had a product with excessive leukocyte levels. Today the figure stands at less than 10%. A statewide survey shows that only 5% of the producers are shipping low quality milk."

The most important element in the Pennsylvania program, Spencer said, is the dairyman's attitude when he knows he has an abnormal milk problem. He then must willingly initiate the steps to be taken for corrective action.

INTERACTIVE INHIBITORY ACTIVITIES AMONG CERTAIN PSYCHROTROPHIC BACTERIA FROM DAIRY FOODS¹

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ABSTRACT

Thirty-eight cultures, including species of *Pseudomonas*, *Achromobacter* and *Alcaligenes*, isolated at 5 C from refrigerated dairy foods were examined for interactive inhibitory activities by the spot-plate method. Eleven of the *Pseudomonas* cultures showed inhibitory activity against one of the *Achromobacter* species. Among the *Pseudomonas* species, eight showed inhibitory activity against four others. Neither the *Achromobacter* nor the *Alcaligenes* species were inhibitory against the other cultures. Inhibition was more pronounced at 7 than at 25 C and increased with increasing concentration of effector species and decreasing concentration of test species. When interacting species of *Pseudomonas* and *Achromobacter* were grown together in broth or skim milk media, inhibition of the *Achromobacter* species occurred when the viable population level of the *Pseudomonas* species had reached 10^6 - 10^8 cells per ml. Sterile Seitz-filtered filtrates of *Pseudomonas* sp. 2 inhibited growth of *Achromobacter* sp. 54.

In recent years, numerous papers have been published on interactive phenomena among microorganisms commonly present in foods. Most recent studies in this area have dealt with the influence of food microorganisms on growth of staphylococci and enterotoxin production. These studies (6, 12, 16) have shown that certain species of *Bacillus*, *Proteus*, *Serratia*, *Escherichia*, *Aerobacter*, *Streptococcus*, *Lactobacillus*, *Leuconostoc*, *Achromobacter*, and *Pseudomonas* can inhibit *Staphylococcus aureus*. In milk and milk products, reports on interactions among bacteria are related mainly to (a) the production of stimulatory or inhibitory principles by certain lactic acid bacteria acting upon the same or other microorganisms (4, 7, 13-15, 17), and (b) interactions of certain microorganisms in cream at 10, 20, and 30 C (8-10). The latter concern groups of microorganisms consisting of *Streptococcus lactis*, *Pseudomonas fragi*, and *Geotrichum candidum*; *Bacillus subtilis*, *Lactobacillus casei*, and *S. lactis*; and *Candida pseudotropicalis*, *Aerobacter (Enterobacter) aerogenes*, and *S. lactis*. A significant portion of the viable population of foods stored under refrigeration frequently consists of psychrotrophic bacteria. Species of *Pseudomonas*, *Achromobacter*, and *Alcaligenes* are commonly found among this group of bacteria. Little

information, however, is available about possible interactive activities among psychrotrophic bacteria in foods. In the present study, interactive inhibitory activities among *Pseudomonas*, *Achromobacter*, and *Alcaligenes* species were studied.

EXPERIMENTAL METHODS

Thirty-eight cultures were selected from the stock culture collection of the Department of Animal Science. A majority of the cultures was isolated at 5 C from various refrigerated milks and milk products. Examinations for various cultural, morphological and physiological characteristics were carried out as outlined in the Manual of Microbiological Methods (18). These included Gram reaction, motility (hanging drop method), reaction in litmus milk, catalase reaction, gelatin liquefaction, casein hydrolysis, growth at 5 to 42 C, indole production and nitrate reduction. Tests also included, presence of flagella by the Bailey method (18), sugar utilization by the Hugh-Leifson procedure (11), production of NH_3 from arginine under anaerobic conditions (20), oxidase reaction (19), production of fluorescein on Bacto-*Pseudomonas* Agar F (PAF), and growth on staphylococcus medium 110 (3, 5). The sensitivity of the cultures to chloramphenicol (100 μg), penicillin (2.5 I.U.), streptomycin (80 μg), and oxytetracycline (10 μg) was tested by the paper disc method.

The cultures were maintained on slants of Standard Methods Agar, SMA (1). Prior to each trial, they were grown for two transfers at 7 C in the medium employed in the experiment. When SMA or PAF plates were used, the inocula consisted of cultures grown in these media without agar. Spot-plate tests for the detection of inhibitory activity were carried out as follows: One-tenth milliliter aliquots of appropriate dilutions of a test culture were placed on the surface of SMA or PAF plates which prior to streaking were dried overnight at 32 C. The inoculum was spread over the surface of the plate with a sterile glass rod. In most trials, 3 plates were used with inocula of about 10^2 , 10^3 , and 10^4 cells per plate. After drying at room temperature drops of appropriate dilutions of effector species were placed on the plates with a 27-gauge needle on a syringe. The inoculum concentrations on each plate were about 10^2 , 10^3 , and 10^4 cells per drop. The drops were about 1 cm in diameter. One or two effector species were placed on each plate. After drying, one set of plates was incubated at 25 C for 3 days, the other at 7 C for 10 days. Following incubation, each plate was carefully examined with a stereoscopic microscope (magnification 20-25X). Inhibitory activity of the effector species was expressed by measuring the zone of clearing between the edge of the drop and growth of the test species on the plate. Concentration of cells in the inocula was determined by plating appropriate dilutions on SMA with incubation at 25 C for 3 days. PAF plates were prepared as described for SMA.

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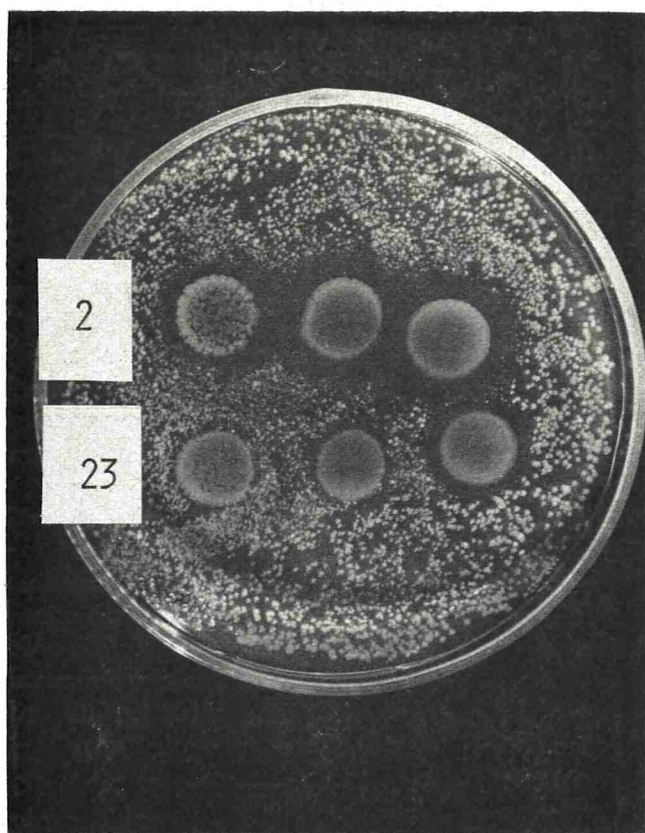


Figure 1. Inhibitory effect of effector species (*Pseudomonas* 2 and 23) on test species (*Achromobacter* 54).

Skimmilk was prepared by reconstitution of low-heat nonfat dry milk solids (9%) in distilled water. The media were autoclaved for 15 min at 121 C and 15 lb steam pressure.

RESULTS AND DISCUSSION

On the basis of various characteristics, 31 of the 38 cultures were *Pseudomonas* species, 6 *Achromobacter* and 1 *Alcaligenes* species. All *Pseudomonas* cultures were gram-negative rods, motile with polar flagella, oxidase-positive, produced NH₃ from arginine under anaerobic conditions, with oxidative action on glucose and were resistant to penicillin (2.5 I.U.). Among these were 2 cultures each of *Pseudomonas fluorescens*, *Pseudomonas taetrolens*, *Pseudomonas synxantha*, *Pseudomonas mildenbergii*, *Pseudomonas mephitica* and 3 of *Pseudomonas fragi*. Eighteen other *Pseudomonas* cultures did not receive a species designation because they did not fit the characteristics of species described by Breed et al. (2). For convenience, these were placed in 5 groups according to production of fluorescein (F), casein hydrolysis (Ch), and pigmentation (Pi). The groups and cultures were (a) F+, Ch+, Pi-, cultures 29, 40, 63, (b) F+, Ch-, Pi-, culture 23, (c) F-, Ch+, Pi+ (orange), culture 56, (d) F-, Ch+, Pi-, cultures 1A, 2, 19, 24, 25, 26, 37 and (e) F-, Ch-, Pi-, cultures 01, 6, 10, 11, M21, and 65.

Achromobacter sp. 2, 3, 51, 54, 57, 58 were gram-negative, non-motile, short stout rods which grew on staphylococcus 110 medium. They were oxidase-negative and sensitive to penicillin, streptomycin and chloramphenicol.

With the spot-plate technique, each of the 38 cultures was used as effector species against the other 37 cultures as test species at three levels of initial cell concentration for both species. Inhibitory activities of the effector species against test species were observed in the following combination of effector-test species: *P. fluorescens* E, 11, and *Pseudomonas* sp. 1A, 2, 19, 23, 24, 25, 26, 40, 63 versus *Achromobacter* sp. 54; *Pseudomonas* sp. 56 versus *P. taetrolens* 1; *P. fluorescens* E, 11, and *Pseudomonas* sp. 2, 24, 26 versus *Pseudomonas* sp. 6; *Pseudomonas* sp. 25 versus *P. mildenbergii* 1; and *Pseudomonas* sp. 1A, 25, 26 versus *P. mildenbergii* 2. An example of the spot-plate technique with *Pseudomonas* sp. 2 and 23 versus *Achromobacter* sp. 54 is presented in Fig. 1.

As expected, variations were noted in the degree of inhibitory activity when one effector species was tested against various test species or with various effector species against the same test species. The results of the influence of *Pseudomonas* sp. 2 and 40 against *Achromobacter* sp. 54 (Table 1) can be used to express certain general observations which hold true for a majority of the inhibitory activities of effector against test species. Inhibition of the

TABLE 1. INHIBITORY ACTIVITY OF *Pseudomonas* SP. 2 AND 40 ON *Achromobacter* SP. 54 AT DIFFERENT LEVELS OF INOCULUM CONCENTRATION.

Log of inoculum concentration per drop of cultures	Log of inoculum concentration of <i>Achromobacter</i> 54 per plate on					
	SMA			PAF		
	4.4	3.4	2.4	4.4	3.4	2.4
Zone of inhibition in mm at 25 C						
<i>Pseudomonas</i> sp. 2						
4.7	2	4	3	0	0	0
3.7	1.5	3	2.5	0	0	0
2.7	1	2.5	2.5	0	0	0
<i>Pseudomonas</i> sp. 40						
4.8	0	0	0	0	0	0
3.8	0	0	0	0	0	0
2.8	0	0	0	0	0	0
at 7 C						
<i>Pseudomonas</i> sp. 2						
4.7	5	6.5	7	4	6	7.5
3.7	4	5.5	7.5	2.5	5	5.5
2.7	3	4.5	5	2	4	5.5
<i>Pseudomonas</i> sp. 40						
4.8	3	3	3	1.5	3	5
3.8	2	2	3	1	2	3
2.8	1.5	1.5	1.5	0.5	0.5	2

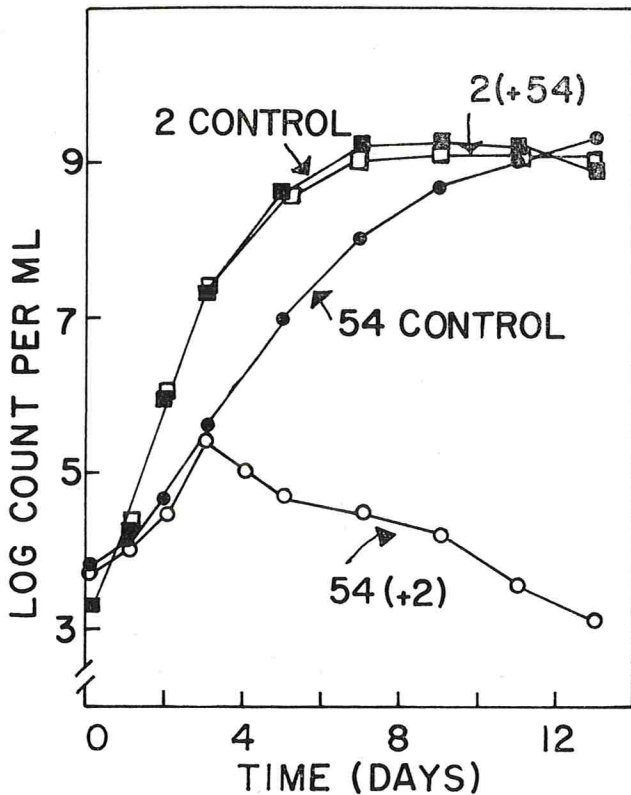


Figure 2. Growth of *Pseudomonas* 2 and *Achromobacter* 54 singly and mixed culture in SMA broth at 7 C. 2+ (54) = viable count of *Pseudomonas* in mixture, 54 (+ 2) = viable count of *Achromobacter* in mixture.

test species was more extensive at 7 than at 25 C. At 7 C, there usually was increased inhibition at the lower concentration of the test species and with higher concentration of the effector species. The latter was also true at 25 C, but not as pronounced. With plate incubation at 7 C, inhibitory activities were observed both on SMA and PAF plates. Some differences in inhibitory activity were noted on comparable plates of SMA and PAF media. However, when inhibition was noted on SMA plates at 25 C, little or no inhibitory activity was observed on PAF plates.

With some species (*Pseudomonas* sp. 25 and 40 versus *Achromobacter* sp. 54) inhibitory activity on SMA was observed at 7 C but not at 25 C. The observations with *Pseudomonas* cultures 2, 25 and 40 against *Achromobacter* sp. 54 were similar in five independent trials. In one series of experiments the concentration of *Achromobacter* sp. 54 on SMA plates ranged from 10^3 to 10^7 , those of *Pseudomonas* sp. 2 and 40 from 10^2 to 10^4 cells per spot on the plate. At a level 10^5 - 10^7 cells of *Achromobacter* sp. 54 per plate the zone of inhibition disappeared at 25 C with *Pseudomonas* sp. 2 and at 7 C with *Pseudomonas* sp. 2 and 40.

When *Achromobacter* sp. 54 was grown with *Pseudomonas* sp. 2 in SMA broth at 7 C (Fig. 2) the level of viable population of culture 54 remained somewhat below that of the control culture during the first 3 days. A marked decrease in viable population of culture 54 occurred when the population level of the *Pseudomonas* culture reached 10^7 - 10^8 cells per ml. Results with a lower initial concentration of culture 54 (6×10^2 /ml) but with the same initial level of *Pseudomonas* sp. 2 (2×10^3 cells/ml) were similar except that the maximum level of culture 54 in the mixture did not exceed 10^4 cells per ml. Growth of *Pseudomonas* sp. 2 in the presence of *Achromobacter* sp. 54 was similar to that of the control culture. Enumeration of *Pseudomonas* sp. 2 in the mixture was possible by plating on SMA with 5 I.U. of penicillin per ml of medium. In addition, *Achromobacter* sp. 54 could be enumerated separately by incubating plates without added antibiotic at 37 to 38 C, which did not allow growth of *Pseudomonas* sp. 2. The accuracy of this technique was checked at various levels of population of both species.

Comparable studies in skimmilk at 7 C (Fig. 3) showed that during the initial 5-day incubation period the rate of increase in viable population of *Achromo-*

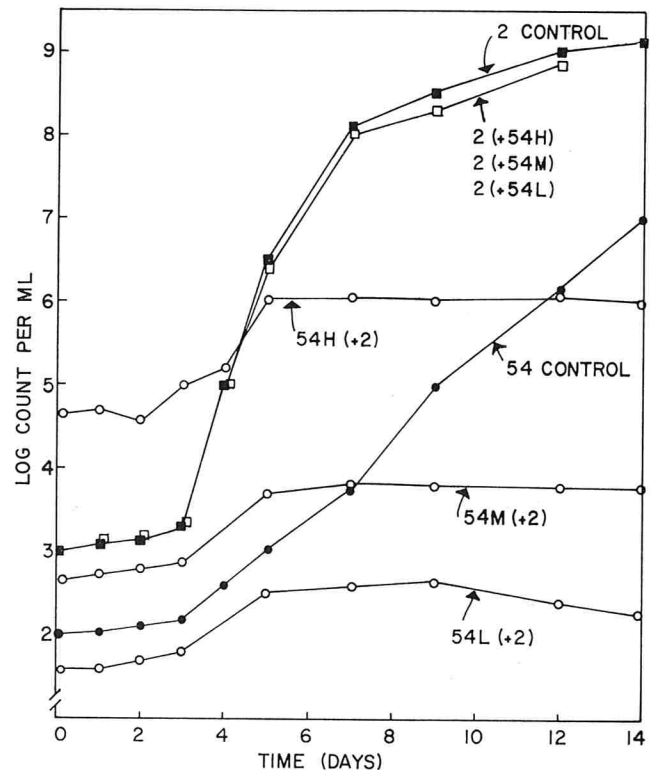


Figure 3. Growth of *Pseudomonas* 2 and *Achromobacter* 54 in milk at 7 C singly and in mixed culture at three different levels of initial population of *Achromobacter* 54 (H = high, M = medium, L = low level of initial population).

bacter sp. 54 in the presence of *Pseudomonas* sp. 2 was similar to that of the control culture. However, on extended incubation, the level of viable population of culture 54 either remained the same or decreased slightly, whereas the viable count of the control culture continued to increase. The gradual increase in viable population of *Achromobacter* sp. 54 in the mixed culture ended when the population level of *Pseudomonas* sp. 2 reached about 25×10^5 cells per ml. With an initial viable population level of 10^2 cells per ml, the population of *Achromobacter* sp. 54 in the control culture increased to 10^7 per ml in 14 days. However, in the presence of *Pseudomonas* sp. 2 (about 10^3 cells/ml) the maximum levels of *Achromobacter* sp. 54, with initial concentrations of 40 , 5×10^2 and 4×10^4 cells/ml, were 4×10^2 , 6×10^3 and 10^6 , respectively. As was observed in SMA broth, growth of *Pseudomonas* sp. 2 in the presence of *Achromobacter* sp. 54 was similar to that of the control culture.

A sterile Seitz-filtered filtrate was prepared from a culture of *Pseudomonas* sp. 2 which was grown in SMA broth for 48 hr at 25 C. The filtrate was used to replace SMA broth at levels ranging from 0 to 100%. These media then were inoculated (0.1%) with a 24-hr SMA broth culture of *Achromobacter* sp. 54 and incubated at 25 C for 5 days. Some inhibition of the *Achromobacter* species occurred when the filtrate made up 10 to 40% of the medium. However, no growth of the *Achromobacter* species was observed when 50% of the medium was replaced with filtrate. The possibility that depletion of certain nutrients was a factor in the repression of *Achromobacter* sp. 54 also was considered. In two experiments with *P. fluorescens* sp. 2 and *Achromobacter* sp. 54 together in either broth or milk medium, a sterile solution of yeast extract was added when the viable population of the latter ceased to increase. One-tenth milliliter of yeast extract was added per 10 ml of medium to give a final concentration of 2.5 g per liter. This addition had little if any influence on the population level of the two species. Results of the present studies may at least, in part, explain the changes in the distribution of various microbial species in milk and meat products when stored under refrigeration for extended periods. Previous studies (21) have shown that after holding for 10 to 20 days at 5 C only species of *Pseudomonas* type I and II were isolated from 7 out of 8 milks. Before holding, the microbial flora usually consisted of species of *Pseudomonas*, *Achromobacter*, *Alcaligenes*, *Flavobacterium* or *Cytophaga*. The results of the present study indicate that *Pseudomonas* species at high levels of population could have been responsible for repression of *Achromobacter* species.

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THE EFFECT OF FILLING TEMPERATURES OF MILK ON THE KEEPING QUALITY OF THE PRODUCT¹

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ABSTRACT

Temperatures of milk above 47 F at time of filling have a detrimental effect on the keeping quality of the product stored in paper containers. Filling temperatures are not as important as storage temperatures in prolonging shelf life. Storage temperatures of 40 F or below are recommended.

The temperature of milk in the container at time of filling and its potential effect on the keeping quality of the product concerns industry personnel and regulatory officials. There is very little information in the literature regarding the effects of this temperature. A recent survey (3) compared temperature increases during filling in knock-down and pre-formed paper containers. A greater temperature increase of milk in knock-down than in pre-formed containers had a detrimental effect on the shelf life of the product when using bacterial counts as a measure of quality. The survey also indicated the need for further study to determine the effect of slow refrigerated cooling of milk, after filling, on the keeping quality. The objective of this study was to determine the effects of increases in the temperature of milk in the container at time of filling and subsequent slow cooling on the storage life of the product.

EXPERIMENTAL PROCEDURE

In 3 replicate trials, milk pasteurized at 172 F for 17 sec and cooled to 38 F was filled into one-half pint pre-formed containers with an average warmup to 45 F. These samples were tempered immediately after filling by cooling in ice water or warming at room temperature to rounded off temperatures of 38, 43, 47, 53, and 58 F.

Preliminary research indicated that case resistance to cooling milk in the containers was in the order from greatest to least of wood, plastic, and wire. The slowest cooling was in the center of the case when containers were stacked 3 layers to a 90 container case. Significant differences were not found among the 12 center containers of such cases; neither were there differences among stacked cases when measured by the 12 center containers. Consequently, for the trials in this study, the center of wooden cases was used for placement of the containers in order to make for as slow cooling of the milk after filling as might be expected in a dairy plant and to minimize differences among samples at the same temperature of filling.

The milk samples representing each of the 5 filling tem-

peratures were placed in the center areas of 3 stacked wooden cases. The remaining room in the cases was taken up with containers filled with water at the same temperature as the milk. These 5 stacks of cases, spaced 3 inches apart, were located in a cold room maintained at 36 F (± 1 F) by means of a blower unit using sweet water as a refrigerant. Elapsed time from filling, through temperature adjustment and placement into the cooler did not exceed 2 hr.

Temperatures of the milk in the containers during the first 24 hr in the milk cooler were recorded by means of copper-constantan thermocouples with a Speedomax Type G, 16 lead recorder having a range of -200 to 40 C, an accuracy of ± 0.1 C and a recording chart with lines at 2 C intervals. Thermocouples were installed in the center of each of 3 representative milk containers for each of the 5 filling temperatures.

The samples, after 24 hr in the milk cooler, were removed and placed in household type refrigerators for storage at 35, 40, 45, 50 and 55 F (± 1 F). These were analyzed for standard plate count (SPC) and coliform count using violet red bile agar (1), and checked for flavor by 2 experienced judges immediately after filling, after 1 day in the milk cooler and at 2, 4, 6, 8, 10, 12, 14 and 16-day refrigerator storage periods or until the milk became sour.

An analysis of variance along with the Scheffé test was applied to determine the significance of the data at the 1 and 5% levels (2). The data used in the analysis were averages of values for the SPC, coliform count and flavor score taken at regular intervals during the storage period. Thus, the analyses were concerned with values for each storage and filling temperature and were independent of the time in storage.

RESULTS AND DISCUSSION

The rate of cooling milk (Fig. 1) during storage at 36 F for 24 hr after filling in one-half pint containers with warm-up temperatures of 38, 43, 47, 53 and 58 F follows generally recognized curves. The milk filled at 53 and 58 F required 24 hr; at 47 F, 18 hr; and at 43 F, 9 hr to reach the important storage temperature of 40 F or below. The lengths of time these milk samples were above 40 F and particularly above 50 F should have had an adverse effect on the keeping quality of the product. Commercial samples of milk may not require these lengths of time to cool from filling temperatures since containers are not normally stored with 3 layers to a case unless a dairy is cramped for storage space. The increased use of wire and light weight plastic should also increase the speed of cooling milk in the con-

¹Scientific contribution No. 332, Agricultural Experiment Station, University of Connecticut, Storrs.

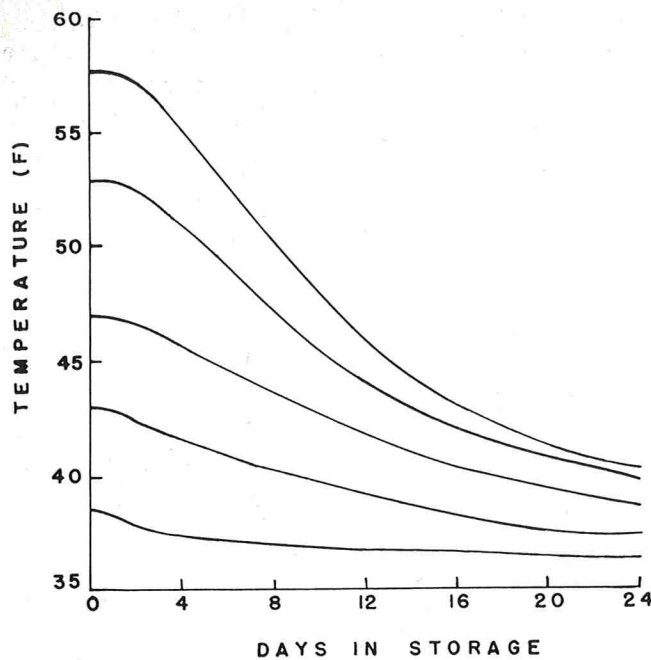


Figure 1. The cooling rate of milk during storage at 36 F following filling in half-pint paper containers.

TABLE 1. THE EFFECT OF FILLING TEMPERATURES ON STANDARD PLATE COUNT, COLIFORM COUNT AND FLAVOR SCORE OF MILK AT VARIOUS STORAGE TEMPERATURES^a

Temperature of Storage, F	Filling Temperature, F				
	38	43	47	53	58
SPC/ml (log ₁₀)					
35	5.22	5.09	5.37	5.63	5.77
40	5.58	5.62	5.61	5.73	5.86
45	5.69	5.82	5.76	5.93	5.95
50	5.72	5.97	5.84	6.11	6.28
55	5.80	5.72	5.82	5.80	6.00
Coliform Count/ml (log ₁₀)					
35	0.45	0.62	0.78	0.96	1.52
40	1.66	1.52	1.64	2.04	2.45
45	2.41	2.59	2.88	3.10	3.29
50	2.84	3.12	3.17	3.60	4.21
55	3.00	3.42	3.50	3.75	3.62
Flavor Score					
35	37.6	37.4	37.1	35.6	34.0
40	37.1	35.8	35.6	33.7	30.1
45	36.7	34.7	32.3	34.2	29.3
50	37.0	33.7	31.3	31.1	27.4
55	33.2	33.1	32.3	29.2	28.6

^aMeans of 3 replicate trials and time in storage.

tainer as was noticed in preliminary research for these experiments.

The effect of filling temperatures on SPC, coliform count, and flavor score of milk at 5 storage tem-

peratures is presented in Table 1. The data are the averages of the values for each day in storage within each filling and storage temperature and represent 3 replicate trials. Since milk did not keep as long at the higher storage temperatures, the number of values represented in the averages for 35, 40, 45, 50 and 55 F of storage are 30, 24, 18, 15 and 12, respectively. Thus, the results can be compared among filling temperatures but not among storage temperatures. There appears to be an increase in bacterial counts and a decrease in flavor scores with increasing temperatures of filling. Greater differences in bacterial counts occur at the lower temperatures of storage. However, statistical analysis of the data using the Scheffé test (2) failed to detect a difference

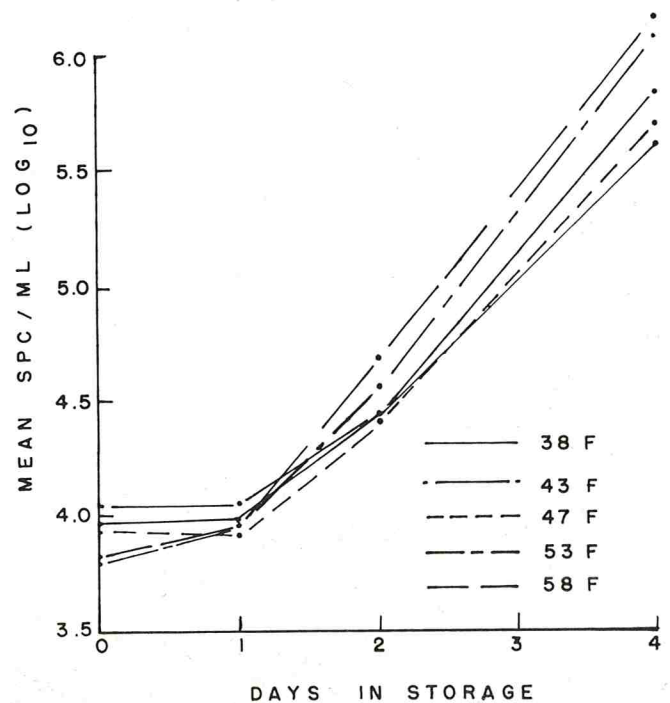


Figure 2. The effect of days in storage following different filling temperatures on standard plate count of milk.

among filling temperatures at the 5% level for SPC and coliform count. The flavor scores for the milk with a 58 F filling temperature were significantly lower than the 38 F ($p < 0.01$) and 43 F ($p < 0.05$) milk. The lack of statistical differences shown among these values (Table 1) appears to belittle the importance of filling temperature effects on the keeping quality of milk. However, the average values used in the analyses included values that were similar among filling temperatures. Such similarity occurred at 0 and 1 day of storage as expected and also with bacterial counts when the growth curve leveled off late in the storage life of the product.

A comparison of the temperature of milk at time

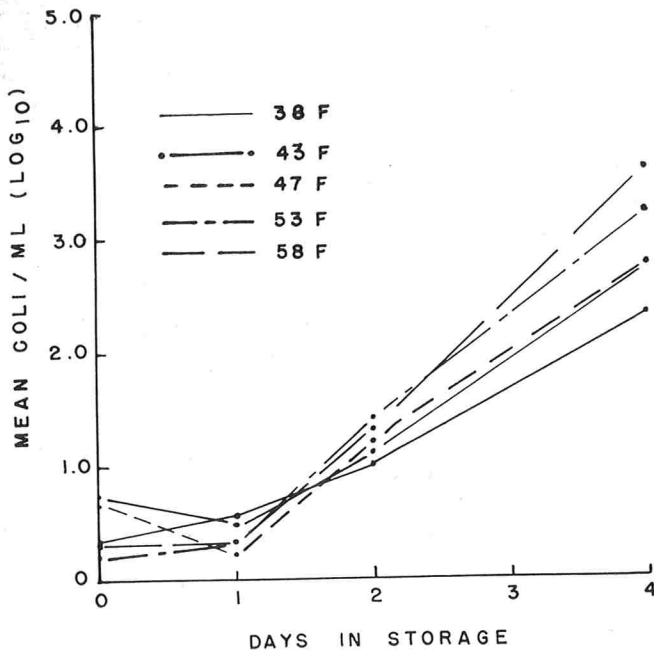


Figure 3. The effect of days in storage following filling temperatures on coliform count of milk.

TABLE 2. THE EFFECT OF FILLING TEMPERATURES ON THE TIME IN STORAGE FOR STANDARD PLATE COUNT TO REACH 100,000^a

Temperature of Storage, F	Filling Temperature, F				
	38	43	47	53	58
	Hr to reach SPC of 100,000				
35	204	200	167	171	141
40	125	122	139	113	96
45	79	77	79	69	71
50	60	55	55	46	39
55	39	42	41	39	37

^aAverage of 3 replicates.

of filling with days in storage for SPC (Fig. 2), coliform count (Fig. 3) and flavor score of milk (Fig. 4) was obtained using the average values for the 5 storage temperatures. The graphs do not extend beyond 4 days of storage because at 55 F the storage life of the milk did not exceed this time period. Data in the figures demonstrate the adverse effect of the higher temperatures of filling milk, particularly 53 and 58 F, on the SPC, coliform count, and flavor score. This is most noticeable at the end of 4 days of storage. The temperature of filling does not appear to have an effect on the measurements for quality during the cooling time in the milk cooler (0 to 1 day).

The data, as presented in Table 2, give the hr at the filling and storage temperatures for the milk to

reach a SPC of 100,000 which is in the area of the marked upward slope of a bacterial growth curve. The values were obtained from graphs drawn for each filling and storage temperature for which SPC averages for 3 replicate trials were plotted against time in storage. Statistically significant differences were not found among the filling temperatures of milk on the basis of the overall data in Table 2. However, a marked difference in results may be noted between filling temperatures at the lower temperatures for storage of milk. For example, there is a difference of 63 hr between filling temperatures of 38 and 58 F at 35 F storage and a difference of 29 hr at 40 F storage. The differences among filling temperatures at 45, 50, and 55 F storage do not appear to be of practical significance. Growth rate of the bacteria at the higher storage temperatures is fast enough, apparently, to minimize differences among filling temperatures.

The information presented shows statistically significant differences in the flavor score data in favor of the lower temperatures for filling one-half pint paper containers. This paper also indicates the advantage of the lower filling temperatures (38 and 43 F) as reflected in keeping quality measurements (similar results might be expected with larger size containers). The storage temperature, however, remains the most important factor in the keeping quality of pasteurized milk. This was indicated in a previous paper (3) and presented in Fig. 5 in which the plotted values represent all the values in this

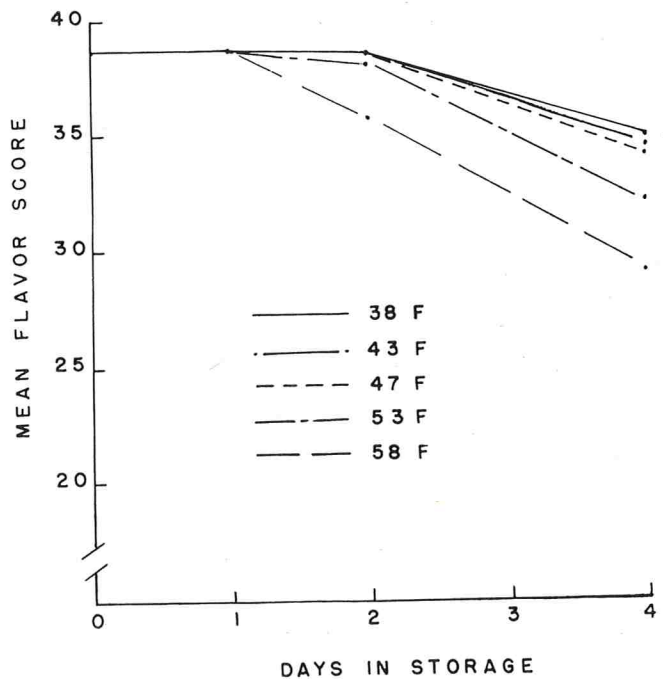


Figure 4. The effect of days in storage following different filling temperatures on flavor score of milk.

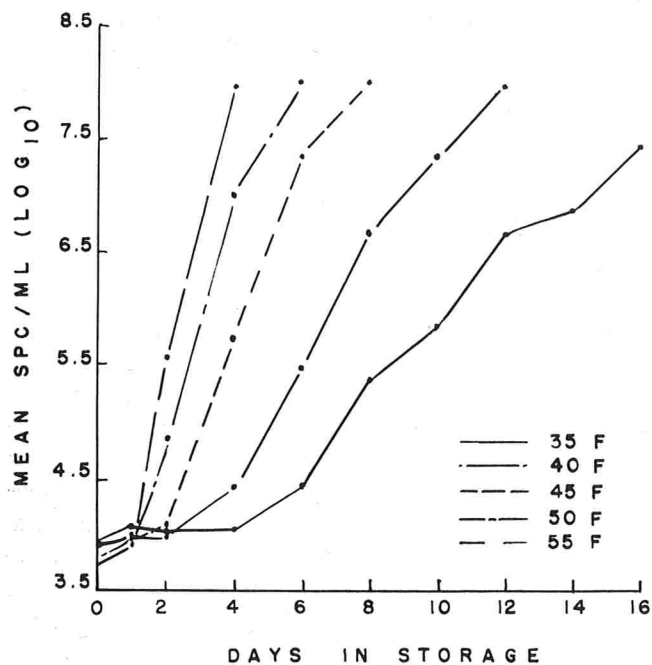


Figure 5. The effect of temperature of storage on bacterial counts of pasteurized milk in pre-formed containers.

study with the averaging out of the filling temperatures. The much quicker rise in the SPC of milk stored above 40 F is obvious. The emphasis in the dairy plant should, thus, be education of the housewife and store and plant personnel to maintain storage temperatures below 40 F. Secondly, emphasis should be placed on minimizing warm-up of the product during filling to prolong shelf life.

ACKNOWLEDGMENTS

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BUTTERFAT, SKIM MILK VALUES QUESTIONED BY ECONOMIST

The economics of filled and synthetic dairy products suggests that such products will be a very real factor in the market place in the future. So reported Robert E. Jacobson, Ohio Extension dairy marketing specialist.

We have already observed the impact of these products with respect to butter and cream. In fluid milk the same potential impact exists, primarily because of the value of butterfat relative to vegetable fat, he pointed out.

It is generally agreed that nutrition of natural milk is superior to that of synthetic milks. However, research has shown that consumers are responsive to new substitute products and that they are particularly concerned with price and taste.

Since the basic consideration in viewing the potential impact of substitute fluid milk is the competitive price position

of natural Class I milk, Jacobson suggested that the milk component valuation procedure used in fluid milk markets may have to be reviewed very carefully.

At the present time the value of butterfat and thus of skim milk utilized in fluid milk is essentially based upon the announced butter purchase price in the dairy support program. Jacobson raised the question as to how realistic these butterfat and skim milk values are in terms of actual market demand.

Along with talk about lowering of butterfat differentials or adopting a system of beverage pricing, there is considerable recognition and concern with the fact that any decrease in butterfat values will probably have to be accompanied by a comparable increase in skim milk values. To the extent that skim milk prices are increased, additional efforts at marketing non-dairy proteins will probably come about, said Jacobson.

TEST METHODS FOR MEASURING MINIMUM HOLDING TIMES IN CONTINUOUS EGG PASTEURIZERS¹

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ABSTRACT

Two test methods that may be used in commercial egg pasteurizers while in normal operation are described. Either may be used without damage to the product and with almost no disturbance to regular plant procedures. These tests have been needed to help determine the degree of compliance with pasteurization requirements.

The first method requires injection of a cold shot into the flow stream entering the holding tube and determination of the time required for the first of this material to arrive at the outlet of the holding tube. The cold shot is introduced into the line by use of a by-pass loop. The arrival of the cold shot at the end of the holding tube is detected by use of a sensitive recorder to indicate the temperature change.

The second method is based on the use of a fluorocarbon compound as a tracer. The compound is dissolved in yolk, which is injected into the flow stream entering the holding tube. Samples taken at the end of the holding tube are checked with a fluorocarbon leak detector of the type used in the refrigeration industry. The first positive sample is taken as the time of arrival of the injected tracer. Fluorocarbon compound 12 which is permitted in the immersion freezing of foods may be used and has no effects on the functional properties of the products.

Methods for determining the minimum holding times being used in the continuous pasteurization of egg products were developed to determine if practices complied with the specified requirements for pasteurization. Specifications for pasteurization of whole egg require heating the product and holding it at or above 140 F for 3.5 min. Requirements for other egg products may be obtained from the Grading Branch of the Poultry Division, Consumer and Marketing Service, USDA. These may also be based on a 3.5 min holding time. Plant practice is to pump the product through a heat exchanger, a holding tube, and a cooler. Holding tubes in the different plants may vary from 1.5 to 3 inches in diameter; pumping rates vary from 1,000 to over 10,000 lb per hr. The holding tubes are sized to hold not less than the amount being pumped in 3.5 min. Commonly they are 100 to 200 ft in length, and consist of several lengths of tubing connected by two 90° elbows at each end.

Because of the high viscosity of some liquid egg

products and the other flow conditions of the holding tubes, it was thought that the flow may sometimes be laminar. In this instance some of the product would flow through the holding tube at a much faster rate than average and would not be held for the specified period of time for pasteurization. Test methods were needed to determine the minimum time that any material is in the holding tube. The method would have to be usable in all plants despite the wide variations in equipment and operating practices. Many of the variables found among the plants could not be duplicated in the laboratory. A search was started for test methods that could be used with the least disturbance to plant operations.

One method for milk pasteurization is based on a similar heat, hold, and cool cycle in similar equipment. The most commonly used test method (1) for determining holding time for this process has been by timing the flow of a salt solution injected into water being pumped through the holding tubes of the milk pasteurizer. The presence of salt is determined by an increase in electrical conductivity. The flow characteristics of milk and water are quite similar, so that data based on water can be used to determine holding times for milk.

Unfortunately, the flow properties of egg products are quite different from water, so that data based on water flow do not apply to egg products. Injection of salt solutions into the egg products in the pasteurizing equipment did not offer a satisfactory method because of the presence of naturally occurring salts in eggs and of additional salt or other materials that increase conductivity that are added to some egg products prior to pasteurization.

METHODS AND EQUIPMENT

Other methods were therefore considered to determine minimum holding time. Our laboratory work has been primarily on cold shot and fluorocarbon injection methods and a few trials using dye injections. The first two methods are acceptable for use in regular plant pasteurization trials as they do not interfere with processing operations or injure the product. The last method is objectionable because color is introduced into the product.

Laboratory equipment for development of these methods consisted of a modified version of a commercial egg pasteurizer (Fig. 1). A rotary type pump with variable speed drive capable of pumping up to 4,500 lb. per hr of egg prod-

¹Reference to a company or product name does not imply approval or recommendation of the product by the U. S. Department of Agriculture to the exclusion of others that may be suitable.

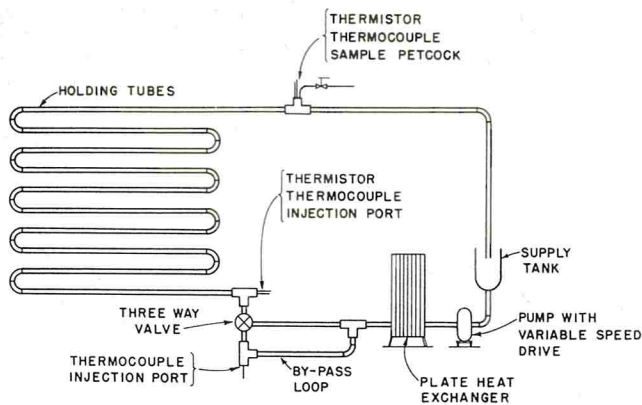


Figure 1. Laboratory test equipment.

ucts was coupled with a plate heat exchanger and a bank of 1.5 inch diameter, stainless steel, holding tubes each 20 ft long. Temperature of the hot water used for heating in the heat exchanger was automatically controlled by an air-operated valve on the steam supply used to heat the water. The hot egg product passed through the holding tubes and returned without cooling to a 5-gal tank that served as a feed supply to the pump. The holding tubes were arranged so that from 1 to 5 loops of two tubes each could be used as desired. Tubes were insulated with 0.5-inch thick foam rubber to minimize temperature drop of product as it flowed through the holding tubes. All fittings were bevel seat with neoprene gaskets. Each of the return bends in the bank of holding tubes consisted of two 90° elbows.

The pipe arrangement and instrumentation shown in Fig 1 were found to be satisfactory for laboratory tests. A by-pass loop holding about 2.2 lb. of product was installed between the heat exchanger and holding tubes as a means of introducing a cold shot into the flow stream. Product was trapped in the by-pass by use of the 3-way valve and then cooled to the desired temperature by running cold water over the loop. By changing the position of the valve, the flow was diverted through the by-pass loop and the cold shot swept into the flow stream. Originally the by-pass loop included a 2-way valve near its entrance so that the by-pass could be completely closed at both ends. This valve was found to be unnecessary as there was no indication that the cold material from the by-pass loop mixed with the main flow when it was left open.

For tests in commercial plants a major problem was the pipe fitting needed for the necessary operations and measurements. Each pasteurizer unit had a different physical arrangement. The problem was partially overcome by use of a by-pass loop and 4-way valve (Fig. 2) to introduce a cold shot. In pasteurizers using 2 inch bevel seat fittings the valve and loop could be interchanged with a 90° elbow located near the start of the holding tubes. If the pasteurizer did not use this type and size of fittings close-coupled adapters were used to make possible the use of the valve and loop.

The 4-way valve was built specifically for this use. By machining and welding, a fourth opening (with a nut connector for more versatility) was added to the body of a standard 3-way valve. A plastic plug (6) providing two separate flow channels was fitted to this body. Entrance and departure for each flow stream are 90° apart. The volume of the cold product in the by-pass loop is equivalent to 4.1 lb. of water.

Another advantage of the 4-way valve is that the flow through the pasteurizer could not be shut off inadvertently as it could be with the 3-way valve. Changing the 4-way valve position can only change between flow through the by-pass

loop and direct flow into the holder tubes. In some plants operating at higher pressures, the material for a fluorocarbon test (described later) could not be injected directly into the flow stream. In these instances the by-pass loop was closed off; the pressure was relieved by bleeding out a small amount of product; the fluorocarbon material was added; and the flow was switched through the by-pass to start the test.

The sensing elements were arranged as shown in Fig. 3. A multipoint temperature indicator with thermocouples was used for determining product temperatures. An amplifier-strip recorder unit (5) with thermistors was used to record temperature changes caused by the cold shots. This unit had a two-point switch so that temperature changes occurring at either

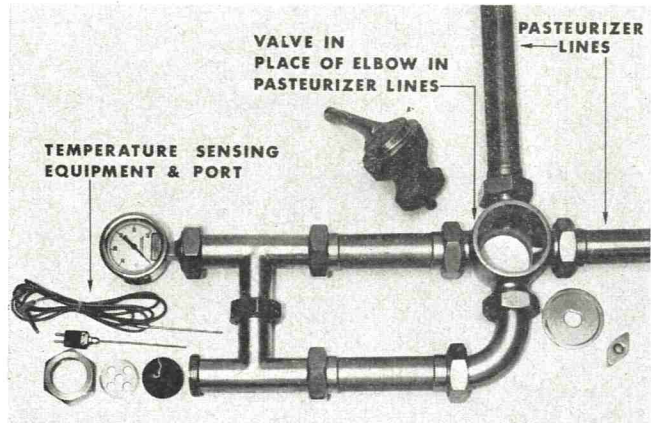


Figure 2. By-pass loop and 4-way valve.

the inlet or outlet of the holding tubes could be recorded. Sensitivity of the unit was adjustable so that full span of the recording paper could be made to vary from 50 to 0.1 F. Usually when a temperature change was sensed in the product entering the holding tubes, the 50 F span was used and in the product leaving the tube, the 2 F span. The latter permitted detection of changes of 0.01 F. Sensitivity beyond this value did not aid in determining the front of a cold shot. The chart speed was set at 2 inches per min. Response time of the thermistors was less than 1 sec.

The stoppers holding the temperature sensing elements at the inlet to the holding tubes and in the by-pass loop contained small holes for inserting a hypodermic needle for injection of fluorocarbon or dye. The port at the outlet of the holding tubes was equipped with a petcock for taking samples.

Coagulation occurred if some of the products (especially whites) were continuously recirculated at pasteurization temperatures. To economize on use of raw materials the tests were made at temperatures of approximately 120 F for whites and 130 F for other products. Pumping rates were determined by weighing the quantity pumped in a 0.5 or 1 min period. Average holding time was determined from the weight of material in the holding tube and pumping rate.

RESULTS

Cold shot test

In making a cold shot run the product was circulated through the system until the system was stabilized at the desired temperature and pumping rate. The by-pass loop was closed and the product in the loop was cooled by running cold water over

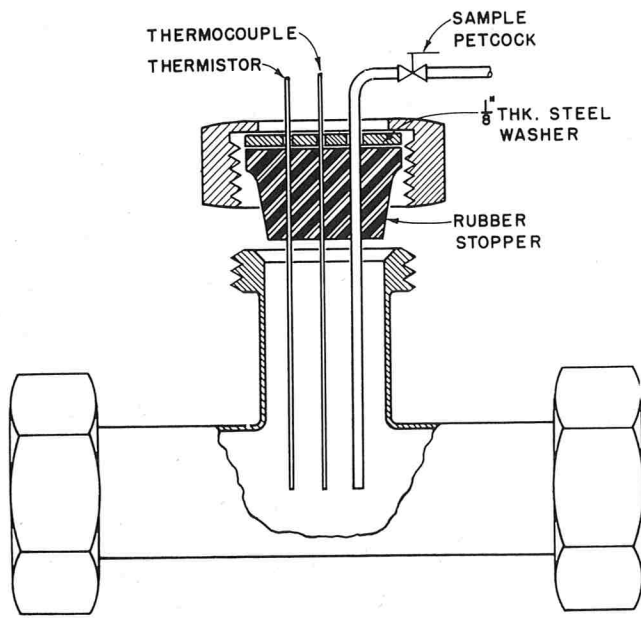


Figure 3. Arrangement of sensing equipment.

the tubing. The amount of cooling was usually 20 to 30 F. (In test runs in commercial plants the cooling should not be started until the required pasteurization time has elapsed.) Temperatures were read and the temperature change recorder was set on the 50 F span to detect the temperature change at the entrance to the holding tube. The position of the 3-way valve was then changed so that the flow went through the by-pass loop and swept the cold shot into the holding tube. The temperature change was recorded when the cold shot entered the holding tubes; then the recorder was switched to the thermistor at the end of the holding tubes and the span of the recorder reduced to 2 F for greater sensitivity. After the temperature drop at this point was recorded, the minimum flow time was determined by direct measurement of the interval between the starts of the two temperature changes (Fig. 4). It was also possible to make test runs satisfactorily with the initial temperature change sensor in the by-pass loop; in this instance the rise in temperature as the hot product swept the cold product into the lines was taken as the starting time.

The temperature drop in the product from the holding tube is only a small fraction of the temperature drop in the cold shot entering the holding tube. By limiting the amount of cooling of the cold shot the temperature drop of the product can be limited to 1 F or even less and a good determination of the minimum holding time made. This small change permits tests to be made in most commercial plants without causing flow diversion or other disturbance of normal operation.

Fluorocarbon test

The fluorocarbon method is based on the detection of a small amount of fluorocarbon gas by a halogen leak detector such as used in refrigeration and air conditioning. The detector (4) used in this work contains a probe through which air is drawn by a small vacuum pump in the unit. This air passes between two electrodes. If a halogen compound is present in the air, the current between the electrodes is increased. This current is amplified causing a small neon light in the probe to flash. The unit is rated as capable of detecting a leak of 0.1 oz per year.

In making a trial, fluorocarbon refrigerant in a suitable carrier was injected into the product at the entrance to the holding tubes. Samples of approximately 10 to 20 ml were collected in test tubes at timed intervals from the petcock at the end of the holding tube over a period expected to cover the arrival of the first fluorocarbon. These samples were checked for presence of the fluorocarbon.

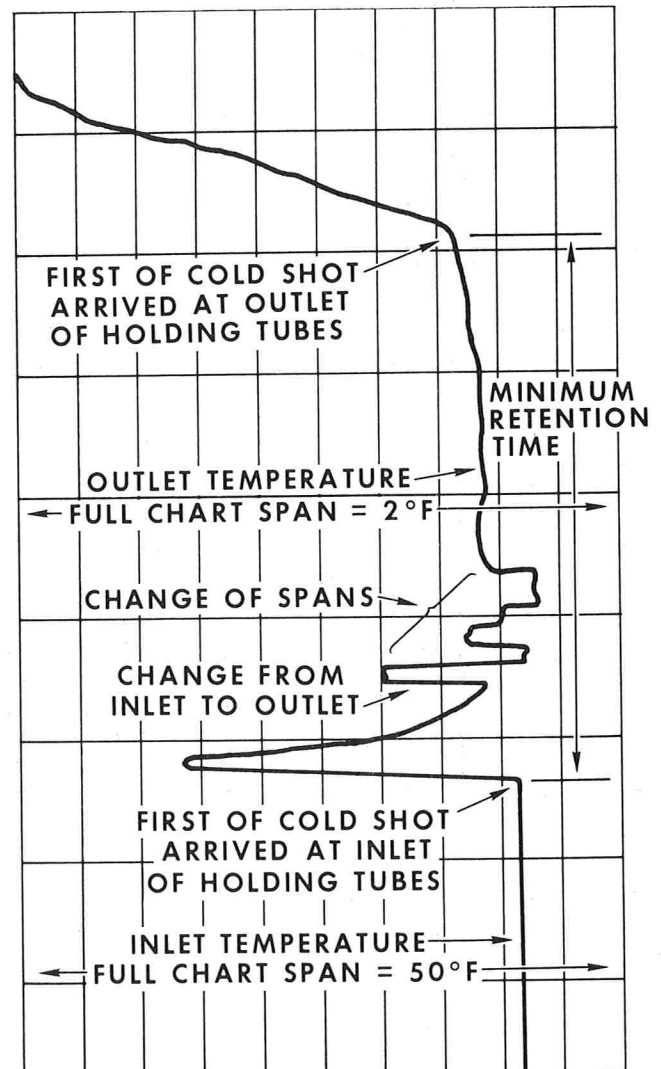


Figure 4. Typical cold shot run.

TABLE 1. FLUOROCARBONS TESTED^a

Compound number	Formula	Molecular weight	Boiling Point F	Vapor pressure at 70 F lb/sq in gage
113	CCl ₂ F-CClF ₂	187.4	118	(-9)
C318	C ₄ F ₈	200	21.5	26
115	CClF ₂ -CF ₃	154.5	-38	105
12	CCl ₂ F ₂	121	-21.6	70

^aData from reference (2).

The mechanism by which this test method works appears rather specific. The fluorocarbon cannot be used alone, regardless of whether it exists as a gas or a liquid. It must be in solution in a carrier that readily disperses through the product flowing in the holding tubes and it goes through the holding tubes while in solution. To detect the fluorocarbon in the samples, it is necessary to transfer the fluorocarbon from solution to a gaseous state since only halogen gases are detected. This is done by shaking the closed test tubes so that the fluorocarbon is released into the air confined with the sample. This air is then drawn through the probe of the halogen detector.

There is an extensive list of halogen-containing compounds that can be considered for this test. When the properties of these compounds are compared with the requirements, the list becomes much smaller. The compound must be readily available in a convenient form, soluble in a carrier that will mix with egg products flowing through holding tubes, and proven to be of negligible toxicity.

In our work the four compounds in Table 1 were tested. Of these the most convenient was 113; it is a liquid at room temperature and is miscible in any

proportions with triethyl citrate, and mineral or vegetable oils, which serve as carriers for mixing with egg products. There has not been any application to FDA for approval of its use in food products, but its toxicity has been rated low by the Underwriters' Laboratories and the American Conference of Governmental Industrial Hygienists (3).

Considerable work was done with compounds 115 and C318, since these are used as propellants for foods in aerosol cans. However, no acceptable carrier was found that would dissolve a sufficient quantity of either compound to give an adequate test after the dilution that occurs in the holding tubes. When the pure compounds were injected into the egg product going to the holding tubes, no positive tests were ever obtained on the product from the holding tubes. Apparently the fluorocarbons existed as gases in the holding tubes and were not caught with the samples taken at the end of the holding tubes.

Approval for use of compound 12 has recently been given for immersion freezing of foods (7). The most acceptable way to use this compound as a test material was with egg yolk as the carrier.

The following method of preparation of the injection material and its use was found to give good

TABLE 2. COMPARISON OF TEST METHODS

Product	Flow rate	Average holding	Cold shot	Minimum holding times -- min	
	lb/hr	time, min		Fluorocarbon	Dye
Whites	1290	3.89	2.60	2.75	2.58
	2770	—	3.00	2.83	2.83
Whole egg	1060	3.18	2.09	2.08	1.92
	1590	3.17	2.10	2.00	2.08
	2090	2.41	1.87	1.83	1.92
	1690	4.97	4.10	4.08	—
	2310	3.62	3.22	3.25	—
Yolk	1060	3.18	1.88	1.92	1.75
	1270	3.96	2.35	2.57	2.57

results. A 1-lb. cylinder of 12, such as is used for charging refrigeration systems, was connected through a valve to three 250 ml Buchner flasks in series, each fitted with a glass tube extending to the bottom through a rubber stopper. The gas was bubbled through approximately 150 ml of water in the first flask, 120 ml of blended yolk in the second, and 150 ml of water in the third. The flask containing yolk was connected with flexible tubing so that it could be shaken in a mechanical shaker while the fluorocarbon gas entered. The comparative rates of bubbling in the two flasks containing water gave a general indication of how much was being taken up by the yolk. One hr of bubbling at a rate of 100 to 150 bubbles per min should give near saturation. Analysis indicated that yolk absorbed about 0.75% by weight. The product should be kept refrigerated in a tight container until ready to use. A check of its strength may be made by 1 ml:10 ml serial dilutions in whole egg. One part in 10,000 of whole egg should yield positive results with the halogen detector.

To test for minimum holding time, 20 ml of the fluorocarbon carrier is injected with a syringe at the entrance to the holding tubes. About 30 seconds before the fluorocarbon is due at the discharge end, samples are taken at 5 sec intervals for 1.5 min. If the product flowing in the holding tube is whole egg or whites, 16 x 150 mm test tubes are filled about 2/3 full; if the product is yolk, test tubes should be 1/3 full. Test tubes are stoppered promptly, shaken, and checked for fluorocarbon while still hot. Samples of yolk products are placed in a water bath at approximately 130 F and diluted with an equal volume of water at the same temperature. The water and higher temperature lower the viscosity so that better contact between the product and air in the top of the test tube occurs during shaking. The fluorocarbon in the fat of the yolk is transferred faster to the enclosed air. The elapsed time from injection to the first positive sample is taken as the minimum holding time for the product flowing through the holding tubes. In test runs in commercial plants the egg product containing fluorocarbon should be held in the filling tank until diluted to 40 gal or more. This reduces the fluorocarbon level below 1 ppm, which is a negligible concentration.

Dye injection test

A water-soluble dye (F&D #90 Black, 1 g in 25 ml water) was used in a similar injection and sampling procedure in laboratory runs. The first of the dye coming through the holding tubes could be readily seen. A fluorescent dye (Fluorescein #32) was

also tried but showed no advantage over the other dye.

DISCUSSION

Duplicate and simultaneous trials by the three methods in the laboratory with egg white, whole egg, plain yolk, and salted yolk showed that any of the methods gave sufficient accuracy for determination of minimum holding times in commercial plants. Some comparative results that were obtained as the methods were being developed are shown in Table 2. Only the last two runs with whole egg were made after the procedures and equipment were standardized. The cost of raw material, which could only be used once in fluorocarbon and dye tests, limited the number of these two tests.

In commercial plant runs the results with the cold shot and fluorocarbon tests were in agreement within 5% except on the tests for one unit. The use of dye in such testing was not considered feasible, as the egg product containing dye could not be used in its normal manner. However the product is not damaged in fluorocarbon and cold shot testing. The latter two tests were equally reliable but experience in the use of either was necessary before consistent results were obtained. The cold shot tests are easier and faster but the equipment cost is much higher.

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BACTERIOLOGICAL METHODS FOR EVALUATION OF RAW MILK QUALITY. A REVIEW¹

I. USE OF BACTERIAL TESTS TO EVALUATE PRODUCTION CONDITIONS

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The purpose of this paper and the one to follow is to review some of the pertinent information on routine quality tests that has appeared in the literature. It is hoped that this may serve as reference material for sanitarians, public health officers, and other interested people.

ABILITY OF BACTERIAL TEST RESULTS TO MEASURE PRODUCTION CONDITIONS

Limitations of bacterial test results for appraising farm production conditions were recognized soon after quality tests were first used. Brew (11) reported that, when he began inspecting dairies in 1907, he soon learned that there was no discernible correlation between milk quality as determined in the laboratory and the "score" of dairy barns. Kelly, Newman, and Hine (45) recognized that many desirable production practices did not greatly affect the bacterial count. They emphasized, in 1917, that common decency, economy, and the esthetic values of the buyer presented a difficult challenge to the dairyman. In discussing the dairy farm score card in 1918, Kelly (43) pointed out that score cards were intended as a guide in improving general conditions on the dairy farm. With improved production conditions, the milk produced would naturally be of higher quality. He emphasized, however, that the score card was not formulated as an index of the bacterial count of milk produced on individual farms. In 1919, Hunter (33) said it was generally accepted that the bacterial content of milk was not a satisfactory index of sanitary production. Bacterial content of milk was then more closely related to care taken in handling after production than to production conditions. De Filippis (20) concluded that milk presented a characteristic total bacterial count essentially independent of production methods. He based his conclusions on results of bacterial examinations of several lots of bulk milk, milk from individual cows, and farm production conditions over 6 years during the 1930's. Nichols and Jackson (57) reported in 1938 that the

Standard Plate Count and methylene blue reduction test were relatively insensitive when used to determine unacceptable production conditions. Approximately 50% of the milk samples collected under unacceptable production conditions had plate counts of <30,000/ml and methylene blue reduction times of >7.5 hr. McKenzie and Bowie (53) observed in 1946 that milk from certain farms with seemingly unsatisfactory production conditions and methods were consistently graded as satisfactory by the routine resazurin test, whereas milk from other farms with visually observable good conditions and methods often failed to meet the standards. They attributed this partly to the fact that many of the poorer farms had a minimal amount of equipment to contaminate the milk. Heeres (29) and Atherton (4) also reported finding little relationship between production practices and bacterial test results. Fay (22) asserted in 1960 that the bacterial count was a valuable tool which, however, did not provide a complete picture of milk quality and could by no means substitute for inspection. In Canada, Johns et al. (41) found in 1964 that a maximum Standard Plate Count limit of 10,000/ml failed to detect 32% of the farms where equipment was not being properly cleaned.

The thermoduric count as an index of production conditions

Wilson and associates (79) reported in 1935 that the laboratory pasteurization test was not suitable for assuring cleanliness of milk supplies. They obtained an extremely low correlation between utensil sterilization and post-pasteurization counts. In spite of contact with imperfectly sterilized utensils, most milks showed approximately 99% reduction in the plate count after pasteurization. The researchers believed that heat-resistant organisms were not uniformly distributed in time or place and that their origin was not confined to unsterilized utensils. Thomas et al. (76) reported in 1948 that absence of thermoduric organisms did not necessarily indicate utensils with low levels of contamination since 25% of milk samples from farms not sterilizing utensils had low thermoduric bacterial counts. Based on studies in the St. Paul and Chicago areas, the Com-

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mittee on Applied Laboratory Methods of the American Public Health Association (34) reported in 1956 that, at the 30,000/ml level, the thermoduric bacterial count was quite inefficient in detecting unsatisfactory raw milk samples. In 1958, Johns (35) found that thermoduric bacterial counts from milks obtained with neglected milking machines were much lower than had been anticipated. Of 16 samples, only three exceeded 1,000/ml, and none exceeded 2,000/ml. In these experiments, it was possible that the machines were not in an unsanitary state long enough to permit a thermoduric flora to become established. Because thermoduric bacterial counts were at about the same level for all milk samples, regardless of the amount of bacterial growth in a sample during preliminary incubation, Johns (37) assumed that the thermoduric bacterial count did not accurately indicate unsanitary production conditions.

Bird and Egdell (7) observed a relationship between the thermoduric bacterial count and production conditions. They obtained post-pasteurization counts of >1,000/ml in 18.7% of the samples from all types of farms, but in only 4.7% of the samples from large farms where production methods were good.

Thomas et al. (75) conducted an experiment where utensils were sterilized but other factors of sanitary production were violated. Of 10 thermoduric bacterial counts, all were under 100/ml except for one at 260/ml. In 1953, Cuthbert, Egdell, and Thomas (17) suggested standards for thermoduric organisms/ml in farm milk supplies: 1,000-good; 10,000-fair; and 100,000-poor. Dahlberg, Adams, and Held (18) found that thermoduric bacteria in raw milk samples, as shown by plant pasteurization, were 1.8% of the total count. Ninety-one per cent of the pasteurized milk samples complied with the maximum thermoduric bacterial count standard of 30,000/ml. Thomas, Hobson, and Griffiths (74) reported that 65% of 195 samples from a six-unit recorder milk plant, efficiently cleansed after each milking and sterilized daily with blown steam did not have thermoduric bacterial counts over 1,000/ml. Samples of the first milk over the cooler were taken at regular intervals over a 3-year period at this farm. Only two of 236 samples had thermoduric bacterial counts over 1,000/ml; 66% did not exceed 100/ml. Only one of 25 farms surveyed by Atherton (4) had an average thermoduric bacterial count over 1,000/ml; 12 farms were under 100/ml. These results demonstrate how remarkably few thermoduric bacteria are contributed by efficiently cleansed and sterilized farm dairy equipment.

The coliform count as an index of production conditions

In 1918, Ayers and Clemmer (6) concluded that the

coliform count, when determined in fresh milk, did not indicate the extent of direct contamination with manure, but did indicate the general conditions of cleanliness under which the milk was produced. They found that about 95% of the samples from cows housed and milked under exceedingly dirty conditions did not contain coliforms in 0.01-ml quantities of the milk. In 1919, Finkelstein (23) observed only small numbers of the colon-aerogenes group in fresh raw milk. He did observe, however, a relationship with production methods: 100/ml where care was used and 588/ml when indifferent production methods were used. Sherman and Wing (66), 1933, recommended a coliform standard of 100/ml on high-grade raw milk containing <10,000/ml total bacterial count as a supplemental quality index. They emphasized that the coliform index was of no value in market-grade raw milk. Other workers (9, 32, 46) have emphasized restricting the coliform count to high-quality raw milk. After analyzing milk samples from 108 New Hampshire farms prior to 1934, Moore and Fuller (55) concluded that the coliform count gave little indication of farm production conditions. Yale and Eglington (80) believed the test had only slight value as a routine test of ordinary fresh raw milk. Neither the coliform count nor the coli-aerogenes ratio seemed at all suitable to Wilson et al. (79) as a method for assessing the cleanliness of production of ordinary market milk. They found that coliform results were irregular and poorly correlated with the sanitary conditions of production. When the numbers of coli bacilli were estimated separately, there was practically no correlation with the plate count, reduction time, or keeping quality of the milk. In some instances, a reverse correlation was observed.

To determine the value of the coliform test in assessing the cleanliness of cows' udders, Johns (39), in 1962, kept two heifers under conditions such that their udders, flanks, and tails became heavily soiled with manure. When milked with bacteriologically clean machines, the coliform count remained surprisingly low, while the total bacterial count increased roughly tenfold. Only two coliform counts exceeded 10/ml, with a maximum of 83/ml. These findings imply that the coliform test on raw milk cannot be relied on to detect unclean udders and teats. Dahlberg et al. (18) found that, in the Birmingham, Alabama, and Washington, D. C., markets, coliform counts were exceedingly low. This was credited to good udder preparation before milking. Johns (39) said that his findings and those of Ayers and Clemmer (6) strongly suggested that low coliform counts on samples from these cities probably resulted from some other factor, such as the heat-sterilization of milking-machine assemblies. With improper cooling, the coliform count was considered of little value

because of rapid growth of these microorganisms (6, 21, 22, 33, 66, 80).

Effect of the milking machine on coliform counts. Johns (37), in 1960, determined counts when cows and milking machines were either kept clean or neglected. Although coliform counts of $>100/\text{ml}$ were obtained on four of 32 samples from neglected milking machines, the general levels were surprisingly low, even when both cows and machines were neglected. Thom (70), 1962, emphasized that unsterile milking equipment is recognized as the most common source of high bacterial counts and coliform contamination in farm-tank milks. The sources of contamination affecting tank milk were, in order of importance: the milking equipment, the farm tank, and the cows. Coliform contamination frequently arose from dirty vacuum lines, where equipment sterilization was otherwise satisfactory. Ayers and Clemmer (6), Yale and Eglington (80), Kämpe (42), Smillie (67), and Thomas (72) reported that much of the coliform contamination of milk was derived from dairy utensils and equipment not adequately cleansed and sterilized.

It appears that the coliform count is of only limited value with fresh, high-quality milk, and of no value for older or lower-quality milk.

Some reasons for bacterial test limitations

Wilson et al. (79) discussed some of the reasons for the limitations of plating methods. There are many different kinds of bacteria in milk; they come from many sources and are in various physiological states from the log phase to the death phase. Also, they occur singly, in pairs, and in long chains. They have different nutritional, respiratory, and temperature requirements. Thus, no one medium incubated for a given time at a given temperature under aerobic conditions can possibly provide a realistic estimate of the bacteriological population. Reduction tests have the limitation that different kinds of bacteria have varying abilities to reduce the dye, and different kinds of bacteria grow at a variety of rates during the incubation period. In direct cell counts, some bacteria do not stain.

Although it is recognized that there are limitations in using bacterial tests to appraise production conditions, this does not mean that there is no relationship between production conditions and bacterial test results. Kelly (44) observed in 1943 that there was a definite relation between farm score and the bacterial count of milk. He indicated that, although this might not hold true in certain individual cases, it was applicable when considering many farms. He further commented that the condition of the establishment or its psychological effect upon the operator leads to the production of higher quality milk. Dahl-

berg et al. (18) also emphasized the psychological effect of desirable production conditions. They stated that, although it was possible to produce clean milk of low bacterial count in dirty surroundings, it generally was not done. Their study revealed that milk produced on farms under the most extensive, detailed, and rigidly enforced sanitary regulations had the best sanitary quality as judged by the usual bacterial tests. Low bacterial counts were associated with good sanitary practices and proper farm cooling of milk. After analyzing more than 4,200 milk samples from cans, bulk tanks, storage tanks, and tank trucks, Brazis and Black (10) reported in 1962 that laxity in cleaning, in bactericidal treatment, or in cooling would be reflected in the bacterial count and might result in the shipment of raw milk having counts in excess of 200,000/ml.

When considering the over-all picture, it is obvious that higher-quality milk results when the highest level of sanitation is practiced. The seeming anomalies result from the dilution of microorganisms into a large volume of milk, the complex interactions between microorganisms, our inability to accurately evaluate microorganism environments, limitations of determining the bacterial content of a milk sample, and the variability of microorganism reproduction rates.

BACTERIAL COUNTS ATTAINABLE BY USING RECOMMENDED PRACTICES

North (58) reported in 1915 on practices in New York in an area in which 71 dairy farmers produced milk that usually had a bacterial count of $<10,000/\text{ml}$. He observed milk almost equal in sanitary character to that from an expensive, sanitary cow stable could be produced in an old and dilapidated barn merely by following a few simple sanitary precautions. In one experiment, 10 farmers who had been producing good-quality milk were taken to 10 farms where the counts were often $>1,000,000/\text{ml}$. The farmers performed one milking in a sanitary manner by using covered pails and sterilized equipment, but no changes were made as to cleanliness of cows or barns. Milk from nine of the 10 farms gave counts of $<10,000/\text{ml}$ when sampled 12 hr later. In 1916, Conn (15) summarized the relationship between farm sanitation and bacterial counts by saying, in effect, that some bacteria will get into milk during milking even under the most ideal conditions but that this number will be extremely small. The initial bacterial count will commonly be $<5,000/\text{ml}$. A good milker will have practically no difficulty in obtaining milk with a bacterial content of $<10,000/\text{ml}$ on practically any sanitary dairy farm.

Prucha and Weeter (62) reported the results of

an experiment at the Illinois Agricultural Experiment Station in 1917. With utensils thoroughly cleaned and sanitized, but with barns ranging from very clean to unclean, 54% of the milk samples had a count of $<10,000/\text{ml}$, and only 14 of the 1,665 samples tested exceeded $50,000/\text{ml}$. They said that the condition of the dairy barn exerted little measurable influence upon the bacterial content of the milk. Prucha, Weeter, and Chambers (63) demonstrated in 1918 that unsterile utensils were largely responsible for excessive bacterial contamination of milk.

Ayers, Cook, and Clemmer (5) reported in 1918 that there are four simple factors necessary for the production of milk with a low bacterial content: sterilized utensils, clean cows with clean udders and teats, small-top pails, and a holding temperature of 10 C or less. Tests were made when only a single factor was varied. The average count of 65 samples of fresh milk produced by observing the essential factors, except washing of udders and teats, was about $4,500/\text{ml}$. When the udder and teats of the cows were washed, the average count of 65 milk samples was approximately $2,200/\text{ml}$. In 1921, Harding et al. (28) reported that the increase in bacterial count resulting from dirt entering the milk varied widely with the nature of the dirt. They found that hair and dandruff from clean cows had much less effect upon the bacterial count than did dirt from extremely dirty cows. Under the worst conditions, when dirt in the milk amounted to 10.8 mg/quart , the increase in bacterial count of the milk was about $17,000/\text{ml}$. Covington et al. (16), in 1952, conducted a study on 171 farms to determine the influence of various factors related to production of high-quality milk. Their preliminary statistical analyses indicated that factors concerned with milking methods and sanitation were of more significance in production of high-quality milk than were factors related to buildings or equipment. Thomas (71) published, in 1937, the data on the bacterial content of milk from 12 dairy farms sampled over a 10-year period and found that, of a total of 870 samples examined, 87% met the prescribed maximum standards of $30,000/\text{ml}$ for certified milk and $200,000/\text{ml}$ for grade-A milk. During winter and spring, bacterial counts under $10,000/\text{ml}$ were recorded for 63% of the samples, even though samples were stored at 15.5 C for 28 hr before being tested. Griffiths, Druce, and Thomas (27), in 1959, as a result of a 5-year study in Wales, concluded that milk produced and handled under hygienic conditions could be expected to have colony counts of $<20,000/\text{ml}$.

The foregoing review of literature shows that no single bacterial test by itself can reflect the conditions of production of milk and that low-count milk can be produced under poor conditions if proper sanitary

practices are used in the handling of milk.

Importance of clean equipment

There is general agreement that improperly cleaned and sanitized milk-contact surfaces are a significant source of bacterial contamination as can be seen in the following reports: Springstead (69); Prucha and Weeter (62); Ayers et al. (5); Prucha et al. (63); and Smillie, Orr, and McLarty (68). It is recognized that high thermophilic bacterial counts are caused by consistent failure to clean and sanitize milk-contact surfaces (2, 8, 54, 56, 73, 74). Murray (56); and Bird, Egdell, and Thomas (8) emphasized that thermophilic flora development on equipment reflected several weeks of negligence in cleaning and sanitizing. Maack and Prucha (49) found that heat-resistant organisms also were resistant to chlorine disinfection.

Johns and McClure (40) called attention to the fact that the contribution of a contaminated surface to the count of a milk supply is concealed because the microorganisms are diluted in a large volume of milk. Among the surfaces that milk contacts, the milking machine is the single most important item. White (78) pointed out in 1962 that it is often difficult to keep the elastic parts of a milking machine in excellent condition because of the mutual solubility of the elastomers with fat. The elastomers also may be vulnerable to light, oxygen, ozone, abrasion, and other chemical and physical agents. Claydon (13, 14) compared new inflations against used inflations in reasonably good physical condition but having microscopic breakdown. His studies showed that milk from units equipped with used liners sometimes had considerably higher counts than milk from new-liner units. Griffiths and Thomas (26) obtained higher counts on rinsings from rubber parts than on rinsings from metal parts. Johns (35) determined that there was a significant relationship between utensil sanitation and growth during preliminary incubation (PI).

In 1928, Holford (30) reported that 94% of 73 milk samples collected from a milking machine that received, successively, a cold-water rinse, a hot-alkaline rinse, and a hot-water rinse gave a bacterial count of $<10,000/\text{ml}$. After the rinses, the teat cups and rubber parts were immersed in a chloride of lime solution. The machines were disassembled once every 6 weeks. Watrous, Kesler, and Atherton (77), 1955, compared four washing and sanitizing methods for milking machines. An adequate washing procedure with a proper alkaline detergent, coupled with dry storage and a warm-water rinse before use, was as satisfactory as chlorine sanitizing or the use of a quaternary ammonium detergent-sanitizer or "lye rack" storage. When equipment is thoroughly clean-

ed and stored dry, there is little opportunity for bacterial development.

Deviations from recommended production procedures

In a survey conducted in 1949 on a relatively large number of dairy farms, Abele (1) observed that the average annual consumption of dairy washing compound was 14 lb. per farm. This amounted to 30% of the minimum amount required for a farm producing 30 gal of milk a day. Since an average farm would produce more milk than this, many of the producers used considerably less than the required amount of detergent.

Atherton (4) reported on a field study, conducted in 1959, of the sanitary care of milking equipment. The survey consisted of visual and (or) "blacklight" inspection of all milk-contact surfaces in milkhouses to determine physical condition and cleanliness. He observed milkstone buildup in most tanks and milking utensils. Few farmers had the basic needs to conduct a proper sanitation program, and cleaning equipment was, for the most part, inadequate, in poor condition, or inconvenient to use. None of the farms had the brushes or burrs necessary to clean all milk-contact surfaces. Few farmers regularly cleaned vacuum lines in the barn or boiled rubber parts in lye. Many cleaning and sanitizing compounds were used without regard to their specific purposes.

Charity, Altman, and Belknap (12) compared the cooling performances of 58 farm bulk-milk tanks in 1961. Approximately 20% of the tanks failed to properly cool milk to 4.4 C. For the second milkings, 35% of the direct-expansion and 23% of the ice-bank tanks permitted the milk to exceed a 10 C blend temperature.

Fryman and Albright (25) observed milking practices and the condition of milking machines on 60 dairy herds in the east-central St. Louis and Chicago milksheds before 1962. Over half the farms visited did not have adequate vacuum reserve to operate the milking machines satisfactorily. Faulty vacuum control valves were found on 40% of the farms, and 49% of the pulsators checked were not operating efficiently. Trying to operate too many units, priming too long before the machines were put on the cows, and keeping cows in stalls too small were the most serious problems observed in milking practices and management.

Randolph, Langlois, and Conner (64), in 1966, studied the temperature of bulk-tank milk at the time of pick-up from 534 grade-A producers. Temperatures of the milk ranged from 0 to 12.8 C, with butterfat particles and ice formations in approximately 8% and 2% of the tanks. About 6% of the bulk-tank thermometers were either broken or out of order. Readings of about 20% of them did not check within 1.7 C; approximately 50% did not check within 0.56

of a "test thermometer." Most bulk tank haulers did not carry or use a "test thermometer" to check the temperature of the milk.

Olsen (60), 1967, believed that more than 95% of the sanitary inspections of dairy farms are made at other than milking-time, except at the large farms that milk up to 20 hr per day. He discussed the disadvantages of this method.

Surveys of procedures, equipment, and use of cleaning and sanitizing chemicals on dairy farms reveal that there are many deviations from recommendations. Such departures from common practice arise primarily from oversight or negligence.

FARM RAW MILK QUALITY

Leucocyte content of milk

Hucker (31), 1942, observed leucocyte counts of <100,000/ml for 68% of 30,331 milk samples from 8,000 cows. Anderson (3), in 1948, reported that the average arithmetic cell count of 19,710 samples from 18 mastitis-free cows over complete lactation periods was 160,000/ml. For cows chronically infected with staphylococci and streptococci (other than *Streptococcus agalactiae*), the average cell count was 380,000/ml and 220,000/ml. MacLeod and Anderson (50), 1952, found that the geometric average cell count of milk from healthy cows, beginning with the second week through the forty-first week after calving was approximately 70,000 cells/ml. MacLeod et al. (52), 1953, studied the relationship between the leucocyte count of herd milk and the incidence of mastitis within the herd. MacLeod, Anderson, and Plastridge (51), 1954, reported that the logarithmic mean leucocyte count of herd milk was 5.67 for an 11.5-month period in Connecticut, which corresponds to a geometric mean count of 470,000/ml.

These reports call for caution in the interpretations of leucocyte counts in milk and the need for supporting tests to establish any pathogenic significance in the herd.

Grade-A raw milk quality

Less than half of the raw milk of eight U.S. cities studied by Dahlberg et al. (18) complied with the 200,000/ml standard. Atherton (4), in 1959, supervised an experiment in which experiment station workers and chemical-company representatives visited 25 farms to inspect and correct sanitary violations. Farmers were supplied with necessary cleaning equipment and chemicals and were instructed as to proper use. Of 108 analyses of milk samples from the 25 farms, 28% were <10,000/ml, and 82% were <50,000/ml. Only three of the counts exceeded 100,000/ml. Counts were much smaller after the sanitary violations were corrected. From their survey of bulk milk for interstate shipment, Brazis and Black (10),

in 1962, found that only 4% of the samples had counts exceeding 200,000/ml. The bacterial counts of raw milk produced at most farms averaged <30,000/ml. Of 4,271 samples collected from 1,571 sources (milk cans, farm bulk tanks, pick-up trucks, storage vats, transport trucks, and storage tanks) 98% had counts under 200,000/ml. Olson (61) reported in 1962 that an examination of producers' records in numerous markets showed that it was not uncommon to find 50% of the farmers consistently producing milk below 10,000/ml and 90% or more below 50,000/ml. In 1966, Ohri and Slatter (59) reported on an 8-month survey of the bacterial quality of bulk-tank-produced fluid-milk supplies for four major markets in Ohio. Counts of 13% of the samples exceeded 200,000/ml. Thirty-seven per cent of the samples had Standard Plate Counts of >50,000/ml, and 31% of the samples had Standard Plate Counts of <10,000/ml.

It seems obvious from these findings that bacteriological standards of 100,000/ml for individual producer milk and 300,000/ml for pooled milk before pasteurization are not at all stringent. The frequent occurrence of production violations associated with seemingly acceptable bacterial-test results reveal that testing procedures are not adequate to detect unsanitary production practices (4, 11, 17, 35, 33, 37, 38, 41, 61, 65).

Manufacturing-grade milk quality

A survey of manufacturing-grade milk bacterial quality reveals that many of the reported bacterial counts are very high. LaGrange and Nelson (47) reported that the psychrophilic bacterial count of manufacturing-grade bulk-tank milk was nearly as large as the Standard Plate Count—and sometimes greatly exceeded it. Forest (24) surveyed 56 manufacturing-grade milk plants before 1960 and found that counts ranged from approximately 500,000/ml to well over 200,000,000/ml. LaGrange and Nelson (48), 1961, observed that the Standard Plate Count of 37.7% of 701 bulk-tank manufacturing-grade samples exceeded 1,000,000/ml; 37.2% had Standard Plate Counts of <200,000/ml. Though the barn conditions on manufacturing-grade farms are not as desirable as those on grade-A farms, reports show that the barn conditions make only a small contribution to the bacterial count. The cleanliness and sanitation of milk-contact surfaces usually are responsible for the major contribution of bacteria. Since much of our manufacturing-grade milk is now adequately cooled, the high counts indicate that there are serious lapses in cleaning and sanitizing milk-contact surfaces. The long storage time to which some manufacturing-grade milk is subjected compounds the effects of the negligent cleaning and sanitizing. High psychrophilic counts found in many manufacturing-grade milk supplies support this conclusion.

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RESEARCH ON RANCIDITY

Research aimed at determining effect of other food components in fats and oil becoming rancid was discussed recently by a Montana State University professor.

A. M. El-Negoumy, agriculture production utilization professor, noted changes causing fats and oils used in food to go rancid causes annual losses of millions of dollars.

His research on effects of L-cysteine, whole casein, K-casein, NDGA and alpha-tocopherol on the oxidative behavior of some milk lipid fractions in model systems covered one phase of work conducted during several years.

Pure fat usually is separated from other components of a

food product for investigation, El-Negoumy said. Because other components of food influence the extent of deterioration, MSU laboratory research is directed toward investigation of such changes in "Model Systems." They contain known concentrations of such components as sugars, proteins, minerals, enzymes, vitamins, etc.

The main objective, El-Negoumy said, is to establish the role of other components in the major flavor problem in terms of concentration and physical form. Means of preventing the destruction of important nutritional components (vitamins, and essential amino acid and fatty acids) through oxidative deterioration of fats also is of interest, he said.

MULTIPLICATION OF *SALMONELLA TYPHIMURIUM* IN SKIMMILK WITH AND WITHOUT ADDED HYDROCHLORIC, LACTIC, AND CITRIC ACIDS¹

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ABSTRACT

Cells of *Salmonella typhimurium* grown in nutrient broth at 37 C were inoculated into samples of sterile skim milk (approximately 10^8 cells per ml) which were then acidified with hydrochloric, lactic, or citric acids and incubated at 22 and 37 C. Acids were added at 2-hr intervals in uniform increments sufficient to reduce the pH from 6.70 to 4.0 (hydrochloric acid), 4.25 (lactic acid), or 4.48 (citric acid). Samples taken at 4-hr intervals were plated, and plates incubated at 37 C for 24 hr. At 37 C, maximum numbers (10^9 cells per ml) were attained after 12 hr, whereas maximum numbers ($>10^8$ cells per ml) in acidified milks appeared after 16 hr of incubation. Citric acid was most inhibitory and was followed in order by lactic and hydrochloric acids. At 22 C, highest numbers appeared in all milks after 16 hr of incubation. Again, citric acid proved most inhibitory, and it was followed in order by lactic and hydrochloric acids.

The heat treatment given to milk during pasteurization is adequate to destroy salmonellae (9). Pasteurized milk can, however, become recontaminated with salmonellae before it is consumed or used in the manufacture of a dairy product. Reports in the literature indicate that food poisoning outbreaks have resulted from consumption of pasteurized milk contaminated with *Salmonella typhimurium* (10), *Salmonella dublin* (6), *Salmonella typhi* (11), and *Salmonella paratyphi* (13, 15). Although these contaminants could enter from a variety of sources, persons ill with salmonellosis or carriers have frequently served to infect the milk (11, 15). Other sources include equipment (6, 10) and water (13).

Destruction of salmonellae in cultured dairy products and by mineral and organic acids has been discussed in recent reviews by Marth (2, 3). Although limited attention has been devoted to the development of salmonellae in milk during the fermentation associated with some cultured products (16), no information is available on the behavior of salmonellae in milks acidified gradually by the direct addition of acids. Reliance on bacteria for acid production in such investigations is complicated by the tendency

of some starters to produce antibiotic substances in addition to acid (4, 5, 7, 14). Hence, experiments described in this paper were designed to determine (a) the growth pattern of *S. typhimurium* in milk at the organism's optimum temperature (37 C) and at the temperature often employed in dairy fermentations (22 C) and (b) how that growth pattern is modified by the addition to milk of small increments of acid over a period of time in a manner somewhat comparable to liberation of acid by a starter culture. A preliminary report of this work has been presented (12).

METHODS

Preparation and inoculation of skim milk

Raw skim milk obtained from the University of Wisconsin dairy plant was divided into lots of 200 ml each which were placed into 500 ml Erlenmeyer flasks. Each flask was supplied with a magnetic stirring bar, was plugged with cotton, and the contents sterilized in an autoclave at 121 C for 15 min. Milks were cooled immediately to 7 C and held at that temperature until they were warmed to 22 or 37 C prior to inoculation.

Cells of *S. typhimurium* (culture supplied by Dr. J. M. Goepfert, Food Research Institute, University of Wisconsin) grown in nutrient broth at 37 C for 24 hr were used to inoculate warmed milks. Sufficient culture was added to provide an initial concentration of salmonellae in the range of 3,000 to 5,000 cells per ml of milk. Inoculated milks were incubated at 22 or 37 C and were stirred continuously with magnetic stirrers. Insulating pads were placed between the flasks and the magnetic stirrer bases to prevent transfer of heat from the stirrer to the milk.

Addition of acids and sampling

Two hours after inoculation, addition of acid was begun. Hydrochloric, lactic, and citric acids were chosen for these experiments since they can occur in some dairy products as a result of either fermentation or direct addition. The acids were prepared at a concentration of 6N and were added to the inoculated milks in small but regular increments at 2-hr intervals during a 16-hr incubation period.

The pH values attained at 2, 4, 6, 8, 10, 12, 14, and 16 hr, when hydrochloric acid was used, were 6.52, 6.12, 5.48, 5.12, 4.70, 4.47, 4.20, and 4.00, respectively. Values at 4-hr intervals are recorded on the abscissa of Fig. 1. Use of lactic acid was accompanied by pH values of 6.52, 6.10, 5.70, 5.05, 4.82, 4.60, 4.40, and 4.25 at intervals of 2, 4, 6, 8, 10, 12, 14,

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

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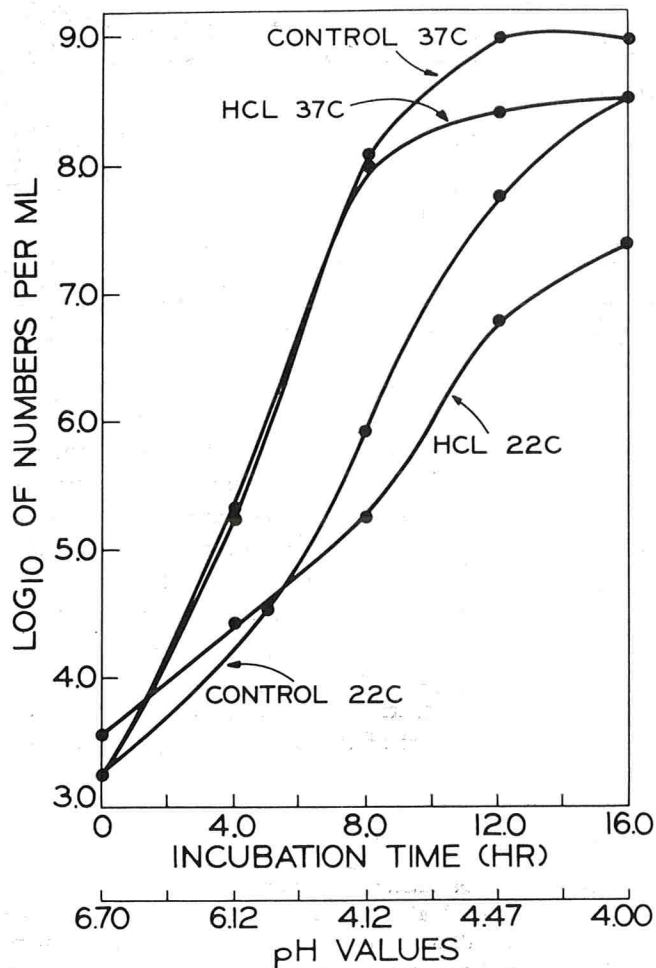


Figure 1. Growth of *Salmonella typhimurium* in skim milks with and without added hydrochloric acid.

and 16 hr, respectively. Fig. 2 lists the pH values at 4-hr intervals. Citric acid was added so that pH values of 6.52, 6.08, 5.70, 5.35, 4.96, 4.70, 4.55, and 4.48 were obtained at the same time intervals previously listed. The pH values noted at 4-hr intervals are reported in Fig. 3.

To determine changes in numbers of salmonellae, samples of milks were taken at 4-hr intervals (with one exception) and were plated using Plate Count Agar (Difco). After incubation at 37 C for 24 hr, plates were counted in the usual manner.

RESULTS AND DISCUSSION

Growth in untreated sterile skim milk

Data are recorded in Fig. 1 on the growth of *S. typhimurium* in untreated sterile skim milks. It can be observed that at 37 C nearly 1×10^9 cells per ml were attained in 12 hr with little apparent additional growth during the last 4 hr of incubation. In contrast to this, at 22 C slightly more than 1.0×10^8 cells per ml appeared after 16 hr of incubation. Although a comparison of data obtained at 12 and 16 hr during incubation at 22 C suggests a diminution of the growth rate, undoubtedly higher numbers than

recorded would have been attained by extending the incubation period beyond 16 hr.

Effect of added hydrochloric acid

The effect of added hydrochloric acid on growth of *S. typhimurium* is also reported in Fig. 1. At 37 C, when compared to the control, no appreciable difference in multiplication was noted until after 8 hr of incubation when the pH value was 5.12. Little additional growth was observed nor could a decline in population be detected during the second 8-hr period of incubation. In spite of limited inhibition by added acid, more than 1×10^8 cells per ml were present after 16 hr at 37 C.

Incubation at 22 C, when hydrochloric acid was added, resulted in a marked reduction in the growth rate of *S. typhimurium*. After 16 hr, slightly more than 1.0×10^7 cells per ml were observed. It is possible that further multiplication would have occurred if the incubation period had been extended, since the maximum stationary growth phase had not yet appeared.

The results described above are in good agreement with those of Levine and Fellers (1), who reported

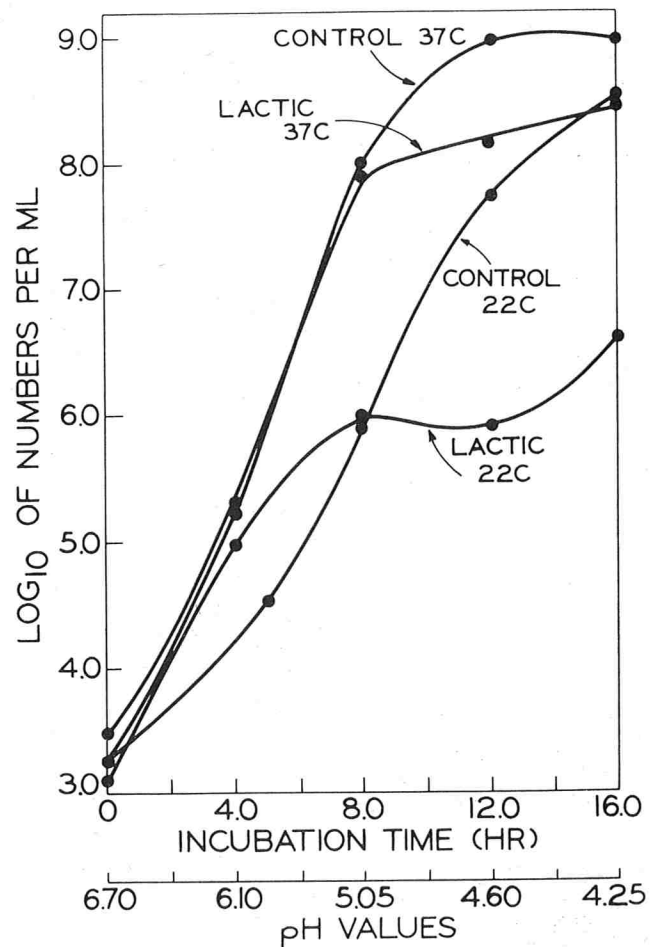


Figure 2. Growth of *Salmonella typhimurium* in skim milks with and without added lactic acid.

that growth of *Salmonella aertrycke* in broth was not inhibited by hydrochloric acid until sufficient acid to obtain a pH value of 4.0 was added. The toxic effect on bacteria of highly dissociated mineral acids has been attributed to the number of free hydrogen ions per unit volume (8).

Effect of added lactic acid

Fig. 2 presents data on the growth of *S. typhimurium* when milk was acidified with lactic acid. At 37 C, behavior of the organisms was similar to that observed at the same temperature when hydrochloric acid was added to milk. The inhibitory effect of lactic acid at 22 C was much greater than that observed with hydrochloric acid at the same temperature. The rate of multiplication in the acidified milk at 22 C appeared to be stimulated initially and was reduced after only 4 hr of incubation when the pH value was 6.10. Data presented here are insufficient to prove conclusively that growth of *S. typhimurium* was stimulated by low concentrations of lactic acid. It does, however, raise the question, and additional work is needed to provide the answer. A further reduction was noted between the fourth and eighth hour of incubation, and a virtual cessation of growth occurred during the next 4-hr period. An increase in number of cells was observed during the final 4-hr period of incubation. According to Levine and Fellers (1), growth of *S. aertrycke* in broth was not inhibited by lactic acid until enough was added to attain a pH value of 4.0. The toxic effect of organic acids is not solely associated with the number of free hydrogen ions in solution, but is related to the whole molecule and is specific for each acid (8).

Effect of added citric acid

The behavior of *S. typhimurium* in the presence of increasing amounts of citric acid is shown in Fig. 3. The growth pattern of the organism at 37 C was similar to those observed earlier with added hydrochloric and lactic acids at the same temperature. It should be pointed out that, although the growth patterns at 37 C were similar regardless of the acid employed, slight differences did exist. Progressively lower numbers were observed after 8 hr of incubation when lactic and citric acids replaced hydrochloric acid.

Of those acids tested, citric acid was associated with the greatest inhibitory effect during the early stages of the incubation period at 22 C. Most of the increase in number of cells occurred during the interval between the eighth and twelfth hour of incubation. This was followed by virtual cessation of cell proliferation during the final 4-hr period. At 22 C, lactic acid was intermediate in its effect, and hydrochloric acid was the least inhibitory of those

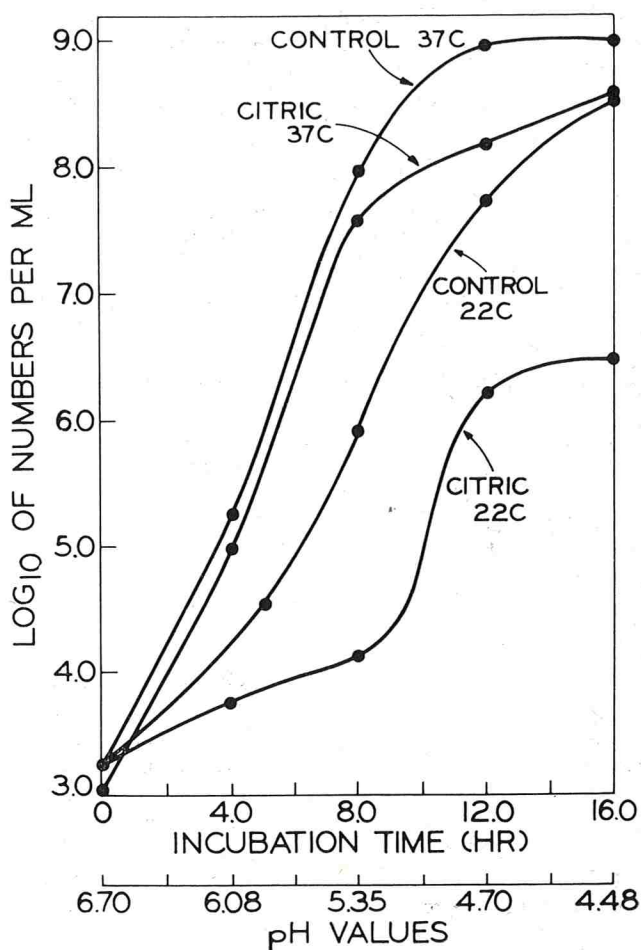


Figure 3. Growth of *Salmonella typhimurium* in skim milk with and without added citric acid.

acids tested.

It is difficult to compare the results of the present investigation with those of most others that deal with the effect of acids on bacteria because the acids were added to the substrate in a different way than in other experiments. Nevertheless, Porter (8) cites data which suggest some similarity between *Pseudomonas fluorescens* and *S. typhimurium* in their reaction to organic acids. It was reported that the pseudomonad was inhibited by lactic acid at a pH value of 4.65 and by citric acid at a pH value of 4.43.

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GROWTH OF LACTIC ACID BACTERIA

The amount of growth attainable by certain lactic acid bacteria can be greatly increased by maintaining the pH of the growth medium at a level favorable for growth, according to S. E. Gilliland and M. L. Speck, Department of Food Science, North Carolina State University, Raleigh, N. C.

When developing the production of concentrated suspensions of lactic streptococci (culture concentrates) for the direct inoculation of cultured dairy products, it is desirable to grow the cultures to as high a population as possible prior to preparing the concentrated suspension. Limitations to the population attainable may result from the accumulation of metabolic end products in a growing bacterial culture, which can result in cessation of growth. It is well known that acid products formed during fermentation by many lactic acid bacteria lower the pH of the growth medium sufficiently to limit growth.

This study was undertaken in an effort to learn more about metabolites other than acid products produced by lactic streptococci when grown at controlled pH and their effects on growth of the streptococci. A ninhydrin positive zone isolated by paper chromatography from the spent broth of a mixed strain lactic streptococcus culture which had been grown with automatic pH control was found to be inhibitory to the culture. The autoinhibitor was stable to acid hydrolysis which indicated that a peptide was not responsible. Thin layer chromatographic studies of the inhibitor and known amino acids indicated the inhibitor was leucine. Experiments in which the effects of leucine on growth were studied indicated L-leucine was not inhibitory while D-leucine was at concentrations as low as 1 mg/ml, indicating the auto-inhibitor to be D-leucine.

FIFTY-FIFTH ANNUAL MEETING OF IAMFES

St. Louis, Missouri
August 18-22, 1968

The Missouri Association of Milk and Food Sanitarians hosted the 55th annual meeting of IAMFES which was held at the Chase-Park Plaza Hotel, St. Louis, Missouri, on August 18-22, 1968. Approximately 370 members and guests were registered. The meeting was well organized and presented numerous opportunities for professional growth and for sociability.

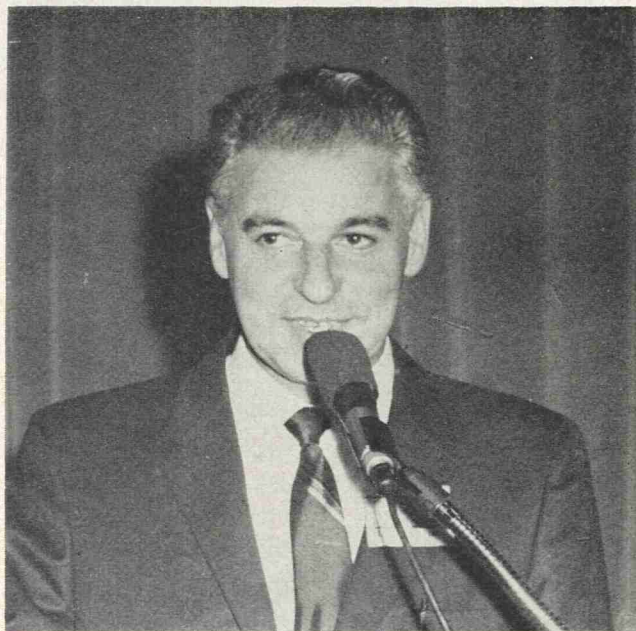
EXECUTIVE BOARD MEETINGS

The IAMFES Executive Board sessions began on Sunday afternoon. An item of major importance considered by the board was reaction of NAS to the seventh draft of the constitution and by-laws devised by the ad hoc committees of the IAMFES and NAS to serve as a basis for amalgamation of the two organizations. Mr. Nicholas Pohlit of NAS explained the action of their Executive Board and suggested that progress was still possible. The Board heard reports on the National Mastitis Council and extension of 3-A Sanitary Standards to equipment used by non-dairy segments of the food industry.

The Editor of the Journal and the Journal Management Committee also reported. The latter recommended institution of a page charge for publication of research papers in the Journal. The Board adopted this recommendation.



Dr. J. Earl Smith, St. Louis Health Commissioner, welcomes IAMFES members and guests to the 55th annual meeting.



Dr. A. N. Myhr gives the presidential address at the opening session of the 55th annual IAMFES meeting.

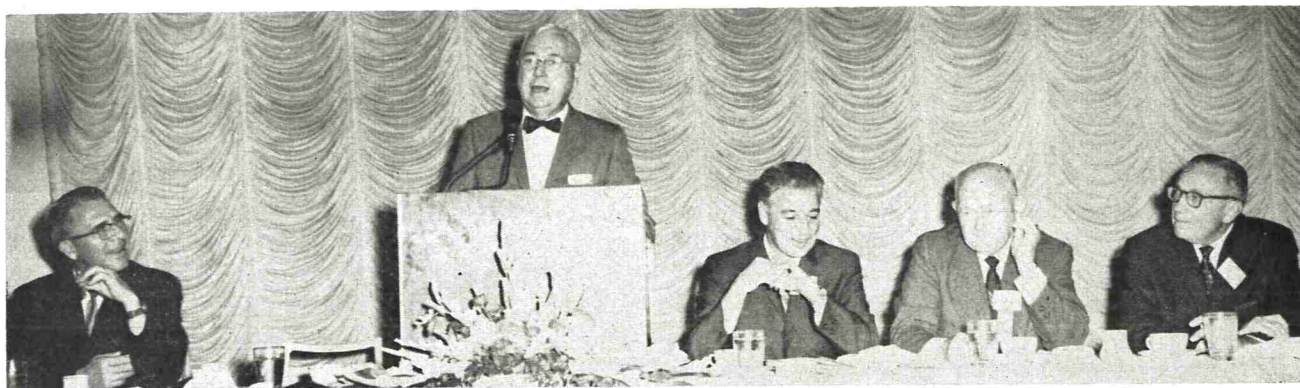
AFFILIATE COUNCIL MEETING

The Affiliate Council meeting was held on Monday evening, August 19, with 17 of 26 affiliate organizations represented. The respective secretaries represented 10 affiliate associations, whereas the other 7 were represented by the president or another designated delegate.

Following a welcome by the president of the Missouri Association of Milk and Food Sanitarians, the opening discussions centered around the present objectives of the Council. The Editor of the *Journal of Milk and Food Technology* advised that the Journal Management Committee would like to devote a page or two each month to activities of affiliates. This will require a more organized and regular reporting of such activities than has been done in the past.

President Myhr reported on developments during the past year regarding the hoped-for emergence of a new and unified sanitarian's organization. His disappointing report on the present state of negotiations resulted in delaying of any effort to develop guidelines to aid Affiliates in consolidation with counterpart NAS organizations at the state or regional levels.

The Council also: (a) requested that each Affiliate be furnished a copy of the latest draft of the proposed by-laws as developed by the ad hoc committees of IAMFES and NAS, (b) recommended that



Dr. E. R. Price presides at the annual banquet.

Affiliates develop suitable "speaker pools" from their membership, (c) requested that the Council Chairman be appointed to the program committee for the annual meeting, and (d) requested the Executive Board to provide Affiliates with summaries of the Board's meetings and activities as soon as possible.

New Affiliate Council officers chosen to serve for the coming year are: Mr. Ben Luce (Washington), Chairman and Dr. L. Wayne Brown (Wisconsin), Secretary.

ANNUAL MEETING

The annual business meeting was called to order by President A. N. Myhr on Wednesday morning, August 21, 1968. Assembled members heard reports from H. L. Thomasson on his activities as executive secretary and on the financial condition of the association. Representatives from the following association committees also gave reports: Dairy Farm Methods, Sanitary Procedures, Food Protection, Bak-

ing Industry, Frozen Food Sanitation, Communicable Diseases Affecting Man, Food Equipment Sanitary Standards, Applied Laboratory Methods, Professional and Educational Development, 3-A Symbol Council, and Inter-Association Cooperation. These reports will appear in the Journal as space becomes available.

It was announced that O. M. Osten (Minnesota) was elected as Second Vice-President and Roy Fairbanks (Illinois) as Secretary-Treasurer.

Resolutions adopted by the membership at the annual meeting are recorded below.

Resolution No. 1

WHEREAS: The 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians was held in St. Louis, Missouri, August 18-22, 1968 in the Chase-Park Plaza Hotel at the invitation of the Missouri Affiliate; and

WHEREAS: The Local Arrangements Committee of the Affiliate provided excellent facilities in the conduct of the meeting;

THEREFORE BE IT RESOLVED: That the Association extend its sincere appreciation to the Missouri Affiliate of



The new IAMFES Executive Board. Left to right: H. L. Thomasson, Executive Secretary; Roy Fairbanks, Secretary-Treasurer; S. O. Noles, President; D. B. Whitehead, First Vice-President; A. N. Myhr, Junior Past-President; O. Osten, Second Vice-President; and M. E. Held, President-Elect.

the International Association of Milk, Food, and Environmental Sanitarians and that the Secretary be instructed to transmit this resolution to the President of the Missouri Affiliate.

Resolution No. 2

WHEREAS: IAMFES has been engaged in negotiations through an ad hoc committee with a similar committee from NAS; and

WHEREAS: This committee has developed a tentative set of by-laws for a new organization; and

WHEREAS: These tentative by-laws and the intent and status of this endeavor has been discussed by means of the presidential address at the 55th Annual Meeting of the IAMFES;

THEREFORE BE IT RESOLVED: That the Association at its 55th Annual Meeting, assembled, reiterate its endorsement of the amalgamation plan and direct the Executive Board to maintain an open-door attitude to the continuance of the effort by the two organizations to develop a set of by-laws to be presented for approval by members of IAMFES.

Resolution No. 3

WHEREAS: There is at present no job description of the Sanitarian generally accepted by the profession, by other public health disciplines, by agencies or industry employing sanitarians, or by the public; and

WHEREAS: A generally accepted job description is essential to the identification, consolidation, recognition, and furtherance of any profession; and

WHEREAS: The attached job description developed by professional sanitarians and published in the Dictionary of Occupational Titles issued by the U. S. Department of Labor is being accepted and widely used in all levels of government and by industry;

THEREFORE BE IT RESOLVED: That the job description of the Sanitarian published in Dictionary of Occupational Titles, 1965, Volume I Third Edition-Professional 079.118, U. S. Department of Labor, be adopted by the International Association of Milk, Food, and Environmental Sanitarians as its official statement of job description of the Sanitarian; and

BE IT FURTHER RESOLVED: That this job description be identified and publicized by the International Association of Milk, Food, and Environmental Sanitarians as the official statement of identification of the Sanitarian by so stating and



S. O. Noles, new IAMFES President, receives the gavel from William V. Hickey.



Problems are discussed in the hallway between sessions at the annual meeting.



Ladies gathered in the hospitality room before proceeding on tours of St. Louis.

publishing in the Journal of the Association and other suitable media.

Job description for Sanitarian (from publication listed above)

Plans, develops, and executes environmental health programs. Organizes and conducts training program in environmental health practices for schools and other groups. Determines and sets health and sanitation standards and enforces regulations concerned with food processing and serving, collection and disposal of solid wastes, sewage treatment and disposal, plumbing, vector control, recreational areas, hospitals, and other institutions, noise, ventilation, air pollution, radiation and other areas. Confers with Government, Community, Industrial, Civil Defense, and private organizations to interpret and promote environmental health programs. Collaborates with other health personnel in epidemiological investigations and control. Advises civic and other officials in development of environmental health laws and regulations.

ANNUAL BANQUET

Members and guests attended a cocktail party hosted by the Local Arrangements Committee before participating in the annual banquet on Wednesday evening, August 21, 1968. Dr. E. R. Price served as master of ceremonies and banjoist Joe Schirmer provided entertainment.

The Sanitarian's Award and accompanying check for \$1000 was awarded to Mr. Roy T. Olson of Spokane, Washington. A. K. "Kelly" Saunders received the Association's Citation Award in recognition of his outstanding contributions to furthering the aims of the IAMFES.

Honorary life memberships were awarded to Dr. M. P. Baker, retired member of the Department of Dairy and Food Industry, Iowa State University and to Dr. W. C. Frazier retired member of the Department of Bacteriology, University of Wisconsin.

Editor's Note: Biographical sketches of R. T. Olson and A. K. Saunders, recipients of the Sanitarian's and Citation Awards, respectfully, will appear in a future issue of the Journal.



The past-president's award goes to Dr. P. R. Elliker. F. E. Uetz (left) presents the plaque to Art Parker who accepted it for Dr. Elliker.

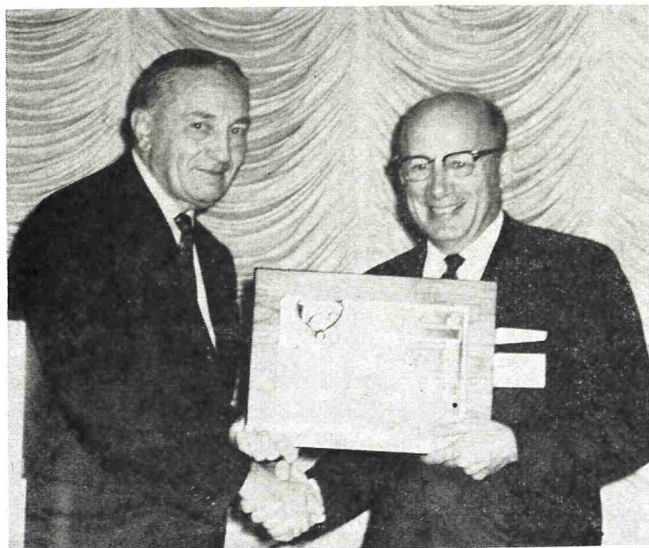


Roy T. Olson (right), recipient of the 1968 Sanitarian Award, receives the plaque and check from F. E. Uetz.



A. K. "Kelly" Saunders (right), recipient of the 1968 Citation Award, receives the plaque from F. E. Uetz.

HONORARY LIFE MEMBERSHIPS GO TO M. P. BAKER AND W. C. FRAZIER



Honorary life membership was awarded to Dr. M. P. Baker. F. E. Uetz (left) presents a plaque to Ray Belknap, who accepts it on Dr. Baker's behalf.

The Executive Board voted to recommend and the members of IAMFES voted to bestow Honorary Life Membership on two persons who made substantial contributions to progress in the production of high quality and safe foods. Recipients of this award in 1968 were Drs. M. P. Baker and W. C. Frazier.

DR. M. P. BAKER

Dr. M. P. Baker was born in 1899 in Marengo, Iowa. He graduated from high school in Toledo, Iowa and later attended Iowa State University where he received the B.S., M.S., and Ph.D. degrees, the latter in 1931. Since then he was, with the exception of two brief intervals, a member of the Iowa State University faculty. He retired as Professor of Dairy and Food Industry in 1964. From 1933 to 1935 he was on the staff of the Wisconsin Alumni Research Foundation and in 1944 and 1945 he worked as field representative of Sealtest Corporation.

At Iowa State University Dr. Baker taught courses in dairy bacteriology and milk sanitation. The latter was his particular interest, not just as an academic subject but as a meaningful application to milk handling and processing and to protection of the public health. Many students have learned the principles and practices of milk sanitation from Dr. Baker and many milk sanitarians and plant managers have received his counsel and advice.

From 1947 to 1950 Dr. Baker was chairman of the International Association of Milk and Food Sanitarians' Committee on Farm Methods and he served for

many years as associate editor of the *Journal of Milk and Food Technology*.

In addition to teaching and doing research at Iowa State University Dr. Baker also served as student counselor. A large number of students have benefited from his personal counsel and guidance during their college years. He has been faculty advisor to the Dairy Industry Club and to Sigma Chi Fraternity at Iowa State University.

DR. W. C. FRAZIER

Dr. William C. Frazier was born in 1895 in Madison, Wisconsin. He and his family moved to Milwaukee, but later returned to Madison where he graduated from the University of Wisconsin, in 1917, with the B.S. degree in agricultural bacteriology. After service with the 32nd Division of the U. S. Army in France during World War I, Frazier returned to the University of Wisconsin and completed work for his Ph.D. degree (bacteriology and chemistry) in 1924. From 1924 to 1934, he worked in Washington, D. C. with the Bureau of Dairy Industry in the U. S. Department of Agriculture. While with the U. S. D. A. Frazier authored a portion of *Fundamentals of Dairy Science*. Frazier returned to the University of Wisconsin in 1934 and remained there as Professor of Bacteriology until his retirement in 1966. In addition to his duties as a professor, Dr. Frazier also served as acting chairman of the Bacteriology Department for three years and as chairman for 10 years.



Dr. W. C. Frazier, new IAMFES Honorary Life Member.



Honorary life membership was awarded to Dr. W. C. Frazier. F. E. Uetz (left) presents a plaque to Dr. E. H. Marth, who accepts it on Dr. Frazier's behalf.

Frazier taught both dairy bacteriology and food bacteriology to countless students, many of whom are now IAMFES members. In addition, he advised

30 Ph.D. students (including two past-presidents of IAMFES and the present editor of the journal) and 40 M. S. students. His laboratory manuals (coauthored with several colleagues) and his textbook, *Food Microbiology*, have been used by many workers in the food industry when they received their training. The second edition of his textbook was published in 1967.

Frazier's research record includes work on the bacteriology of Swiss and brick cheese, characteristics of high temperature starter cultures, bacteriology of milk produced with the aid of bulk cooling tanks, bacteriology of milk produced with loose housing of dairy cattle, effect of every-other-day pick-up on raw milk quality, cleaning and sanitizing of farm milk-pipelines, sterile concentrated milk, and on competition and moisture requirements of bacteria associated with foods. Results of research conducted or supervised by Frazier led to the publication of approximately 90 papers, many of which appeared in the *Journal of Milk and Food Technology*.

ASSOCIATION AFFAIRS

REPORT OF THE EDITOR, JOURNAL OF MILK AND FOOD TECHNOLOGY, 1967-1968

Approximately one year ago the undersigned assumed the editorship of the *Journal of Milk and Food Technology*. The transition from one editor to another was quite smooth, primarily because Dr. J. C. Olson, Jr. provided adequate and expert counsel and guidance to the present editor. It was possible to meet with Dr. Olson in Eau Claire, Wisconsin and again at the 1967 IAMFES meeting. Transfer of materials related to the journal took place at both of these sessions. The undersigned assumed complete responsibility as editor in October, 1967.

REVIEW OF VOLUME THIRTY

Publication of the December, 1967 issue of the journal completed volume 30. This volume contained 388 pages (not counting advertising and covers) of which 137 pages, or 35.3%, were devoted to the publication of 30 papers reporting results of original research. Another 47 pages, or 12.1% of the total pages, were devoted to 11 technical articles of general interest. Some of these were papers given at 1966 and 1967 annual meetings, whereas others were submitted. Twenty-three non-technical articles of general interest occupied 72 pages or 18.5% of the entire volume. General interest papers, technical and non-technical, comprised 119 pages or 30.6% of the volume. Sixty-four pages or 16.4% of the volume were devoted to association affairs and news and events occupied another 51 pages or 13.2% of the volume. Association affairs and news and events combined occupied 115 pages or 29.6% of the volume. The technical portion of volume 30 consisted of 184 pages, whereas 187 pages were devoted

to non-technical materials. During 1967 a total of 64 technical and non-technical articles were published.

Research papers dealt with a variety of subjects including fecal streptococci, mastitis, microbiology of milk and milk products, test procedures, microbiology of meat and fish products, action of cleaners, and cleanliness of milk contact surfaces.

General interest papers discussed such subjects as abnormal milk, automatic dishwashing, processing plant and food-service industry sanitation, standards for milk, mycotoxins, public health laboratories, management, microbial standards, 3-A standards, and sanitation in space exploration.

PRESENT STATUS OF VOLUME THIRTY-ONE

A complete review of the first six issues of volume 31 will not be presented at this time. Instead, some comments will be made about material presently available for publication. As of August 13, 1968, 15 papers have been accepted, revised by authors when necessary, and are awaiting publication. This is the equivalent of three issues of the journal. Additionally, there are 19 papers in some stage of review or revision by authors. It is possible that one or two of these may be withdrawn by authors. Even if several are lost, this material is sufficient for another three issues. Furthermore, the editor has been informed by several authors that two more papers will be submitted in the near future.

The 1968 annual meeting should yield an additional 28 papers. If all authors respond with suitable manuscripts, enough papers will be generated from this source for five issues of the journal. Consequently, after the annual meeting enough material will be on hand to publish 11 issues of the journal even if no papers are submitted during that

period—a situation which is not very likely to occur. Several letters to the editor—one presenting results obtained by a sanitarian in Waterloo, Iowa and others dealing with data in a paper which appeared in an earlier issue—will be published in the near future.

EDITORIAL BOARD

The present editorial board consists of 15 specialists representing various phases of the food industry. Governmental, industrial, and university laboratories are represented. One person, Dr. E. A. Zottola, food microbiologist in the Department of Food Science and Industries, University of Minnesota, was added to the editorial board during the past year. Dr. Zottola has already made substantial contributions in the review of papers and his addition to the editorial board has been beneficial.

During the course of this past year, the editor has also requested help in the review of papers from a number of persons not on the editorial board. Their help was enlisted to lighten the load of the editorial board and also to deal with papers on subjects different from the specialties represented by board members. Help was provided by: Dr. R. L. Bradley, Jr., Dr. R. H. Deibel, Dr. J. M. Goepfert, Mr. Frank McKee, Dr. J. C. Olson, Jr., Dr. N. F. Olson, Dr. W. D. Powrie, Mr. D. I. Thompson, Mr. Leon Tumerman, Dr. J. H. von Elbe, and Dr. W. C. Winder.

ASSOCIATE EDITOR

Mr. W. J. Dixon died during June of 1968 after serving the journal for a number of years as its associate editor. Mr. Dixon's principal responsibilities were in the area of non-technical papers of general interest and association affairs and news and events. The editor and managing editor have agreed to subdivide these responsibilities with the former seeing after all papers and the latter arranging for the association affairs and news and events sections. This division of responsibilities will continue until other arrangements are made.

EQUIPMENT PURCHASED

During this past year, a portable electric typewriter, typewriter table, filing cabinet, and several rubber stamps were purchased for use by the editor.

NEEDS AS SEEN BY THE EDITOR

1. Encouragement of membership to report observations and experiences via the "letter to the editor" mechanism if the information should be disseminated but does not lend itself to a full-fledged scientific paper. Sanitarians should find this to be helpful if they will bother to contribute.

2. Consideration should be given to the occasional addition of extra pages, when needed, to insure prompt publication of research papers.

3. The non-technical sections occupied 187 pages or approximately 50% of volume 30. This seems to be a disproportionate part of the journal and, perhaps the Journal Management Committee should review the composition of the Journal.

Respectfully submitted,

ELMER H. MARTH

Editor, *Journal of Milk and Food Technology*

NOTICE OF PAGE CHARGE FOR PUBLICATION OF RESEARCH PAPERS

The Journal Management Committee recommended and the Executive Board voted to establish a page charge for research papers published in the *Journal of Milk and Food Technology*. Institution of the page charge is necessary to compensate for higher publication costs, to insure a continually expanding journal which will be of maximum benefit to its readers, and to make possible continued prompt publication of research papers.

A charge of \$25.00 per printed page will become effective for all research manuscripts received after January 1, 1969. Most institutions accept the page charge as a necessary cost of conducting research and communicating the results. Nevertheless, it is realized that some authors may not have funds available for this purpose and hence exceptions can be made when necessary. Inability to pay the page charge shall not constitute a bar to publication of an acceptable manuscript.

REPORT OF THE EXECUTIVE SECRETARY AND MANAGING EDITOR, 1967-1968

I am glad to report an improvement in our membership and a continued improvement in our financial situation. Affiliate membership remained about the same as last year and our direct membership showed a net gain of approximately 150. This was largely due to 146 new bakery sanitarians. We are happy to have them as members and feel sure they will make a worth while contribution. We hope too that they will profit from their participation in our association. With their help we hope to improve our coverage of this area in our Journal and the program at our annual meetings.

Our subscriptions increased again this year. The subscriptions plus an average membership of between 2,900 and 3,000, gives us an average circulation of the Journal of over 4,000 per month.

Our financial position is further improved this year as we showed a net of over \$2,500 which added to our reserve brings our net assets to over \$17,000, over \$13,000 of which is cash.

An outstanding occurrence this year was the combining of our Virginia Affiliate with the Virginia Dairy Fieldmen's Association. Their new name is Virginia Association of Sanitarians and Dairy Fieldmen. Indications are that the new organization will be able to provide some excellent programs and effective leadership in milk and food sanitation in Virginia.

We again performed all the routine duties and attended the usual number of meetings. In view of the turn of events with regard to our merger with NAS, I would like to make the following recommendations to you and the Executive Board.

1. Expand our efforts in meat, poultry, bakery, and other food sanitation in general. We have a great increase in sales in the food sanitation area of our 3-A Sanitary Standards and Foodborne Disease Investigation book. We have just received the 10th printing of 5,000 copies of this book, making a total of over 45,000 copies sold. The Public Health Inspectors Association of England is buying the Procedure, advertising it in their Journal, and selling it to their membership.

2. Improve and expand our committees in food sanitation.

There is no doubt in my mind that with the help of all our members we can increase our membership and make a great contribution to food sanitation in this country.

I am beginning my 18th year as your Executive Secretary and Managing Editor. It has been a pleasure and a privilege

to serve you. I hope to be able to continue serving you for a long time.

Respectfully submitted,

H. L. THOMASSON

Executive Secretary and Managing Editor

NEWS AND EVENTS

ZERO CONCORD COW MONITOR

Now—at last—there's a simple, low-cost, small compact, easy-to-use, cleaned-in-place, sanitary device that enables the dairyman to keep a record of each, individual cow's production and health at each milking. It's the new, revolutionary Zero Concord Cow Monitor. With this Cow Monitor—the dairyman can determine each day how much money each cow is making, or possibly losing, for him.

The Cow Monitor does not interfere with normal milking procedure. It does not disturb the system's low, stable vacuum. It does not have any detrimental effect on the milk. And it makes no difference whether the dairyman milks in a parlor or stanchion barn. Furthermore, it is not necessary to go to the expense of installing a low line in an attempt to obtain these benefits. To operate—the Milk Measuring Meter (upper part) of the Cow Monitor is attached to the milk conveying vacuum pipeline—while the Milk Measuring Chamber (lower part) is positioned within easy reach and sight of the operator. The position of the Measuring Chamber can be adjusted easily to the height of the milk line and the size of the operator for easy reading and accessibility.

The Cow Monitor has a Flow Plunger which, just before the milk enters the milk conveying pipeline, permits a proportionate percentage of the milk to be measured. This supplies the dairyman with a percentage of the total volume of milk given by each cow. From this the calibrated weight can be quickly obtained. After each cow's reading is taken—the milk is drawn back into the milk conveying line by vacuum. Or, a milk sample can be taken out, if desired. The lightweight, transparent material from which the Cow Monitor is made allows complete observation of its entire interior during milking as well as while cleaning and sanitizing. The Cow Monitor can be cleaned and sanitized automatically in place along with the milker units by the Zero Concord Milking System's built-in, automatic self-cleaning and sanitizing system.

For full information about Zero Concord Complete Pipeline Milking System with the Zero Concord Cow Monitor—write to Zero Manufacturing Company; Washington, Missouri 63090.

1968 LISTING OF ADJUSTABLE OUTPUT RATE CHEMICAL FEEDING EQUIPMENT FOR SWIMMING POOLS—STANDARD NO. 19

The Testing Laboratory is pleased to announce the official Listing of Adjustable Output Rate Chemical Feeding Equipment for Swimming Pools. These evaluations and approvals are under the provisions of NSF Standard No. 19. A copy of the official Listing of such equipment, together with a copy of the Standard, is enclosed for your information. A limited supply of Listings is available on request.

DAIRY FIELDMEN AND SANITARIANS' CONFERENCE TO BE HELD AT PURDUE

The Animal Sciences Department and Food Sciences Institute at Purdue University have announced a one-day conference for Dairy Fieldmen and Sanitarians to be held November 19, 1968. The meeting will be held in the Memorial Center at Purdue University. The conference is sponsored in cooperation with the Indiana Dairy Products Association.

The conference will feature presentations on Corn Silage Feeding by M. D. Cunningham, Animal Sciences Department, Purdue University; Breeding Problems Today by C. J. Callahan, Veterinary Science Department, Purdue University; Dairy Production Research at Purdue by C. H. Noller, Animal Sciences Department, Purdue University; Total Enclosed Housing Experiences by J. A. Speicher, Dairy Department, Michigan State University; Cleaning on the Dairy Farm by D. B. Whitehead, Diversey Corporation, Chicago; and Milk Flavor and Keeping Quality—A 1968 Survey by R. W. Stein, Animal Sciences Department, Purdue University.

The luncheon speaker will be J. W. Hicks, Executive Assistant to the President, Purdue University. He will discuss The Higher Education Dollar Dilemma.

Additional information may be obtained by contacting H. F. Ford, Smith Hall, Purdue University, Lafayette, Indiana.

CLASSIFIED ADS

SANITARIAN III—Immediate Opening—To establish and operate a new Sanitation Department, Rock Island County, Rock Island, Illinois. Offers a challenging position for the fully qualified person. Salary commensurate to start and up to \$12,000, plus fringe benefits, car or full mileage allowance. Communication with qualifications should be directed to: President, Rock Island County Board of Health, County Office Building, Rock Island, Illinois 61201.

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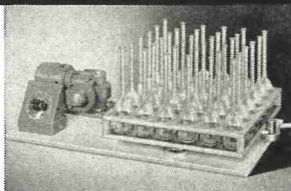
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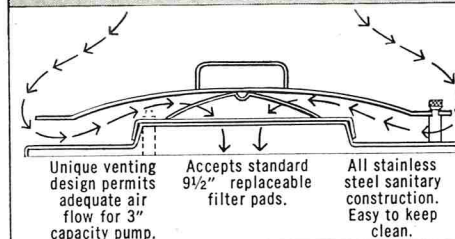
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The COW MONITOR is designed for both parlor and stanchion barn milking. To operate — you attach it to your milk conveying vacuum pipeline. Simple in design — the COW MONITOR is easy to use. It's small and compact. Sanitary. And is cleaned and sanitized in place.

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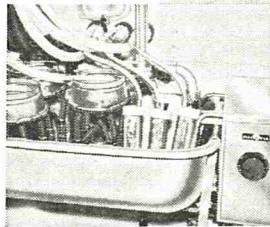
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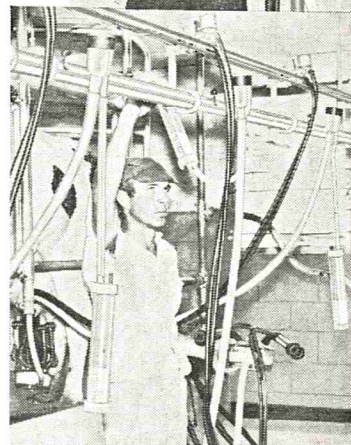
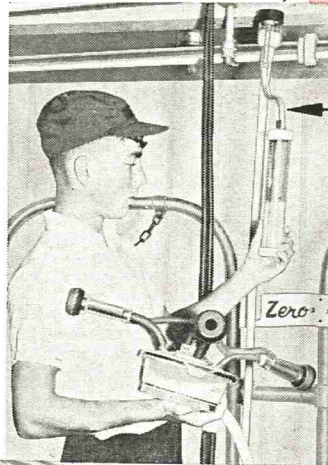
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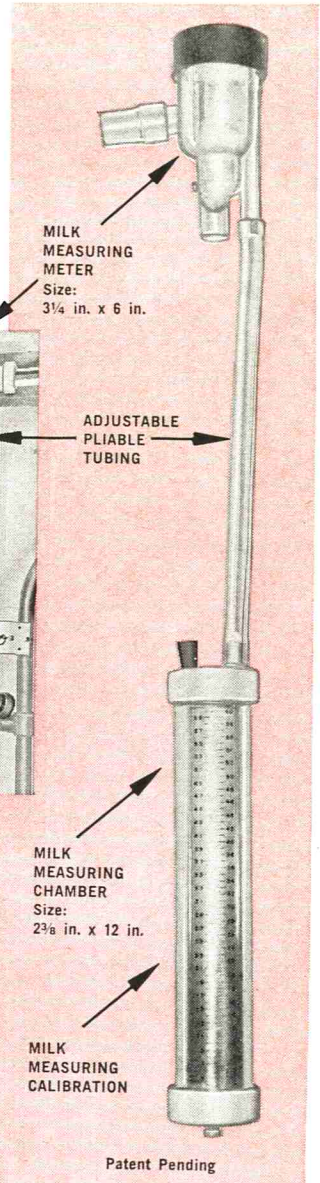
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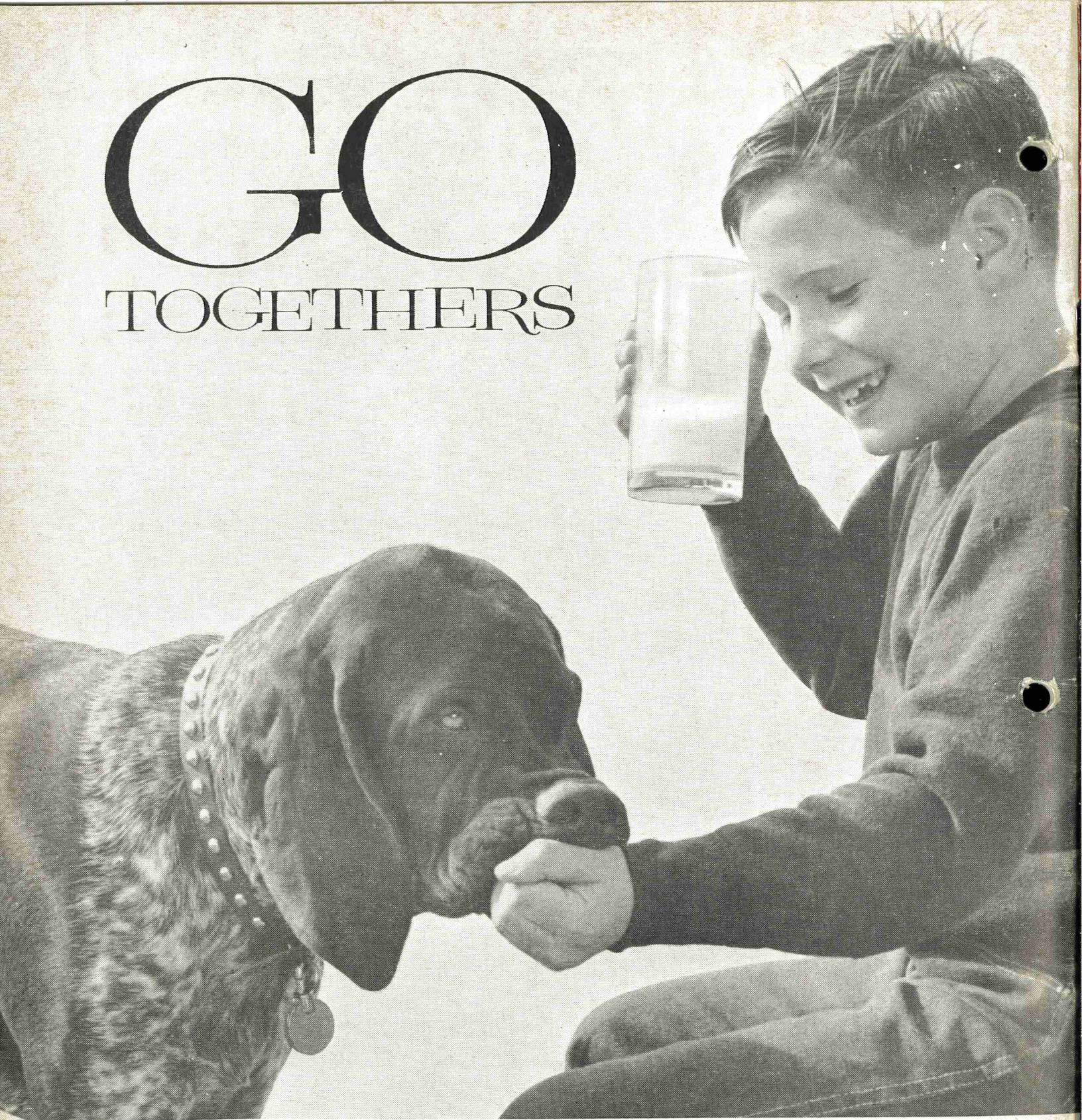
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