

DAIRY, FOOD AND ENVIRONMENTAL

Sanitation

A PUBLICATION OF THE INTERNATIONAL ASSOCIATION OF MILK, FOOD AND ENVIRONMENTAL SANITARIANS, INC.

JUNE 1996

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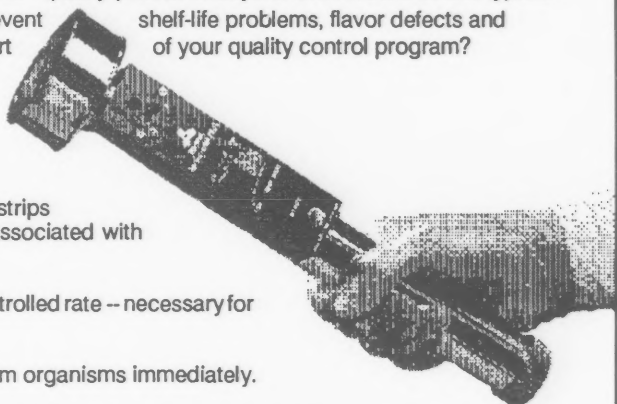
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ARTICLES

- Use of Time and Temperature Specifications for Holding and Storing Food in Retail Food Operations** 374
O. Peter Snyder
- A Statistical Approach to Evaluating the Effectiveness of Hand-Cleansing Products Used in the Food-Processing Industry** 389
Daryl S. Paulson
- Regulatory Reform Recommendations** 393
Reprinted from Reinventing Food Regulations, Part IV-January 1996

ASSOCIATION NEWS

- Sustaining Members 367
- Thoughts From the President 370
- Perspectives From the Executive Director 372
- New IAMFES Members 396

DEPARTMENTS

- Updates 398
- News 400
- Advertising Index 403
- Industry Products 404
- Business Exchange 408
- Coming Events 409

EXTRAS

- IAMFES Booklet Form 411
- IAMFES Membership Application 412

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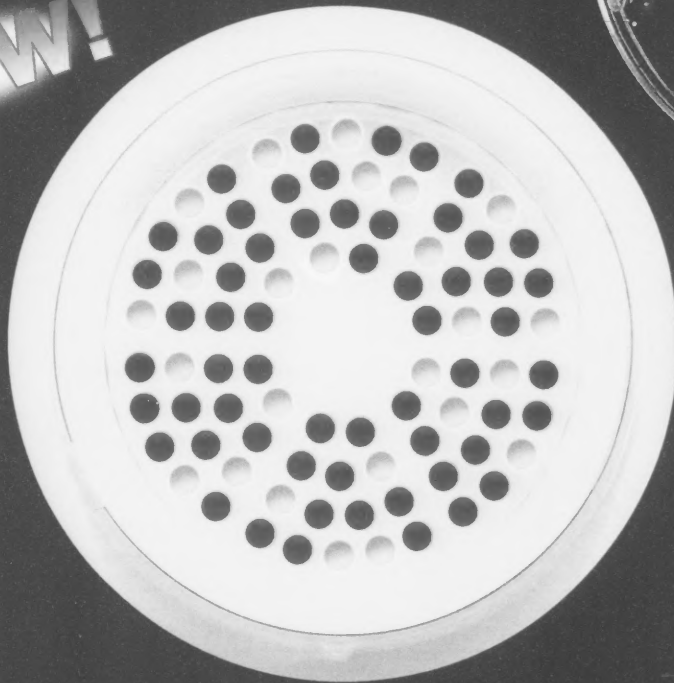


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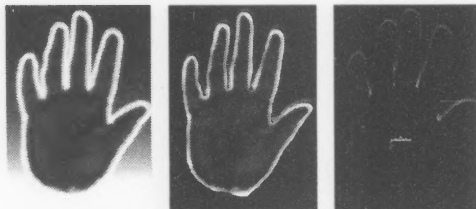
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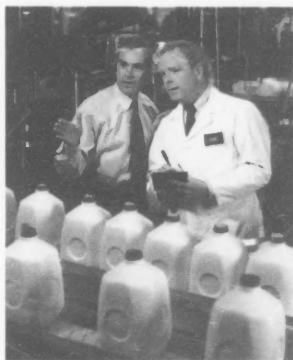
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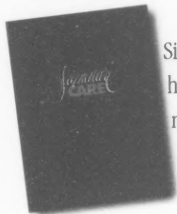
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THOUGHTS

FROM THE PRESIDENT



By F. ANN DRAUGHON,
IAMFES President

“Endings...”

It doesn't seem possible, but this will be my last column as President of IAMFES. How time flies when we're having fun. Dr. Bob Gravani began the tradition of a monthly president's column in 1988 as an effort to improve communication between the IAMFES Board and the membership. I feel kinship with Bob since this was also the year when our last Executive Manager of IAMFES was hired. Each President who has served IAMFES has left his mark on our Association. For the first time, a President will leave HER mark on the Association. I hope it will have been a good one. I have been blessed with a great Executive Board and a truly outstanding and supportive office staff in Des Moines. They have made what might have been a difficult year, merely challenging. Let's look back over the past year and see how far we have come.

This has been an interesting year since we hired a new Executive Director, Mr. Dave Merrifield on December 1, 1995. Mr. David Tharp, our finance

director, was our acting administrative official in the IAMFES office during the interim between the annual meeting and December. David did an outstanding job for IAMFES in the interim. The long-awaited transition was made to move to MACK Publishing for the *Journal of Food Protection* and ILSI supplements during his tenure. A new Managing Editor for IAMFES publications, Ms. Carol Mouchka, was appointed. She and her staff made significant improvements in both journals, but major improvements were made in *Dairy, Food and Environmental Sanitation*. A new Scientific Editor for *Journal of Food Protection* was appointed, John Sofos, whose four-year appointment officially began January 1, 1996. A new Scientific Editor for *Dairy, Food and Environmental Sanitation* was appointed, Bill LaGrange, whose four-year appointment also began January 1, 1996. These are only a few of the things which were accomplished while David Tharp was acting administrator for IAMFES. On behalf of the Board, the IAMFES staff and the Membership, I want to thank him for his dedication and hard work for IAMFES as interim acting administrator.

I hope you will take the time to meet our new Executive Director, Dave Merrifield, in Seattle. Mr. Merrifield brings many years of experience in management and team building to IAMFES. He has already helped the Board to get focused on an annual Strategic Planning Process to optimize use of resources and to target key areas in the association which need attention. His well-written columns such as “We have no other mission than to implement the will of our members” or his March column on “membership growth” tell you that Dave is in tune with who we are and what we want to be.

During my time on your Executive Board, I have been impressed and humbled by the dedication of IAMFES members. They organize the annual meeting program, symposia, work-

shops, affiliate meetings, chair and serve on committees, publish newsletters, write booklets, write articles, help to set regulations and standards related to equipment, food and the environment, write white papers, edit journals, serve on editorial review boards, serve on review committees and other jobs too numerous to mention.

Some of our other goals for this year are about to be realized, others still need work. The IAMFES office will soon be using E-mail, although we have decided to limit Internet access for now. The Education Task Force is off and running, we have two new Professional Development Groups, a new Canadian affiliate which is organizing a terrific program for the IAMFES annual meeting and membership in IAMFES is slightly up this year. My feeling is that we have made a great deal of progress this year but we still have a lot of work to do. I feel confident that under the leadership of Dr. Michael Brodsky, your new IAMFES President, great strides will be made.

It has been a great pleasure working with my friends and colleagues on the Executive Board of IAMFES—Dee Clingman, Michael Brodsky, Gale Prince, Bob Brackett, and Joe Disch. Each is a dedicated and talented professional whose ideas and decisions represent thoughtful consideration and the best interests of IAMFES. I would also like to thank Dave Merrifield and our office staff for their support during the last year. It has also been a great pleasure to work with the committee, task force and PDG chairs, members, affiliate representatives and others who have written or called on association business. I would like to express a very special thanks for the constant support and encouragement of my sons, Brad and Andrew, while I served as President and throughout my term on the Board. Finally, I would like to thank you, the membership, for giving me the opportunity to serve as your president. It has been the high point of my career.

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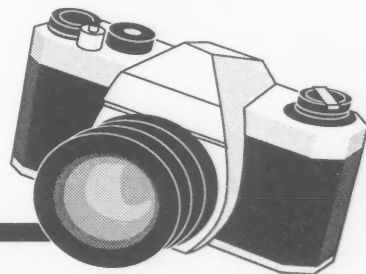
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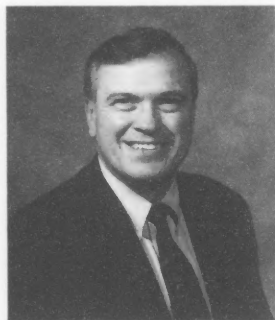
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PERSPECTIVES...

From the Executive Director



By DAVID M. MERRIFIELD,
IAMFES Executive Director

“IAMFES is only as good as its committed members who volunteer”

A few days ago I attended a seminar on confrontational communications and, although the subject is not something I would normally write about in my column (unless we were facing a media situation with the possibility of getting some really bad press), there was an intriguing lesson offered. In making his point, the speaker said, “Tell me and I’ll forget it; show me and I may remember it; involve me and I’ll understand it.” I thought at the time, what a wonderful piece of wisdom. Later I realized that this is adaptable to more than just communications, for example, how we look at IAMFES, its membership, and service.

If we write or talk to members about IAMFES and its mission, goals, plans, finances, journals, leadership, and just about everything else we encounter daily, little will be remembered or understood, at least on a long-term basis. We can increase the retention and understanding by showing a picture or producing a spreadsheet, but only by a small margin. However, if we can somehow involve the membership in the daily activities of the association, retention, understanding, interest, and activity increases, including membership in the organization and attendance at our Annual Meeting. Another way to look at it is that involvement creates enthusiasm, and enthusiasm breeds more enthusiasm. Enthusiasm and involvement are contagious.

But how do members get involved? One way is to get excited about projects and long-range goals. Wouldn’t it be wonderful if we could set up a core group of food and milk professionals in a new country each year? Wouldn’t it be something if we could make food supplies as safe in severely underdeveloped areas as it is

in North America or Western Europe? Wouldn’t it be fantastic if we had a hand in defeating diseases caused by unsafe food and food handling worldwide? But this takes commitment and leadership; it takes enthusiasm and energy; and, above all, it takes involvement.

I hope that if you’ve read this far, you’re asking yourself, where can I start or how do I get involved? The best way is by volunteering to serve on an IAMFES committee, professional development group, or task force. Right now we’re looking for IAMFES members to serve and lead in several areas. Many of our existing groups need those who are willing to work and get involved. That involvement is just a phone call away.

Our recently published mini-directory lists all the association’s committees, professional development groups, and task forces that could use your help and expertise. If you’re interested in a particular group, call the group’s chair, call me, or call any member of the Executive Board. If there’s not an existing group that interests you, but you see a need or a void, talk to us about creating a new task force or professional development group. Above all else, we want to reach our mission of providing food safety professionals worldwide with a forum to exchange information on protecting the food supply. We can only do this through your involvement.

Volunteerism is the lifeblood of all associations. IAMFES is only as good as its committed members who volunteer, people who want to leave a place better than the way they found it.

Involve me and I’ll understand. Better yet, involve me and I’ll make a difference.

Now it's *your* turn.

We, the publication staff, have made some adjustments regarding the layout and design of *Dairy, Food and Environmental Sanitation*, resulting in an entirely new "look." This new look was created in an attempt to make the articles easier to read, the department columns more appealing, and to give the journal an overall update.

But, as anyone knows, looks aren't everything. Maybe we've missed something you, as readers and subscribers, have noticed, and would like us to change. Or, maybe you like what you see and are as pleased and excited about the changes as we have been.

Well, now is your chance to let us know exactly what you think. We are asking that you write, call or even fax us a message with your comments, criticisms, and suggestions.

We've even made it simple for you by including the form below. Please take a moment to fill it out and return it to us. After all, as members, the journal is your tool for communication with the rest of the association. Why not take advantage of this opportunity to let your opinions be heard? Your brief answers could help make *Dairy, Food and Environmental Sanitation* even better!



★ ★ YOUR OPINION COUNTS! ★ ★

Name: _____ No. Years as an IAMFES Member: _____

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Use of Time and Temperature Specifications for Holding and Storing Food in Retail Food Operations

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SUMMARY

The 1993 FDA Food Code¹ has now established some limiting time and temperature specifications for holding and storing potentially hazardous food. The purpose of this paper is to provide a research data base for developing specific time-temperature standards for safe holding and/or storing potentially hazardous food in retail food facilities and chilled-food operations in the actual temperature range for pathogenic bacterial growth in food, between 32 to 130°F (0 to 54.4°C).

Data regarding the rate of growth of various pathogenic bacteria and aerobic bacteria in food were compiled from research studies. The data were used to predict the growth rate of the bacteria in food as a function of temperature and to compare this to 1993 FDA Food Code Recommendations for holding and storing potentially hazardous foods.

This analysis shows that the 1993 FDA Food Code for holding at temperatures and times of 41°F (5°C) for 10 days and at 102°F (38.9°C) for 4 h, coupled with a square root equation for modeling bacterial growth, can be used as a basis for developing combinations of times and temperatures that can be used for holding foods safely from 32 to 130°F (0 to 54.4°C). These calculated times and temperatures are representative of 10 generations of pathogenic bacteria multiplication following holding at 41°F (5°C) for 10 days and/or 4 hours at 102°F (38.9°C), as allowed by the 1993 FDA Food Code (31). These equivalent temperatures and times will allow the retail food industry to continue to operate with current commercial refrigerators that are not designed to hold food at 41°F (5°C).

Application of this information can be used to assure food safety and to prevent the unnecessary waste of food, especially in retail operations when food is not always kept below 41°F (5°C). Using the data and information in this analysis will also permit the safe application of time-temperature standards to food items stored in chilled-food systems where, for economic reasons, refrigerated foods need to be capable of a 60-day storage period or more at 28 to 32°F (-2.2 to 0°C).

INTRODUCTION

Research studies through the years have established that bacterial growth and growth rate are dependent on the supply of nutrients, the supply of water, atmosphere; pH of surrounding media or environment, and temperature. The 1993 FDA Food Code (31) has now established some limiting time and temperature specifications for holding and storing potentially hazardous food in order to prevent multiplication of pathogenic bacteria in food to levels that will cause illness or disease.

The 1993 FDA Food Code (31):

- Recommends maintaining potentially hazardous food at 60°C (140°F) or above, or at 5°C (41°F) or below [§3-501.16].

- Allows a 10-day time period for holding refrigerated, ready-to-eat, potentially hazardous food safely at or below 5°C (41°F) [§3-501.18 (A)].

- Limits the shelf life of reduced-oxygen-packaged food maintained at or below 5°C (41°F) to 14 days [§3-502.12].

- Recommends that potentially hazardous food be served or discarded within 4 h from the time the food is removed from temperature control between 5°C (41°F) and 60°C (140°F) [§3-501.19 (B)].

Figure 1. Generation times for projected bacterial growth based on 1993 FDA Food Code holding/storage recommendations (°Fahrenheit)

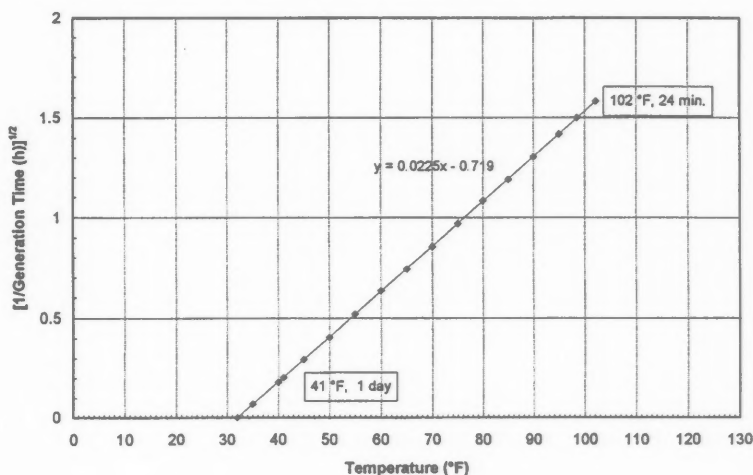
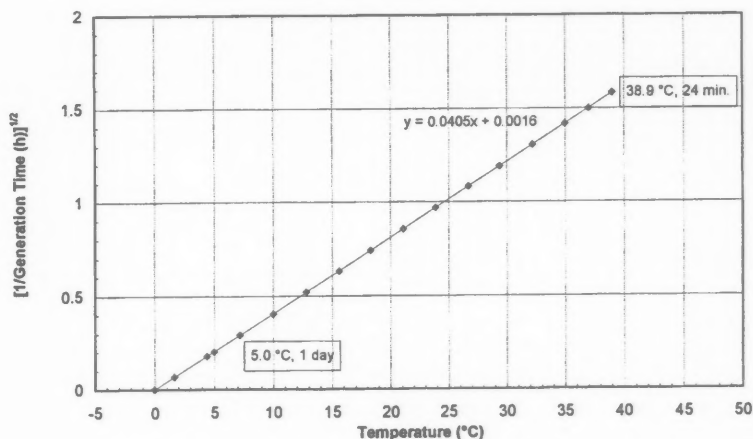


Figure 2. Generation times for projected pathogenic bacterial growth based on 1993 FDA Food Code holding/storage recommendations (°Celsius)



Unfortunately, the FDA has not defined the microbiological basis for choosing 41°F (5°C) and 10 or 14 days as the lower safe holding temperature and time or for designating 140°F (60°C) as the high safe food-holding temperature. In addition, the FDA 1993 Food Code (31) has not provided the scientific basis for discarding food if it has been removed from "temperature control" for 4 h or more.

Most refrigeration systems, including new foodservice walk-in and reach-in refrigerators, are not capable of maintaining food temperature at 41°F (5°C) or below 100% of the time (49). New reach-in refrigerators, built to National Sanitation Foundation (NSF) approval standards, require the refrigerated air temperature of the refrigerators being tested at the factory to maintain a temperature of 38°F (± 2°F) over a 4-h period. The

refrigerators are tested when they are empty and the doors are never opened. There are no cooling capability standards for any NSF reach-in refrigeration equipment. There are no NSF performance criteria for walk-in refrigerators. Distributors of refrigeration equipment must therefore determine what refrigerator meets the requirements of the retail food production or foodservice facility, yet no one has specified a standard way to do this.

Salad bars and cold preparation tables have no NSF-specified refrigeration equipment operating-performance standards for maintaining temperature. Frazier and Sawyer (33) reported differences in cold serving units, which demonstrated that food held in mechanically refrigerated salad bars was below 45°F (7.2°C) after 2 h, while food held in mechanically cooled units with ice was above 45°F (7.2°C). The ice actually insulated the products from the mechanically cooled basin and allowed internal temperatures of the products to increase. Studies in other retail food operations and delicatessens have shown that potentially hazardous food is often above 41°F (5°C), but usually less than 55°F (12.8°C) (11, 12, 20, 90, 97).

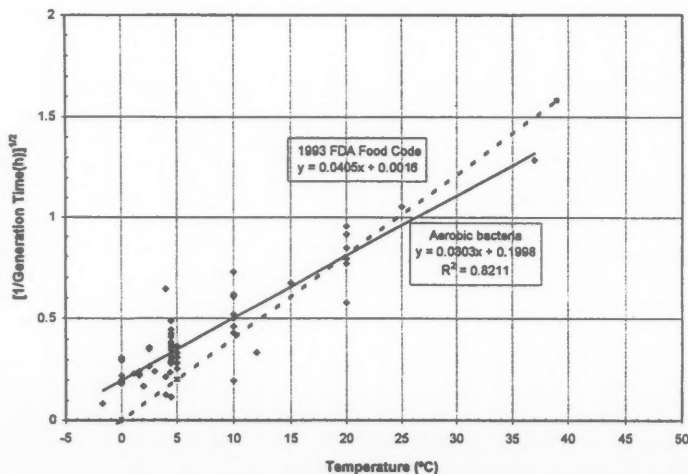
Since it is recognized that rate and extent of bacterial growth are temperature and time dependent, regulatory code recommendations for holding and/or storing food should be based on an analysis of research studies of the growth of pathogenic bacteria in various foods, taking into consideration public health risk. Regulatory code recommendations must also consider the capability of current equipment used in retail food operations to maintain temperature. It does no good to require a specific food temperature if equipment cannot perform to that standard during food production and service.

The hot holding temperature standard recommended by both the 1976 FDA Food Sanitation Manual (29) and the 1993 FDA Food Code (31), is that hot foods be held at a temperature of 140°F (54.4°C) or above to prevent multiplication of

TABLE 1. Generation times calculated for 1993 FDA Food Code

Temp. (°C)	Temp. (°F)	Calculated generation time (h)	Rounded Generation Time(s)		
			1	5	10
0	32.0	390625.0	6 (days)	30 (days)	60 (days)
1.67	35.0	208.6	3	15	30
4.4	40.0	30.9	1.3	6.5	13
5.0	41.0	24.0	1	5	10
7.2	45.0	11.6	12 (h)	2.5	5
10.0	50.0	6.0	6	30 (h)	2.5
12.8	55.0	3.7	3.6	18	1.5
15.6	60.0	2.5	2.4	12	1
18.3	65.0	1.8	1.8	9	18 (h)
21.1	70.0	1.4	1.4	7	14
23.9	75.0	1.1	1.1	5.5	11
26.7	80.0	0.9	50 (min)	4	8.5
29.4	85.0	0.7	42	3.5	7
32.2	90.0	0.6	36	3	6
35.0	95.0	0.5	30	2.5	5
39.0	102.2	0.4	24	2	4

Figure 3. Generation times for aerobic bacteria in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations



foodborne pathogens. However, §3-401.14 of the 1993 FDA Code (31), indicates that 10^7 *Salmonella* per gram can be inactivated in roast beef at 130°F (54.4°C) in 121 min. Actually, the highest known growth temperature for a foodborne pathogenic bacteria is that of *Clostridium perfringens* at 126.1°F (52.3°C) and is referred to as the Phoenix phenomenon (80). Practical studies to establish high-temperature growth limits for the foodborne pathogenic bacteria *Staphylococcus aureus*, *Salmonella enteritidis*, and *C. perfringens* have been reported by Brown and Twedt (14) and Angelotti et al. (3). All are below this temperature. Therefore, the hot holding temperature for food should be based on a temperature above 126.1°F (52.3°C).

More than 10 years ago, the State of South Carolina established the minimum hot food holding temperature at 130°F (54.4°C) and has not had any food safety problems related to this directive. The FDA Unicode (30), §2-501.41, proposed that the safe holding temperature for hot food be set at 130°F (54.4°C) or above. Therefore, it would seem that 130°F (54.4°C) is an adequate food-temperature standard that prevents multiplication of pathogenic bacteria.

There is also another equipment problem that must be addressed. The surface of uncovered food in hot holding tables is usually about 110 to 120°F (43 to 49°C). The reason for this low temperature is that the surface is exposed to an ambient relative humidity of 50 to 60% that allows loss of moisture and subsequent cooling of the surface. Therefore, time limits must be specified for food in hot holding tables if the relative humidity at the surface of the food is not 90% or above.

The purpose of this paper is to provide research data for a more definitive basis for developing specific time-temperature standards for safe holding and/or storing potentially hazardous food in retail food facilities and chilled food operations in the actual temperature range for pathogenic bacterial growth in food between 32 and 130°F (0 to 54.4°C).

Figure 4. Generation times for *Listeria monocytogenes* in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations

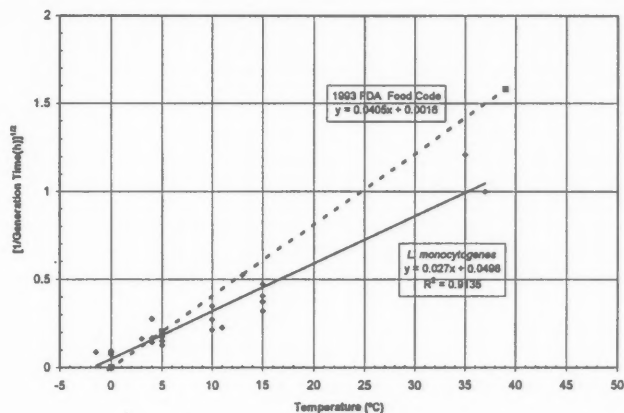


Figure 5. Generation times for *Yersinia enterocolitica* in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations

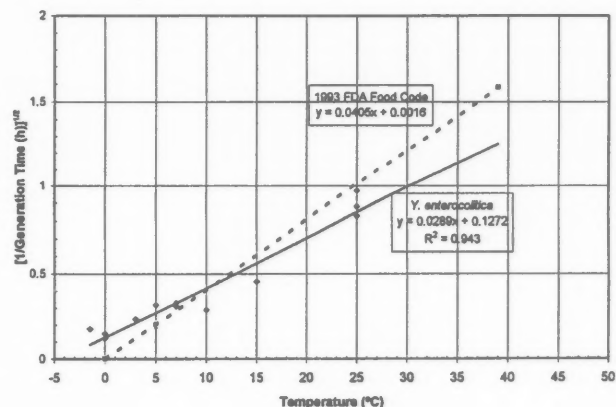
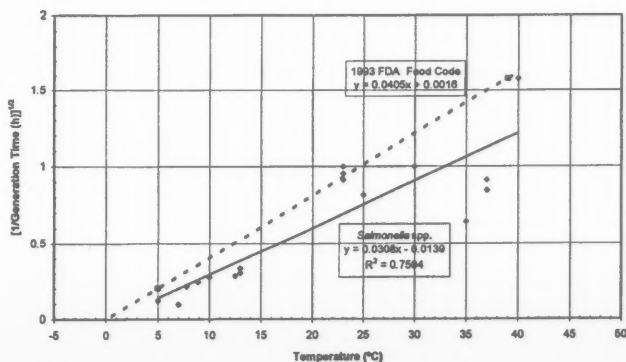


Figure 6. Generation times for *Salmonella* spp. in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations



DATA FOR DEVELOPING STANDARDS

Range of temperatures for growth of foodborne pathogenic bacteria

Hudson et al. (46) reported the growth of *Listeria monocytogenes*, *Aeromonas hydrophila*, and *Yersinia enterocolitica* in vacuum-packaged roast beef slices at 29.3°F (-1.5°C). This is the lowest growth temperature reported for known foodborne pathogenic bacteria to date. Thus, the hazardous temperature range for the growth of pathogenic bacteria in food is 29.3 to 126.1°F (-1.5 to 52.3°C).

Some enterotoxigenic strains of *Escherichia coli* have been reported to grow at 39.2°F (4°C) (62). Non-proteolytic types of *Clostridium botulinum* begin to grow at 38°F (3.3°C) (45), and *Bacillus cereus* has been reported to grow at 39°F (4°C) (92). *Salmonella* spp. begin to multiply at 41.5°F (5.5°C) (3, 55). The highest known growth temperature is that of *C. perfringens*, as previously discussed.

Prediction of microbial growth through calculations

What information is available to develop a science-based approach to food holding under conditions which allow the growth of pathogenic bacteria that could be present in the food? A mathematical model that has been shown to be quite accurate for modeling bacterial growth over a temperature range is that of Ratkowsky et al. (71, 72). The equation is as follows:

$$\sqrt{r} = b(T - T_0),$$

where r is growth rate, or (generation time)⁻¹; b is slope of the regression line; T is temperature of the bacteria; and T_0 is theoretical low temperature point for zero growth. This square root equation has been used to predict the growth rates of a variety of microorganisms. The equation has been reviewed by a number of scientists and has proven to be quite useful (1, 2, 56, 73).

TABLE 2. Generation times for aerobic bacteria in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Type of bacteria	Reference no.
29	-1.7	140.7	0.08	Raw ground beef		26
32	0	24.8	0.20	Chicken meat		4
32	0	26.6	0.19	Dairy product	<i>Pseudomonas</i>	76
32	0	30.2	0.18	Fish	<i>P. fluorescens</i>	76
32	0	11.3	0.30	Dairy product	<i>P. fragi</i>	76
32	0	10.3	0.32	Chicken	<i>Pseudomonas</i>	76
32	0	20.0	0.22	Fish	gram-neg. rod	76
32	0	30.2	0.18		<i>P. fluorescens</i>	76
32	0	26.4	0.19		<i>P. fluorescens</i>	76
32	0	10.3	0.31		<i>Pseudomonas</i>	76
34	1.1	18.3	0.23	Whole fresh chickens		77
35	1.6	16.6	0.25	Hake		47
35	1.6	19.8	0.22	Rockfish		47
35	1.6	18.8	0.23	English sole		47
35.6	2.0	34.2	0.17	Egg substitute		66
36.5	2.5	7.7	0.36	Dairy product	<i>P. fragi</i>	76
36.5	2.5	8.0	0.35	Chicken	<i>Pseudomonas</i>	76
36.5	2.5	13.8	0.27	Meat	<i>Pseudomonas</i>	76
37.4	3.0	16.7	0.24	Raw ground beef		88
39.2	4.0	21.2	0.22	Raw ground beef		6
39.2	4.0	2.4	0.65	Raw ground beef		32
30.2	4.0	61.6	0.13	Restructured beef stk.		60
40	4.4	17.5	0.24	Chicken meat		4
40	4.5	73.0	0.12	Milk	<i>C. hastiforme</i>	76
40	4.5	11.7	0.29	Dairy product	<i>Pseudomonas</i>	76
40	4.5	6.7	0.39	Fish	<i>P. fluorescens</i>	76
40	4.5	5.0	0.45	Dairy product	<i>P. fragi</i>	76
40	4.5	7.0	0.38	Chicken	<i>Pseudomonas</i>	76
40	4.5	7.6	0.36	Fish	gram-neg. rod.	76
40	4.5	9.7	0.32	Meat	<i>Pseudomonas</i>	76
40	4.5	10.7	0.31		<i>P. fluorescens</i>	76
40	4.5	8.2	0.35		<i>P. fluorescens</i>	76
40	4.5	4.2	0.49		<i>P. fluorescens</i>	76
40	4.5	5.5	0.43		<i>Pseudomonas</i>	76
40	4.5	5.9	0.41		<i>Pseudomonas</i>	76
40	4.5	12.5	0.28		<i>B. circulans</i>	76
40	4.5	12.2	0.29	Milk	<i>B. circulans</i>	76
40	4.5	12.1	0.29		<i>B. circulans</i>	76
40	4.5	11.5	0.29		<i>B. circulans</i>	76
40	4.5	12.1	0.29		<i>B. circulans</i>	76
41	5.0	7.4	0.37	Chicken meat		27
41	5.0	8.9	0.34	Raw ground beef		70
41	5.0	10.2	0.31	Fresh beef loins		74
41	5.0	15.0	0.26	Aged beef loins		74
41	5.0	12.3	0.29	Raw ground beef		89
50	10.0	3.7	0.52	Chicken meat		4
50	10.0	4.7	0.46	Chicken meat		27
50	10.0	25.5	0.20	Milk	<i>C. hastiforme</i>	76

TABLE 2. Continued

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Type of bacteria	Reference no.
50	10.0	5.4	0.43	Dairy product	<i>Pseudomonas</i>	76
50	10.0	2.6	0.62	Dairy product	<i>P. fragi</i>	76
50	10.0	2.7	0.61	Chicken	<i>Pseudomonas</i>	76
50	10.0	1.9	0.73	Fish	gram-neg. rod	76
50	10.0	4.0	0.50	Meat	<i>Pseudomonas</i>	76
50	10.0	2.7	0.61	Meat	<i>Pseudomonas</i>	76
53.6	12.0	8.8	0.34	Fresh eggs		66
59	15.0	2.2	0.67	Chicken meat		27
68	20.0	1.4	0.85	Chicken meat		27
68	20.0	3.0	0.58	Fresh eggs		66
68	20.0	1.7	0.77	Dairy product	<i>Pseudomonas</i>	76
68	20.0	1.4	0.85	Fish	<i>P. fluorescens</i>	76
68	20.0	1.1	0.95	Dairy product	<i>P. fragi</i>	76
68	20.0	1.6	0.79	Chicken	<i>Pseudomonas</i>	76
68	20.0	1.2	0.91	Meat	<i>Pseudomonas</i>	76
77	25.0	0.9	1.05	Chicken meat		27

Establishing base temperatures and times for predicting pathogenic bacterial growth

To establish base temperatures and times for predicting pathogenic bacterial growth, two control points are necessary: times at high and low temperatures. Interestingly, the 1993 FDA Food Code (31) can be used for this information. The low-temperature and time control point of 41°F (5°C) for 10 days can be taken from the code, and a high-temperature, fastest multiplication-time control point can logically be set at 102°F (38.9°C) using the FDA recommendation of 4 h between 42 to 139°F (5.6 to 59.4°C). Setting the temperature at 102°F (38.9°C) is a good representation for the growth of *S. aureus* and *Salmonella* spp., which can multiply optimally in the range of one generation every 20 to 24 min at this temperature.

By placing the high-temperature point at 102°F (38.9°C) and the low temperature at 41°F (5°C), the slope of a regression line for bacterial growth goes through 32°F (0°C). This appropriately facilitates the calculation of pathogenic growth rates in

degrees Celsius (°C) over food holding and/or storage temperatures of 41 to 102°F (5 to 38.9°C). The mathematical formulas of Ratkowsky et al. (71, 72) can then be utilized to model or predict pathogenic bacterial growth over a temperature range of 32 to 102°F (0 to 38.9°C) using a statistical software program.

There are two problems with this, however, at the high and low ends of the growth-prediction line. Plotting the regression line through 32°F (0°C) assumes that there is no growth of pathogens below this point. However, this is not true. Therefore, the data have been adjusted to be in keeping with the actual growth data for *L. monocytogenes*, as determined from the scientific literature reported in this paper. From 102 to 130°F (38.9 to 54.4°C), where growth of pathogenic bacteria becomes slower and ceases, the time must be developed empirically, for the present. *Clostridium perfringens* multiplies about every 20 min at 124 to 125°F (51.1 to 51.6°C), so it is assumed that the 4-h limit would apply up to 127.1°F (53°C), the temperature at which the growth of *C. perfringens* ceases.

How many generations of bacteria should be allowed?

An analysis must also be made concerning the number of generations of pathogenic bacteria that will be present in products if potentially hazardous food is held at 41°F (5°C) for 10 days, and at 102°F (38.9°C) for 4 h (240 min), as allowed by the 1993 FDA Food Code (31). Based on the data from research studies identified in this paper, 1 day at 41°F (5°C) is an approximate generation time for one multiplication of *L. monocytogenes*, and 24 min at 102°F (38.9°C) is an acceptable value for one multiplication of *Salmonella* spp. or *S. aureus*. This conveniently works out to 10 multiplications of *L. monocytogenes* and 10 multiplications of *Salmonella* spp. or *S. aureus* at the respective temperatures. This is an increase of population by a factor of 1,024.

Adjusting to the dynamics of temperature fluctuation. However, processing and storage of food actually takes place over a range of times and temperatures. Therefore, the question becomes whether or not it is possible to use this information to integrate calculated growth

over a range of times and temperatures with the goal of limiting the total growth to 10 generations of pathogenic bacteria before the food is consumed or discarded. Research reported by Powers et al. (69), Oz and Farnsworth (64), Taoukis and Labuza (86), Fu et al. (34), Dickson et al. (21), Li and Torres (52), Gill et al. (35), and Mitchel et al. (58) has shown that bacterial growth rates closely follow cycling temperatures. As the temperature of cold food increases, the rate of bacterial growth within the food increases. As temperature decreases, the growth rate of bacteria decreases to that of the new temperature within an hour or two. When the time-temperature history of the food is known, it is possible to integrate the total expected number of bacterial multiplications over a designated period of time. This can be accomplished in hazard analysis critical control point (HACCP)-based production systems, where each process step is monitored and controlled.

SAFETY PARAMETERS CALCULATIONS

Calculation of safe holding times and temperatures between 32° to 130°F (0°C to 54.4°C) based on the 1993 FDA food code

Figure 1 and Figure 2 are graphical illustrations of the use of the Ratkowsky equation to calculate growth rates over the range of 32 to 102°F (0 to 38.9°C). The equation from Figure 2, $y = 0.405x + 0.0016$, was used to calculate growth rates at specific temperatures because it is easier to use. The 0.0016 intercept value is quite small and can be excluded from the calculations. The results of these calculations are shown in Table 1 for 1, 5, and 10 generations of pathogen multiplication.

This table or the regression equation can then be used to evaluate pathogenic bacterial growth in retail food processes or holding periods to assess safety of food products (that there are less than 10 generations of

Figure 7. Generation times for *Staphylococcus aureus* in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations

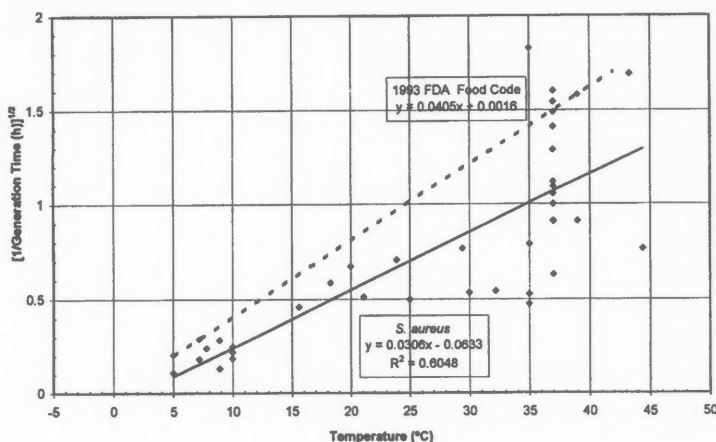
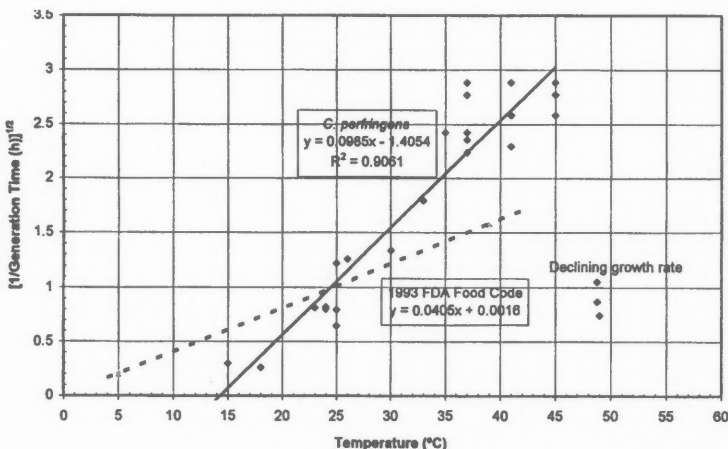


Figure 8. Generation times for *Clostridium perfringens* in a variety of foods as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations



pathogen multiplication). By following the time-temperature flow of the food in the operation, it is possible to calculate the sum of growth of pathogenic bacteria in the food during the time it was processed or held.

Are the times reported in Table 1 reasonable? Many research studies over the years have reported generation times of pathogenic bacteria in various foods. These genera-

tion times have been used to calculate and plot regression lines using a computer software program for comparison of actual bacterial growth to the recommended 1993 FDA Food Code (31) values. Data derived from the growth of the *L. monocytogenes*, *S. aureus*, *Salmonella* spp. and aerobic spoilage bacteria, as well as *C. botulinum*, in food were used to determine if the FDA's two growth

TABLE 3. Generation times for *Listeria monocytogenes* in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Reference no.
29.3	-1.5	129.0	0.09	Roast beef	46
32	0	131.3	0.09	Vac. pkg. raw beef (fat)	39
32	0	113.8	0.09	Vac. pkg. raw beef (lean)	39
32	0	110.0	0.10	Carned beef	40
32	0	180.0	0.07	Ham	40
37.4	3.0	37.6	0.16	Roast beef	46
39.2	4.0	13.0	0.28	Milk	22
39.2	4.0	35.0	0.17	Milk	53
39.2	4.0	48.0	0.14	Milk	53
39.2	4.0	36.0	0.17	Milk	54
41	5.0	43.0	0.15	Raw cabbage	9
41	5.0	44.0	0.15	Coaked meat	15
41	5.0	61.0	0.13	Caaked meat	15
41	5.0	30.3	0.18	Vac. pkg. raw beef (lean)	39
41	5.0	24.5	0.20	Carned beef	40
41	5.0	33.2	0.17	Ham	40
50	10.0	21.7	0.21	Lettuce	10
50	10.0	8.2	0.35	Carned beef	40
50	10.0	13.4	0.27	Ham	40
51.8	11	19.2	0.23	Cabbage	63
55.4	13.0	3.7	0.52	Milk	54
59	15.0	9.7	0.32	Asparagus	8
59	15.0	7.2	0.37	Braccali	8
59	15.0	7.2	0.37	Cauliflower	8
59	15.0	4.5	0.47	Carned beef	40
59	15.0	6.1	0.41	Ham	40
95	35.0	0.7	1.21	Milk	54
98.6	37.0	1.0	1.00	Milk	22

points of 10 days at 41°F (5°C) and 4 hours at 102°F (38.9°C) are reasonable to use as anchor points to predict growth at specified temperatures over the temperature range of 32 to 102°F (0 to 38.9°C).

In Figure 3 generation times for aerobic bacteria in a variety of foods are compared to the predicted FDA safety standard. The plot of the data shows that at temperatures below 59°F (15°C), it is common for aerobic bacteria to multiply faster than the predicted safety standard. This is a very good situation, since it is more desirable for food to spoil before it becomes hazardous due to the multipli-

cation of pathogenic bacteria. Data, calculations, and references are listed in Table 2. This observation that the growth of psychrophilic spoilage bacteria appear to dominate at lower temperatures (below 59°F [15°C]) partially explains the often-cited cause of foodborne illness incidents, lack of refrigeration. The lack of refrigeration means that the food was left at room temperature, 70°F (21.1°C) or above. At these temperatures the growth of pathogenic bacteria is rapid and is not inhibited by the growth of psychrophilic spoilage bacteria. (For example, lactic acid bacteria produce antibacterial com-

pounds, which inhibit the growth of some pathogenic bacteria.)

Figures 4, 5, 6, 7, and 8 are plotted generations times of *L. monocytogenes*, *Y. enterocolitica*, *Salmonella* spp., *S. aureus*, and *C. perfringens* in a variety of foods compared to the predicted FDA acceptable-risk standard. By examining the plotted data, it becomes apparent that the predicted 1993 FDA Food Code values do have some risk, but are acceptable. Some pathogens such as *Y. enterocolitica* can multiply faster than once per day at 41 to 98.6°F (5 to 37°C). However, *Y. enterocolitica* must multiply to a very high population

TABLE 4. Generation times for *Yersinia enterocolitica* in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Reference no.
29.3	-1.5	32.1	0.18	Vac. pack. beef	46
32	0	67.4	0.12	Imitation crab legs	96
32	0	45.2	0.15	Raw beef	44
32	0	44.0	0.15	Oysters	67
37	3	18.0	0.24	Bailed shrimp	67
41	5	9.8	0.32	Beef fat	38
41	5	27.1	0.19	Imitation crab legs	94
45	7	10.3	0.31	Cooked beef	43
45	7	9.2	0.33	Raw beef	43
50	10	12.0	0.29	Imitation crab legs	94
59	15	4.8	0.46	Imitation crab legs	94
77	25	1.3	0.88	Basal broth	38
77	25	1.1	0.97	Cooked beef	43
77	25	1.5	0.83	Raw beef	43

TABLE 5. Generation times for *Salmonella* spp. in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Reference no.
41	5.0	66.7	0.12	Bacon	28
44.6	7.0	106.8	0.10	Raw ground beef	36
46	7.8	21.8	0.21	Chicken á la king	3
48	8.9	16.8	0.24	Chicken á la king	3
50	10.0	13.3	0.27	Chicken á la king	3
55	12.5	12.5	0.28	Raw ground beef	36
55.4	13.0	9.0	0.33	Skim milk	65
55.4	13.0	10.9	0.30	Evaporated milk	65
73.4	23	1.2	0.91	Cantaloupe	37
73.4	23	1.1	0.95	Honeydew melon	37
73.4	23	1.0	1.00	Watermelon	37
77	25	1.5	0.82	Raw ground beef	89
86	30	1.0	1.00	Barbecued chicken	83
95	35	2.4	0.65	Chicken á la king	3
98.6	37	1.2	0.91	Skim milk	65
98.6	37	1.4	0.85	Evaporated milk	65
104	40	0.4	1.58	Barbecued chicken	68

(10⁷/g) to cause illness or disease. The 10-day limit is an acceptable risk, when other factors normally found in food that delay or slow pathogenic bacterial growth are considered (e.g., pH, a_w, E_h, and other inhibitors in formulated foods or foods prepared from standard recipes). (References for the data for these plots are shown in Tables 3, 4, 5, 6 and 7.)

Computer model data based on pathogen growth in media. Buchanan (16), USDA Eastern Regional Research Center, has developed a computer modeling program that can be applied for predicting the growth of bacterial pathogens. These values are based on growth of bacterial pathogens in pure media systems. In Figure 9, the plotted values were obtained from the Buchanan Pathogen Modeling Program 4.0 (17) using pH 6.0 and 0.5% salt. The data were then calculated according to Ratkowsky's square root equation and plotted along with the predicted 1993 FDA Food Code (31) recommendations for comparison. It can be seen that data derived from Buchanan's Pathogen Modeling Program predicts growth slightly more rapid than the predicted 1993 FDA Food Code recommendations. This is to be expected, since these are growth rates of pathogens in media that stimulates optimal growth, not in food. The data and results of the calculations are shown in Table 8.

What about *C. botulinum*? In Figure 10 the time for *C. botulinum* toxin production is plotted together with the predicted 1993 FDA Food Code recommendations. (Table 9 shows the data used for this plot.) It can be seen from the plot of the data that the FDA code prediction has a great deal of safety built into it in terms of toxin production by *C. botulinum*. There will be some multiplication of *C. botulinum* in food. However, most research reports have dealt with the level at which there has been sufficient amount of growth to produce enough toxin to kill mice. This would be the unsafe point as defined in the 1993 FDA Food Code (31). The predicted FDA time allowances are very conservative in terms of time and temperature for the production of *C. botulinum* toxin. There should never be a *C. botulinum* toxin prob-

TABLE 6. Generation times for *Staphylococcus aureus* in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Reference no.
43	6.1	78.3	0.11	Egg custard	3
46	7.8	29.5	0.18	Egg custard	3
48	8.9	16.8	0.24	Egg custard	3
48	8.9	55.7	0.13	Chicken á la king	3
50	10.0	12.0	0.29	Egg custard	3
50	10.0	20.3	0.22	Chicken á la king	3
50	10.0	28.3	0.19	Cooked chicken	95
53.6	12.0	15.9	0.25	Fresh eggs	66
59	15.0	4.7	0.46	Cooked turkey	95
68	20.0	2.9	0.59	Raw milk	23
68	20.0	2.2	0.67	Cooked turkey	95
71.6	22.0	3.8	0.51	Skim and whole milk	48
77	25.0	2.0	0.71	Raw milk	23
78.8	26.0	4.0	0.50	Hamburger sandwiches	7
86	30.0	1.7	0.77	Raw milk	23
86	30.0	3.5	0.53	Barbecued chicken	83
95	35.0	3.4	0.54	Egg custard	3
95	35.0	3.6	0.53	Chicken á la king	3
95	35.0	4.4	0.48	Ham salad	3
95	35.0	1.6	0.79	Raw milk	23
98.6	37.0	0.3	1.83	Skim milk	42
98.6	37.0	0.6	1.29	Whole milk	42
98.6	37.0	0.9	1.05	Light cream	42
98.6	37.0	1.2	0.91	Heavy whipping cream	42
98.6	37.0	0.8	1.12	Skim milk	48
98.6	37.0	1.0	1.00	Whole milk	48
98.6	37.0	2.5	0.63	Bacon	51
98.6	37.0	0.39	1.60	Cream	87
98.6	37.0	0.42	1.54	Whole milk	87
98.6	37.0	0.45	1.49	Skim milk	87
98.6	37.0	0.84	1.09	Cheese whey	87
98.6	37.0	0.50	1.41	Shrimp slurry	91
110	43.3	1.2	0.91	Roast beef	13
112	44.4	0.35	1.69	Barbecued chicken	68
114	45.5	1.7	0.77	Roast beef	13

lem using the projected FDA time-temperature values.

REVIEW

A summary comparison of the empirical values for the five pathogenic bacteria, aerobic bacteria, and *C. botulinum* toxin production and the FDA 1993 Food Code (31) recom-

mendations is shown in Figure 11. Except for the growth of *C. perfringens* at high temperatures and of *L. monocytogenes* and *Y. enterocolitica* at low temperatures, the predicted 1993 FDA Code food-holding temperatures and times standards (31), while allowing 10 multiplications of pathogenic bacteria, are an acceptable risk.

In most retail food operations, low levels of pathogens, which include *L. monocytogenes*, *Salmonella* spp., and *S. aureus*, will be present in food and can multiply. This analysis shows that the predicted 1993 FDA Food Code (31) holding temperatures and times of 41°F (5°C) for 10 days and 4 h at 102°F (38.9°C) coupled with the Ratkowsky square root equation (71, 72) can be used as a basis for developing a combination of times and temperatures that can be used for holding foods safely from 32 to 130°F (0 to 54.4°C). These calculated times and temperatures are representative of 10 generations of pathogenic bacteria multiplication at 41°F (5°C) for 10 days and/or 4 h at 102°F (38.9°C), as allowed by the 1993 FDA Food Code (31). These equivalent temperatures and times will allow the retail food industry to continue to operate with current commercial refrigerators that are not designed to hold food at 41°F (5°C).

The information presented in this analysis can be integrated throughout the processing and storage of food to conservatively predict the number of generations of pathogenic bacteria multiplication in a recipe process. Predictions are conservative because typical recipes and food formulations have ingredients that reduce bacterial growth rates as determined in optimal food. In this way, a recipe or food-production process can be certified as safe by a "certified chilled-food process authority" when the process HACCP system is approved. The safety standard is that the projected multiplication of pathogenic bacteria must be less than 10 generations in food before there is inactivation of the microorganisms by cooking or other forms of pasteurization, or consumption of the food. After food is cooked or pasteurized, times and temperatures must control pathogens in a specific food to less than 10 generations.

Application of this information can be used to assure food safety and to prevent the unnecessary waste of food, especially in retail operations when food is not always kept below 41°F (5°C). Using the data and information in this analysis will also per-

Figure 9. Generation times for *Listeria monocytogenes*, *Escherichia coli*, *Salmonella* spp., and *Staphylococcus aureus* [Buchanan's data [17]], compared to 1993 FDA Food Code holding/storage recommendations

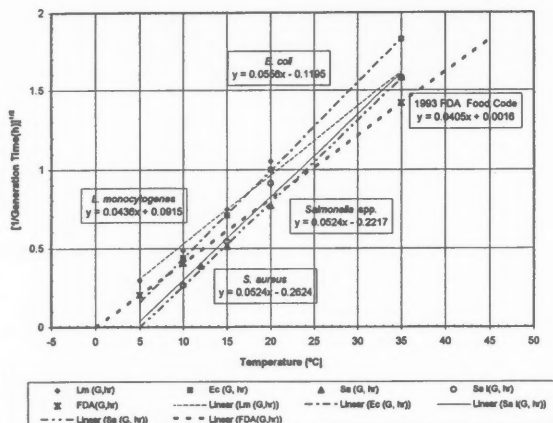


Figure 10. Time for toxin production in a variety of foods by *Clostridium botulinum* as a function of temperature, compared to 1993 FDA Food Code holding/storage recommendations

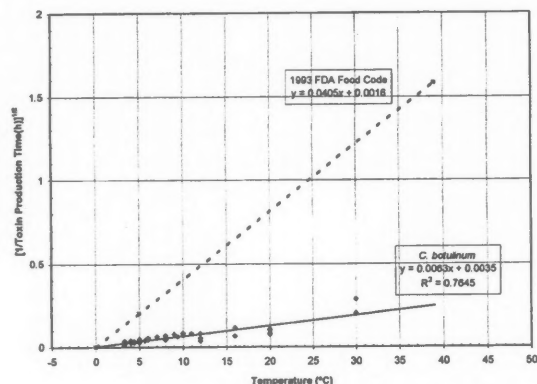
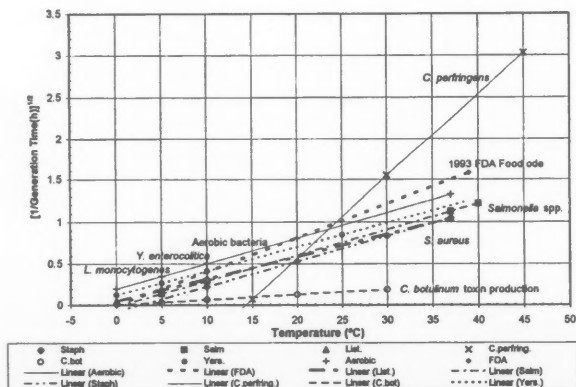


Figure 11. Summary of generation times (growth rate data) of pathogenic bacterium in a variety of foods, compared to 1993 FDA Food Code holding/storage recommendations



mit the safe application of time-temperature standards to food items stored in chilled food systems where, for economic reasons, refrigerated foods need to be capable of a 60-day storage period or more at 28 to 32°F (-2.2 to 0°C).

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TABLE 7. Generation times for *Clostridium perfringens* in a variety of foods as a function of temperature

Temp. (°F)	Temp. (°C)	Gen. time (h)	(1/Gen. time) ^{1/2} (h ⁻¹)	Food	Reference no.
59	15.0	11.2	0.30	Thioglycolate broth	75
65	18.0	14.5	0.26	Beef cubes	41
73.4	23	1.51	0.81	Cooked mashed pinto beans	59
75	24	1.47	0.82	Ground beef cosserole	84
75	24	1.55	0.80	Turkey rolls	84
77	25	2.38	0.65	Cooked meat	6
77	25	1.57	0.80	Turkey rice soup	6
77	25	0.67	1.22	Mashed potatoes	6
78	26	0.63	1.26	Cooked ground beef	93
86	30	0.56	1.34	Borbecued chicken	83
91.4	33	0.31	1.80	Cooked ground beef	93
95	35	0.17	2.43	Cooked meat	6
98.6	37	0.20	2.24	Cooked chicken breast	57
98.6	37	0.18	2.36	Cooked chicken leg	57
98.6	37	0.20	2.24	Cooked turkey breast	57
98.6	37	0.17	2.43	Cooked turkey leg	57
98.6	37	0.12	2.89	Cooked mashed pinto beans	59
98.6	37	0.13	2.77	Turkey rolls	84
105.8	41	0.12	2.89	Cooked ground beef	93
105.8	41	0.15	2.58	Row ground beef	94
105.8	41	0.19	2.29	Row beef strips	94
113	45	0.48	1.44	Borbecued chicken	68
113	45	0.15	2.58	Meat loaf	79
113	45	0.12	2.89	Cooked ground beef	93
113	45	0.13	2.77	Row ground beef	94
120	48.8	0.9	1.05	Roast beef	14
120	48.8	1.31	0.87	Roast beef	13
120.2	49	1.8	0.75	Cooked ground beef	93
123.8	51	0.51	1.40	Cooked ground beef	94

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TABLE 8. Generation times for *Listeria monocytogenes*, *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus* (Buchanan's data [17])

Temp. (°F)	Temp. (°C)	Generation time (h)	Calculated generation time (h)	Microorganism
41	5	11.2	37.3	<i>Listeria monocytogenes</i>
50	10	4.2	6.0	<i>Listeria monocytogenes</i>
50	10	5.2	6.0	<i>Escherichia coli</i>
50	10	14.0	6.0	<i>Salmonella</i> spp.
53.6	12	6.6	3.9	<i>Staphylococcus aureus</i>
59	15	1.8	2.3	<i>Listeria monocytogenes</i>
59	15	2.0	2.3	<i>Escherichia coli</i>
59	15	3.8	2.3	<i>Staphylococcus aureus</i>
59	15	3.4	2.3	<i>Salmonella</i> spp.
68	20	0.9	1.2	<i>Listeria monocytogenes</i>
68	20	1.0	1.2	<i>Escherichia coli</i>
68	20	1.7	1.2	<i>Staphylococcus aureus</i>
68	20	1.2	1.2	<i>Salmonella</i> spp.
95	35	0.3	0.4	<i>Escherichia coli</i>
95	35	0.4	0.4	<i>Listeria monocytogenes</i>
95	35	0.4	0.4	<i>Staphylococcus aureus</i>
95	35	0.4	0.4	<i>Salmonella</i> spp.

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TABLE 9. Times for production of toxin by *Clostridium botulinum* in a variety of foods as a function of temperature °

Temp. (°F)	Temp. (°C)	Toxin time (h)	(1/Toxin time) ^{1/2} (h ⁻¹)	Type	Food	Reference no.
38	3.3	744	0.037	E	Beef stew	78
38	3.3	3094	0.018	B	Cooked meat	24
38	3.3	1440	0.026	F	Cooked meat	25
38	3.3	964	0.032	BEF	Fish	5
39.2	4.0	744	0.037	B	Beef	19
39.2	4.0	1440	0.026	BEF	Salmon	5
39.2	4.0	1344	0.027	BEF	Rockfish	5
39.2	4.0	644	0.039	BEF	Fish	5
40	4.4	1320	0.028	E	Crabmeat	18
40	4.4	864	0.034	B	Cooked meat	24
40	4.4	768	0.036	F	Cooked meat	25
41	5.0	1344	0.027	E	Cooked meat media	61
41	5.0	426	0.048	BEF	Fish	5
42	5.6	624	0.040	B	Cooked meat	24
42	5.6	624	0.040	F	Cooked meat	25
42.8	6.0	456	0.047	E	Beef stew	78
42.8	6.0	312	0.057	BEF	Fish	5
44.6	7.0	243	0.064	BEF	Fish	5
46.4	8.0	360	0.053	BEF	Salmon	5
46.4	8.0	504	0.045	BEF	Rockfish	5
46.4	8.0	197	0.071	BEF	Fish	5
48.2	9.0	163	0.079	BEF	Fish	5
49	9.4	240	0.065	E	Beef stew	78
50	10.0	192	0.072	E	Crabmeat	18
50	10.0	138	0.085	BEF	Fish	5
51.8	11.0	144	0.083	E	Beef stew	78
53.6	12.0	336	0.055	E	Crabmeat	81
53.6	12.0	720	0.037	E	Hamburger	50
53.6	12.0	144	0.083	BEF	Salmon	5
53.6	12.0	360	0.053	BEF	Rockfish	5
60.8	16.0	72	0.118	BEF	Salmon	5
60.8	16.0	216	0.068	BEF	Rockfish	5
68	20.0	84	0.109	A	Mushrooms	85
68	20.0	96	0.102	A	Cabbage	82
68	20.0	168	0.077	A & B	Sandwiches	50
68	20.0	144	0.083	BEF	Rockfish	5
86	30.0	12	0.289	BEF	Salmon	5
86	30.0	24	0.204	BEF	Rockfish	5

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"These calculations were developed before the FDA 1995 food code was published. Although there are revisions and additions to the 1995 food code, the FDA recommended times and temperatures for holding potentially hazardous foods (with the exception of roasts cooked according to §3-401.14, FDA 1995 food code) are the same.

A Statistical Approach to Evaluating the Effectiveness of Hand-Cleansing Products Used in the Food-Processing Industry

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INTRODUCTION

The potential for food handlers to be vectors in the transmission of foodborne disease continues to be a significant issue (2, 3, 11). Microorganisms found on the hand surfaces are classified in two general categories. The first category consists of contaminating microorganisms which are accidentally picked up by food handlers and are transient in that they reside on the hands only temporarily. The second category consists of those microorganisms which permanently reside on the hand surfaces, the normal microflora of the skin. For example, on the hands, *Staphylococcus epidermidis* is a resident bacterium and *Escherichia coli* is a transient or contaminating bacterial species.

In the food industry, both categories are important. Contaminating microorganisms are responsible for infectious disease outbreaks often passed from food handlers to consumers via food. Perhaps the most common occurrence of this phenomenon is in

situations where food handlers encounter enteric microorganisms (e.g. *Escherichia coli*, *Salmonella* spp., and *Shigella* spp.) from contact with their infected feces or the infected feces of others (usually via hand-to-hand transmission). The problem occurs when these microorganisms are not removed by an effective handwashing. The contaminating microorganisms are then passed on to the food being prepared and, thus, to the consumers through the food.

The microorganisms which normally reside on the hands usually do not pose any threat of infectious disease to consumers. These microorganisms are more important in contributing to food spoilage, particularly in partially prepared foods such as precooked chicken and fish.

Designing an accurate and valid method of determining the effectiveness of hand-cleansing products is critical. Since a number of serious disease outbreaks associated with various hand-cleansing practices has been established, it is critical

that one knows for a fact the effectiveness of the hand-cleansing practices.

Since the skin surfaces provide a unique habitat for microorganisms, knowledge of skin microbial ecology as well as histology, physical features, and nutrient factors of the skin are important.

Knowing the histological structure of the skin can be an aid in understanding both the physical and nutritional characteristics of the skin relative to microorganisms. A number of histological structures that must be taken into account relative to the microbial populations encountered include exocrine sweat glands, sebaceous glands, apocrine glands, and hair. Other physical factors influencing microbial growth in both variety and population numbers include the pH, temperature, and humidity of the skin, and the surface oxygen/carbon dioxide tension as well as age, diet, and anatomical site of interest. Finally, a knowledge of the types of microorganisms that normally inhabit and colonize the

skin surfaces is valuable. They include coryneform bacteria, the *Micrococcaceae*, including *Staphylococcus* strains; *Streptococcus* spp; gram-negative bacteria including *Escherichia coli*; various fungi; virus particles; and *Mycoplasma* spp. (6).

With this knowledge, the investigator can determine what is the best media on which to culture the microorganisms that will be encountered at the anatomical sites of interest. But one cannot stop here. One must collect the numerical data and evaluate them. Statistical methods are of great benefit in this respect.

Statistically designed evaluations

A statistically designed evaluation is one that systematically collects, organizes, analyzes, and draws valid conclusions about the hand-cleansing product(s) being evaluated (4). When one designs an experimental evaluation, it is critical that the objectives be explicitly stated and that the evaluation be designed to answer those objectives clearly and concisely.

Description of the purpose of the evaluation

A concise description of the purpose of the evaluation is so obvious that it is often ignored until the evaluation has been completed. But, unfortunately, often the original objectives have become obscure and unclear. Then the investigator must backtrack through the evaluation records, trying to determine what the original objectives were.

Once the purpose of the evaluation has been determined, the study can be designed to answer the objectives and purpose in a valid manner. Validity in experimental designs encompasses two areas: internal and external validity.

Internal validity

Internal validity is research-design validity. In particular, it deals with the way the study is designed, how sample data are collected and how the study is experimentally controlled, especially with respect to investigator bias. It is well known that each investigator has a "vested interest" in realizing that the area of their interest be successful. This bias must be taken into account (13).

Fortunately, internal validity can be assured by using proper experimental design procedures (e.g., randomizing, blocking and blinding the study). While there are a number of aspects to internal validity, two of the most common are historical and instrumentation validity (7).

Historical validity assures that no event occurs between sample time measurements which biases the study results. An example of the negation of historical validity happened when a meat packing plant conducted a handwashing efficacy study. The investigator initially took baseline samples of the employees which were accurate and reliable. The investigator then assigned individuals a test product but, unknown to the investigator, 7 of the 10 participants began using an antimicrobial soap in their personal hygiene practices. They wanted to look good for the investigator. The test product was credited with providing effective degerming properties but, in reality, the effect was largely due to the antimicrobial soaps used in personal hygiene practices.

Instrumentation validity is achieved by assuring that no extraneous events occur which affect the measuring instruments used in the experiment. For example, recently, in a poultry processing plant, a quality-control microbiologist used different agar media lots in assessing a hand-washing study. The media lots, made by different manufacturers,

differed significantly in nutritional characteristics and, therefore, microbial growth, thus biasing the data. Microbial colonies grew well on one lot but not the other. This growth difference was attributed to the hand-cleansing soaps, which was not the case.

External validity

External validity refers to the extent the results of a specific study can be generalized to the population at large (population validity) or to all general environmental conditions (environmental validity). An example of a lack of population validity occurred when an investigator used all females of Nordic descent in a handwash efficacy evaluation. Since these women tended to have low microbial population counts on their hands, the investigator concluded washing with merely soap and water was adequate for all company processing plants. However, it soon became apparent that this regimen was not as effective as portrayed. A major reason was that men as well as individuals from different ethnic backgrounds had greater normal microbial populations residing on their hand surfaces. A mild, non-antimicrobial soap and water wash was not enough to cleanse the hands of those employees.

An example of a lack of environmental validity can also be given from this particular study. Not only did the investigator utilize women from Nordic descent, but also the study was conducted in Montana in the winter, where the microbial populations residing on the hands are relatively low because of the dry, cold air. Higher microbial populations were encountered in the southern processing plants in Georgia, Louisiana, and southern Texas. Again, a mild, non-antimicrobial soap and water wash was not adequate to cleanse the hands of employees working in those areas.

No experimental design has built-in controls for assuring external validity (8). A simple way to ensure external validity is to have the study conducted independently at a different geographic location. If consistent results are observed and the same conclusions drawn by a different investigator, the external validity of the study is probably satisfactory.

Statistical methods

The vast majority of quantitative research designs utilize statistics. Hence, it is critical to select appropriate statistical models (e.g., linear regression, analysis of variance, analysis of covariance, Student's *t* test, or others) that complement the experimental design.

The exact statistical model to be used depends, in part, on the data distribution generated (normal, skewed, bimodal, exponential, binomial, or other). The use of exploratory data analysis procedures can help the investigator select the appropriate statistical model and develop an intuitive "feel" for the data before the actual statistical analysis begins.

It is also important to ensure that the experimental data collected are of linear scale, a requisite of most statistical models. For example, if one is evaluating the antimicrobial properties of a hand cleanser, the experimental data are the microbial colony counts. A problem is that microbial inactivation rates are usually not linear; they are exponential. Hence, the exponential microbial count data must be transformed to linear scale. Let me present an example. Say the baseline average microbial counts are 1.0×10^6 . Upon washing with an iodine product, the microbial population levels are 1.0×10^4 , and an hour later, they are 1.0×10^5 . Evaluating these numbers as they are (in exponential scale) poses statistical problems, for these data

are nonlinear. However, if the logarithmic values of these data are used, the data are transformed to log linear scale. The log transformed values—6, 4, and 5, respectively—can now be utilized in linear statistical models.

Additionally, it is necessary to establish the levels of both alpha (α) and beta (β) error, so that the appropriate number of test items (sample size) to be evaluated can be selected relative to the desired statistical confidence level. Recall that α error (type I error) is committed when one rejects a true-null hypothesis and β error (type II error) is committed by accepting a false-null hypothesis. For example, an α error occurs when one states that there is a difference between handwashing products or methods when there really is not; a β error occurs when one concludes that there is no difference between handwashing products or methods when there really is. The easiest way to control both α and β errors is to use more test subjects so that the possibility of both α and β errors is reduced. Otherwise, merely setting the α error to a very small level will increase the probability of β error.

Let us now briefly address the two general types of statistical models available: parametric and nonparametric.

Parametric statistics

Parametric statistics include the Student's *t* test, linear regression, analysis of variance, and analysis of covariance utilizing parameters (the mean [average], the standard deviation, and the variance) in evaluating data. The data collected are termed "interval" data (102.915, 1×10^5 , 7.23914...). Interval data can be ranked as well as subdivided into an infinite number of intervals (5). Usually, interval data relate to some standard physical measurement (e.g., weight, amount of soap, or flow velocity).

Common parametric models

Student's *t* test. Probably the most common parametric statistical model is the Student's *t* test. It is often used to compare two groups of data to each other. That is, it is used to compare a test group of values to a specific value or to compare two groups of values (a test and a control group or two test groups) to one another. It can be used as a "one tail" test to determine if one group is "better" or "worse" than another, or a "two-tail" test to determine if they "differ." An example where a *t* test can be used is when one has two different products and wants to determine if they are equivalent in antimicrobial effectiveness.

Analysis of variance (ANOVA). Analysis of variance is also a common parametric statistic that is used to compare more than two groups. There are a number of variants of this model, depending upon the number and combination of groups, categories, and levels one desires to evaluate. Common ones include one-factor, two-factor, and three-factor designs, as well as crossover and nested designs (6, 8). This design is valuable when one wants to compare more than two different products to one another at different times. For example, if one wants to compare the antimicrobial efficacy of three different products immediately after the wash as well as one hour later, an ANOVA model can be used.

Regression. Regression analysis is also a common statistical method. It is used to predict a response or dependent variable (*y*) from the value of an independent variable (*x*). These models are commonly used in time-series evaluations. Examples are thermal-death rates used in canning practices, disinfectant kill-time rates, D-value determinations and product degradation rates (10).

Nonparametric statistics

Nonparametric statistics do not utilize parameters (mean, standard deviation, and variance) in evaluating data. However, they can utilize interval and noninterval data, both nominal and ordinal. Nominal data can be grouped but not ranked. Data such as right/left, male/female, yes/no, and 0/1 are nominal data. Ordinal data can be both grouped and ranked. Examples include good/bad, poor/average/excellent, lower class/middle class/upper class, and low/medium/high levels of drugs.

Nonparametric statistics are often used with interval data when the sample size is very small. When using very small sample sizes, the variable data distribution often cannot be assured to be "normal," a requisite for using parametric statistics. A normal "bell curve" distribution is not a requirement of nonparametric models. Hence, they are preferred in this area over parametric models.

Common nonparametric models

Mann-Whitney statistic. This test is the nonparametric analog to the Student's *t* test. It is used to compare two groups to one another. Unlike the parametric Student's *t* test which assumes a normal "bell-shaped" distribution, the Mann-Whitney statistic requires

only that the sample data be randomly selected.

Kruskal-Wallis model. This is the nonparametric analog to a one-factor ANOVA model. It is used to compare multiple groups of one factor. For example, suppose one wants to evaluate the effectiveness of a hand-cleansing product at five different application times. The Kruskal-Wallis model could be employed for this evaluation.

Linear regression. A common nonparametric regression analog to the log linear regression method of determining the D-value in sterilization processes is the Stumbo-Murphy-Cochran method (12). However, there are several other nonparametric analogs for both linear and nonlinear situations which are very reliable (1).

CONCLUSION

It is important that each evaluation be designed to address the purpose of the evaluation. Additionally, it is important that investigators be familiar with a large selection of quantitative designs. This will prevent the investigator from trying to evaluate hand-washing products from a limited perspective with limited statistical ability, providing limited quality results.

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REGULATORY REFORM RECOMMENDATIONS

EXPORTS AND IMPORTS

The U.S. imports and exports tens of billions of dollars worth of food each year. International trade in the food arena is complex because nations often employ different systems of food safety. Nations have differing standards for the production of safe and wholesome food as well as varying regulatory procedures for inspecting and safeguarding product safety and quality. Companies seeking premarket approval of food additives and animal drugs, for example, must complete different applications for marketing approval in each country, entailing varying batteries of required tests. Similarly, most countries have laws like those in the United States that require imports of meat and poultry to have been subjected to inspection requirements equivalent to domestically produced products, and often require some form of certification to demonstrate that these products meet these requirements. FDA and FSIS try to facilitate international trade in the products they regulate in a manner consistent with their primary missions of food safety and consumer protection, with U.S. regulatory requirements, and, to the extent possible, with foreign requirements.

1. Harmonization of International Standards (FDA and FSIS)

Background: As noted above, nations often employ different regulatory standards relating to food safety. Because so much of our

nation's food supply is either imported or exported, there is a substantial need to harmonize standards while retaining the U.S.'s high level of public health protection.

Proposal and Justification: FDA will seek common, science-based, international standards. The Agency will work with other countries, such as Canada, Mexico and the European Union and through international fora, especially the Codex Alimentarius Commission, to harmonize food and animal drug safety standards. In addition, FDA will encourage the harmonization of registration requirements for animal drugs.

FSIS will continue to ensure that equivalent inspection systems and standards for meat and poultry products exist in all countries exporting such products to the U.S., especially in light of the better U.S. safety standards expected under HACCP.

FDA also will evaluate the food safety systems of other countries, with the purpose of entering into agreements with those countries having food safety systems that offer equivalent levels of public health protection to those of the U.S. or that can provide assurance that their products will be in compliance with FDA requirements.

In addition, FDA and FSIS will work together to improve procedures for U.S. evaluation and, where appropriate, acceptance of Codex standards and to facilitate public participation in that process.

Impact: Increased harmonization offers clear benefits for U.S. public health. It increases the safety and quality of food imported into the U.S. It can also improve the safety and quality of foods produced and sold in foreign countries, as more countries participate in the international standard setting process.

Harmonization benefits industry by replacing many different standards with one international standard that must be met. In the long run, harmonization provides a level playing field, brings cost savings to industry, opens markets, enhances opportunities for export of U.S. goods and, in some cases, lessens the time needed to bring new products to market.

Harmonization permits FDA and FSIS to make more efficient use of their resources, as other countries share the workload of developing new standards. Investing now in harmonization may save future U.S. government resources by fostering cooperation with other countries in the assessment of new products.

Bilateral and multilateral agreements improve the safety of food imported into the U.S. from countries with which agencies have such agreements, allowing the agencies focus inspection and laboratory resources in other, more crucial areas, and provide predictable requirements for U.S. exports to such countries.

Implementation and Timeline: FDA and FSIS will build on and expand efforts to achieve international harmonization by:

- Continuing to participate actively and exert leadership in the development of international standards by Codex and other relevant international standard-setting organizations.
- Promoting international adoption of U.S. standards whenever appropriate.
- Developing routine procedures for the review of international standards, guidelines and recommendations with a view toward accepting them when they provide adequate health protection and for revision or revocation of existing U.S. requirements, as necessary. (Proposed procedures are expected to be completed within one year.)
- Initiating work towards more harmonization with our North American Free Trade Agreement (NAFTA) and other regional trading partners. Such efforts should become part of the work plans of existing technical working groups formed under the Canada/U.S. Free Trade Agreement.
- Intensifying efforts to enter into agreements with other countries.
- Improving procedures for consideration of international standards in FDA and FSIS rulemaking.
- Beginning an initiative to harmonize registration requirements for animal drugs. The first proposal for harmonized guidelines should be completed within three years.

2. Enhanced Use of the Private Sector in Monitoring Imported Foods (FDA)

Background: FDA oversees the importation each year of about 1.5 million food entries. While the Agency reviews paper or electronic documentation on almost all imports, it has the resources to

examine physically only about 8 percent of the entries, and to perform laboratory analyses on about 2 percent. While the Agency targets its resources towards those products most likely to be in violation of the Federal Food, Drug, and Cosmetic Act, the relatively low inspection rate has been the subject of congressional hearings on the safety of imported foods.

FDA would like to make increased and better use of private, state and local laboratories to monitor food imports, both to reduce the length of time importers of foods must wait for results of laboratory analysis, and to increase the percentage of imported foods receiving sample analysis.

FDA already has several initiatives under way. For example, the Agency's New York District has just completed a pilot program in which importers of seafood, after receiving approval from FDA, were able to choose between having their products sampled and tested by FDA or by a private laboratory at their own expense. The private laboratories allowed FDA increased access to their facilities and submitted all of their results directly to the Agency. The Agency and the import and laboratory communities are now evaluating the program to see if it met the needs and expectations of all parties.

The Boston District of FDA is presently conducting a similar pilot program. Additionally, the Agency has entered into or is negotiating partnership agreements with several state governments in which state inspectors collect import food samples for FDA analysis, or for analysis by the states themselves.

Private laboratories already play a substantial role in testing imported foods that the Agency has detained without physical examination. (FDA may detain products without physical examination where there is prior evidence of a violation.) FDA expends substantial resources monitoring the laboratories and reviewing their analytical reports.

Proposal and Justification:

FDA will work to develop pilot programs that make better use of private and state or local laboratories for analyzing food imports. The Agency will solicit input from the import, laboratory, and consumer communities by holding public meetings around the country, and by publishing in the Federal Register a notice requesting comments on how best to enhance Agency use of private, state and local laboratories for analyzing food imports.

Impact: The development of pilot programs will enable the Agency to learn how best to make further use of non-FDA laboratories for monitoring and analyzing imported foods. Ultimately, these programs should enable the Agency to institute programs that will make significantly increased and better use of the private sector and state and local governments for monitoring imported foods in order to ensure their safety. Such enhanced use of non-FDA resources should also reduce the time importers of foods have to wait for results of laboratory analysis, while at the same time increase the percentage of imported foods receiving sample analysis.

Implementation and Timeline: The Agency will hold a series of public meetings, and will publish a Federal Register notice, to solicit information on how best to make increased and better use of private, state and local laboratories to monitor imported foods. FDA will then begin to initiate pilot programs based on that information. Additionally, to help develop pilot programs making enhanced Agency use of private laboratories, FDA also will publish, by December 1996, either a guidance document and/or proposed rule to establish acceptable practices for laboratories.

3. Animal Drug Exports (FDA)

Background: Current law prohibits the export of U.S. manufactured animal drug products

unless the drug's substance, labeling, and use conform to an approved marketing application in the U.S. or FDA has approved an export application for the animal drug product. For FDA to approve such an export application, the drug must be subject to an investigational use exemption and the manufacturer must be actively pursuing U.S. marketing approval. In addition, current law permits export of unapproved products to only 21 developed countries. This means that, even if an animal drug is approved by the importing country, it often cannot be exported to that country from the U.S.

Proposal and Justification:

FDA will work to allow the export of animal drugs, whether or not they have been approved for marketing in the U.S., to any country so long as the exported product has been approved for marketing in the receiving country. This change from current procedures would significantly relax restrictions on exports of animal drugs.

Impact: First, U.S. manufacturers of animal drugs will have the opportunity to expand their exports. Because use conditions for animal drugs in other countries can differ dramatically from use conditions in the U.S., foreign countries frequently approve products with different dosages, claims, strengths, animal species, etc. than are considered for use in the U.S. Legislative changes that permit the export of products in forms or with labeling that have not been approved in the U.S. will therefore expand the market available to U.S. exporters.

Second, companies may be more likely to locate animal drug manufacturing plants on U.S. territory. Industry believes that the current statutory language has contributed to animal drug manu-

facturers locating plants off-shore where domestic laws do not prohibit finished dosage form drugs from being labeled according to the specifications of the foreign purchaser and according to the laws of the country to which it is intended for export.

Implementation and

Timeline: This action requires a statutory change. The Administration is engaged in discussions with Congress on new legislation.

4. Abbreviated Application for Veterinary Drug Residues in Imported Foods

Background: Currently, FDA establishes legally acceptable levels (tolerance levels) of veterinary drug residues in food only through its drug approval process. Thus, even for drugs that would not be used domestically (for example, because they are intended to treat diseases or pests that are not problems here), and for which the only domestic health concern would be that the residues in food be safe, the sponsor would submit, and the agency would review, data demonstrating that the drug is effective and safe for use in animals.

This requirement is burdensome both to the agency and industry, and adds nothing to public health or safety of American consumers. It also has the following undesirable effects:

- it discourages manufacturers of drugs used in foreign countries from seeking tolerances for the drug residues in food, so that the United States government is less informed in foods exported to the United States;
- it impedes the agency's ability to accept standards set by the Codex Alimentarius Commission (Codes) for residues of veterinary drugs

in foods, despite the FDA's commitment to Codes, and the standing given to Codex standards by the Uruguay Round Agreements; and

- it shrinks the market abroad for animal drugs (that are or could be manufactured domestically) aimed at treating conditions or species not common in the United States, when food from those animals is intended for export to the United States.

Proposal and Justification:

For animal drugs intended for use abroad, FDA will develop an administrative mechanism, or will seek specific legislative authority, to enable the agency to focus its reviews on the safety of the drug residue in the imported food product. FDA would rely on the provisions of its new animal drug regulations that spell out the residue studies and toxicological data required to determine whether such a drug residue is safe, such that a tolerance level would be appropriate for humans who consume the food. Such tolerances could be granted based on outside petitions or on the agency's own initiative, for example after reviewing a Codex decision to adopt a veterinary drug residue tolerance. The agency would eliminate or reduce the requirements for its review of whether the drug is safe and effective for use in animals in foreign countries.

Impact: This change would eliminate entirely, or make less burdensome, an unnecessary approval requirement and would be a step in the direction of international harmonization of regulatory requirements, as encouraged by the Uruguay Round Agreements.

Implementation and Timeline: FDA is pursuing administrative solutions and concurrently seeking this specific legislative authority.

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UpDates

Dresser Instrument Division Promotes James Cummings to General Manager—Control Instruments Operations

On February 5, 1996, John W. Caldwell, President Dresser Instrument Division, headquartered in Stratford, CT, announced the appointment of James W. Cummings to General Manager—Control Instruments Operations, Milford, CT.

Jim Cummings has been with the Instrument Division for 20 years in various engineering and managerial capacities. He spent eight years working with pressure gauge products produced at the Stratford Operations (Connecticut) and Commercial Instrument Operations (Berea, KY). For the past 12 years, Mr. Cummings has been with the Control Instruments Operations in Milford, CT.

Mr. Cummings graduated in 1976 with a Bachelor of Science in Mechanical Engineering from Western New England College, Springfield, MA. In 1982, he received a M.B.A. from the University of Connecticut.

Dryden Engineering Appoints New Contamination Control Specialist

Tracking the growth of electronics-based industries in the Pacific Northwest, Dryden Engineering Company, Inc. has hired Tony Carson to join the firm's team of Contamination Control Specialists serving the high-tech

corridor between Oregon and Vancouver, British Columbia.

Mr. Carson has been involved with cleanroom services since 1985. Prior to joining Dryden Engineering, he held positions as the manager for the Western Cleanroom Divisions for two Fortune-listed cleanroom garment processors. In his field, he has pioneered cost-reducing site management services in the region's largest cleanrooms.

Joining Dryden Engineering's Rick Olsen in servicing the growing list of electronics-based companies that are congregating in the north-west Oregon and Puget Sound area, Mr. Carson is well known for his work throughout the West on issues related to personnel entry, contract staffing, gownroom layout, garment selection and processing.

In his announcement of expanded services in the Pacific Northwest, Dick Dryden, the firm's founder and Chief Executive, noted that Carson and Olsen will share responsibility for expansion of Dryden's Special Products Group in the area.

International Operations Executive Promoted at Dresser Instrument Division

John W. Caldwell, President Dresser Instrument Division, announced the appointment of Calvin E. Kish to Vice President, International Operations, from General Manager, International Operations. The Instrument Division operates its International

Operations at division headquarters in Stratford, Connecticut.

Cal Kish's 20-year tenure with Dresser Instrument Division includes manufacturing management and general manager at the Control Instrument Operations in Milford, CT. A resident of Trumbull, CT, he has been with the International Operations since 1990.

Mr. Kish graduated from the University of New Haven, New Haven, CT, in 1967 with a Bachelor of Science in Industrial Engineering.

Biotrace International Signs Marketing Agreement with Ecolab Inc.

Biotrace International Plc and Ecolab Inc., Food and Beverage Division, have signed an agreement for Ecolab to distribute Biotrace's rapid sanitation testing systems in the North American dairy, food and beverage markets.

Biotrace International is headquartered in the United Kingdom with its North American subsidiary based in Plainsboro, NJ. Ecolab will market and distribute Biotrace's Uni-Lite® XCEL brand.

New Inside Sales Representative Appointed at G&H

G&H Products Corp. has appointed Bob Lawrence as the new Inside Sales Representative for the Pump Department. Bob will provide customer service and sales assistance for pumps, including sizing and application recommendations.

Bob has previous experience with providing pump sizing and application assistance for a whole-sale pump and plumbing supply house, as well as supervisory experience in customer service. He holds a BA from Marquette University.

G&H Products Corp. is a full-line supplier of stainless steel pumps, valves, measuring and control equipment. G&H is a part of the worldwide market leader, the LKM Group, a division of Alfa Laval.

IFT Announces 1996 Achievement Award Recipients

Nicholas Appert Award

Michael P. Doyle, Ph.D., professor of food microbiology, Dept. of Food Science and Technology, and director, Center for Food Safety & Quality Enhancement, University of Georgia, is the Nicholas Appert Award winner. IFT's highest award honors Doyle for his pioneering research in microbiological food safety. The medal carries with it a \$5,000 honorarium.

International Award

Larry R. Beuchat, Ph.D., professor of Food Science and Technology, University of Georgia, is the winner of the International Award for his success in teaching food science and technology to developing nations such as Ghana and India. He will receive a plaque and \$3,000.

Dahlke Elected DFISA Chairman—Sherrill, Chairman-Elect

James S. Dahlke, President, Medalist Industries, Inc., was named Chairman of the Board of the Dairy and Food Industries Supply Association (DFISA), at the Association's Annual Conference held at the Loew's Coronado Bay Resort. As Chairman, Dahlke will preside over the 23-member Board of Directors.

Dahlke, actively involved on DFISA committees for more than fifteen years, has served on the Association's Board of Directors, the DFISA Foundation Board of Directors, and the International Trade, Marketing, Exposition Floor,

Executive and Special Awards Committees. Also elected at the Conference was DFISA's new Chairman-Elect, John R. Sherrill, who has been President of M.G. Newell for the past eleven years. Involved in this industry since 1968, he has represented Distribution & Transportation members on DFISA's Board of Directors since 1992, and he completed a term as President of Food Industry Suppliers Association (FISA) in 1995, where he was elected Vice President in 1991.

In addition to the Chairman-Elect selection this year, there were only four Director openings, and the race was very close. Three At Large Directors were elected from a field of six candidates. Each of the following people will serve a 3-year term: Beth Kloos, The Haynes Manufacturing Company, Westlake, OH; Steve Lefevre, King Engineering Corporation, Ann Arbor, MI; and John Nelson, Nelson-Jameson, Inc., Marshfield, WI.

One commodity director slot, representing ingredient supplier members, was also open, and filled by Bruce Poulterer, Germantown (USA) Company, Broomall, PA.

In Memory of...

*Art Parker
L. J. Bianco
R. J. Wilkins
Paris B. Boles*

We extend our deepest sympathy to the families of the above IAMFES members who recently passed away. IAMFES will always have sincere gratitude for their contribution to the association and the profession.

Attention Members:

A new Professional Development Group on Viral Foodborne Disease is looking for a few good members.

The group will focus its efforts on issues including the epidemiology of foodborne viral diseases, traditional and emerging detection methodologies and methods to control viral contamination in foods.

Interested parties are invited to attend the first meeting on Sunday, June 30 from 3:00 to 4:00 p.m. at the Sheraton Seattle Hotel and Towers in Seattle, Washington in conjunction with IAMFES Annual Meeting.

For more information contact Dr. Lee-Ann Jaykus, Department of Food Science, North Carolina State University, Raleigh, NC 27695; Phone (919)515-2971, Fax (919)515-7124, Email leeann_jaykus@ncsu.edu.

Chlorine Dioxide Seen as Solution to Food Contamination Problems

The recent incidents of food poisoning and contamination has created an outcry for more effective sanitation and shelf life extension measures.

Throughout the United States, pressure on food processors and responsible agencies to enact more stringent controls over the harvesting, processing and distribution of various foods is under consideration. The FDA has recently approved the use of chlorine dioxide as a carcass dip and for disinfecting chiller water for poultry *Salmonella* control.

Bill Knapp, a sanitization consultant, claims many of the reported cases can be attributed to the lack of effective biocides currently being used in food processing plants. "The heightened contamination awareness coupled with the need to solve tough microbial problems, is causing many plant managers to review their sanitation methods and options," said Knapp.

One solution gaining popularity, according to Knapp, is chlorine dioxide, particularly in its stabilized form. "Chlorine dioxide, long recognized as an effective antimicrobial, is an environment-friendly compound with excellent biocidal and oxidation capabilities," he said. "When applied in the stabilized form it will safely produce chlorine dioxide without the capital expenditures required with on-site generation equipment."

Knapp said research conducted with International Dioxide, Inc., which has developed a patented process for stabilizing chlorine dioxide, "has shown the solution to be most effective as a sanitizer, disinfectant and odor control product." He added that "with two and a half times the oxidizing capacity of chlorine, and with its broad spectrum antimicrobial



NEWS

efficacy, stabilized chlorine dioxide effectively doubles to oxidize unwanted compounds and remove biofilm without chlorinating organics."

Bovine Spongiform Encephalopathy (BSE) and the Risks to Public Health and the Beef Industry

Bovine Spongiform Encephalopathy (BSE) is a fatal degenerative disease in cattle which affects the central nervous system. BSE was first identified in 1986 in England and was attributed to feeding animal by-products to cattle as a protein source. British by-products, unlike U.S. meat and bone meal contained a great deal of sheep by-products since they are large producers of sheep. As sheep are commonly infected with scrapie, it was assumed, not scientifically proven, that the BSE originated from the feeding of these by-products. In 1989, England imposed a ban of feeding such by-products (Specified Ban on Offal - SBO). Since the ban, there has been a decline in the incidence of BSE.

BSE does not occur in humans but appears to be related to a group of diseases which exhibit many of

the same symptoms; brains from those affected are histopathologically classified as having spongiform encephalopathy (SE). However, there is no epidemiological evidence to suggest this disease in animals is tied to similar diseases in humans. The related diseases include scrapie (affects sheep and goats); transmissible mink encephalopathy of mink; feline spongiform encephalopathy and chronic wasting disease of mule deer and elk. There are three related but extremely rare diseases in humans: Creutzfeldt-Jakob Disease (CJD); Kuru, a human SE disease seen in certain New Guinea natives which practice cannibalism of brains and Gerstmann-Straussler syndrome.

Creutzfeldt-Jakob Disease is the one recently cited in the British press as being related to BSE. Manifestation of these diseases is similar; a degeneration of the central nervous system. There is no test to detect the disease in a live animal (or human), the only confirmation is by histological examination of the brain.

Bovine Spongiform Encephalopathy (BSE) is thought to be caused by prions, small infectious proteins. There is a high degree of public fear in Great Britain over whether ingestion of beef from cattle which may have contained prions which caused Creutzfeldt Jakob Disease (CJD). The recent observation of a new clinical form of CJD has sparked fear that it may be caused by ingestion of BSE-contaminated beef.

There is evidence that BSE originated through feed containing meat and bone meal (MBM) from scrapie-infected sheep offal. Since 1989 the British government has banned the feeding of MBM derived from ruminants. However, the incidence of BSE is widespread in England, although it appears to have peaked.

The question of transmission to humans is one of urgent interest, but only a few limited studies have so far addressed this question.

Cross-species transfer has, in general, only been observed after direct intra-cerebral injection of infectious brain tissue. Studies of human exposure are continuing and should shed light on the risks to the public of BSE-beef in the food chain. At the present time there is no evidence which suggests that the new cases of CJD are in any way related to BSE exposure.

This article was provided by Penn State University.

FDA Approves Eggs Pasteurized IN THEIR SHELL

Pasteurized Eggs, L.P. (PE-LP) announced that it has developed the first and only technology approved by the Food and Drug Administration allowing the claim PASTEURIZED for eggs still inside their shells according to J. Randall Thompson, vice president.

The patent-pending technology destroys *Salmonella* through mild heating without use of chemicals, additives, microwave or radiation. The taste is unchanged. *Salmonella* is the major contributor of food poisoning found in eggs and chickens. Statistics indicate that as many as one billion shell eggs sold in the U.S. each year contain some contamination.

Government Reports state that up to 80 million Americans encounter food poisoning annually, costing billions and causing an estimated 9,000 deaths.

Equipment delivery to licensees will begin this Fall. PE-LP will work within the existing producer-distribution system. PE-LP predicts that pasteurized eggs will become standard fare following the pattern of milk, cheese and liquid eggs which all were required to be pasteurized once their technologies became available.

The U.S. Department of Agriculture will monitor the production and certify the product. A new USDA consumer label will be used

for these purposes. No more worry! Sunny side up anyone?

Update on BST

FDA approved Monsanto Company's recombinant bovine somatotropin (rbST) product, Posilac®, in November 1993 after a comprehensive review of the product's safety and efficacy, including human food safety. Posilac® is the only rbST product approved for increasing milk production in dairy cattle. The product has been commercially available since February 4, 1994.

In a March 14, 1995 FDA TALK PAPER, the Agency stated that during the first year of commercial use of Posilac®, a total of 806 reports of adverse effects were reported to Monsanto and submitted to FDA. A CVM update issued on October 12, 1995, included information on 509 reports of adverse effects reported from February 1 to August 25, 1995.

The following is an update on the adverse experiences to Posilac® reported to FDA from August 26, 1995 through February 3, 1996. During this period, FDA received 144 adverse experience reports. It is important to note that a report of an adverse effect in relation to a drug does not itself establish that the effect was caused by the drug. FDA believes that 83 of the 144 reports were possibly associated with the use of Posilac®, and that the other 61 reports were not related to treatment with Posilac®. Also, all of the reported clinical manifestations are known to occur in dairy cattle not supplemented with Posilac®.

Of the 83 reports possibly related to the use of Posilac®, 18 included reproductive disorders, 10 included digestive disorders, 23 included mastitis, 19 included injection site reactions, 12 included swelling of the udder or abnormal milk, 9 included foot or leg problems, and 17 involved increased somatic cell counts. In some cases, a single report contained multiple conditions.

The number and severity of the reported conditions raise no new animal health concerns about the safety of Posilac®. There is no indication that the drug is any less effective than labeled. In addition, FDA and State regulatory officials have found no indication of a change in the incidence of violative drug residues in milk associated with the commercial use of Posilac®.

Based on these reports of adverse reactions to Posilac®, FDA finds no cause for concern. However, it is important for dairy farmers to continue to report all adverse reactions associated with the use of rbST. They may report such reactions to Monsanto, to FDA through their veterinarian, or directly to FDA's Center for Veterinary Medicine. CVM accepts collect calls during working hours, and an answering machine is available to record after-hours calls. The telephone numbers are (301) 594-1751 for collect calls during working hours, and (301) 594-0797 to leave a message on evenings and weekends.

A First: Paperless ISO 9002 Certification in the Federal Government

The Food Research and Development Centre's Industrial Program team obtained its ISO 9002 certification hands down. The team is especially proud of this success since, according to Serge Sévigny, President of BioControl Systems Inc., a firm specializing in quality management in the food sector, only 15% of enterprises succeed in obtaining this certification at the first trial.

This certification is a first in several ways: the Centre is the first federal organization to obtain its certification with a paperless quality system, a feat achieved using a software called Providence Quality Expert™ developed by the Quebec firm Amadeus Software Inc. The Centre is also the first

organization within Agriculture and Agri-Food Canada to obtain ISO 9002 certification. Finally, the Centre is among the rare service firms that have adopted the ISO 9000 standard as the basis of their quality system.

In March 1995, the Industrial Program's technical and professional staff was given a new challenge by the Centre's Board of Governors, comprised of food industry representatives: adopting the ISO 9002 standard.

The Industrial Program has its new quality policy: A simple and rapid access to a versatile food R & D environment. As the policy indicates, registration paperwork is kept to a minimum and handled rapidly. In addition, the Centre's equipment can be adapted, moved and even modified to meet the client's needs, a flexibility that is essential in the field of research and development. Behind ISO certification there is a team's promise to understand the clients' expectations, to provide them with a professional service at the best cost, to make their visit at the Centre a quality experience.

AFFI Tells FDA It Lacks Legal Authority on Nutrient Content, Health Claims Proposal

Regulation Would Impose Record Keeping Burdens on Industry

The American Frozen Food Institute (AFFI) urged the Food and Drug Administration (FDA) not to proceed with a proposal to establish new requirements for manufacturers that base a nutrient content and/or health claim on a new technology, nonstandardized testing method, or other information not easily accessible by the agency.

According to AFFI, the proposal would impose additional record keeping burdens on many companies and would require manufacturers to make such records available to regulators on demand.

AFFI emphasized that FDA lacks the legal authority to require companies to retain the prescribed records and provide the agency with access to them.

AFFI stated that mandating the creation and retention of records to support claims based on new ingredients and food technologies would impose a significant burden on food companies. For example, records that satisfy internal company requirements regarding claim substantiation might no longer be sufficient.

"To satisfy FDA officials, companies could be forced to change their procedures substantially, instituting extensive new information collection, digestion, and retention requirements," said AFFI.

Furthermore, AFFI opposes the proposed rule as a "substantial and wholly unnecessary intrusion into everyday business operations" because it would require broad access to company records, which is not justified by FDA in its proposal.

AFFI also expressed concern with regard to protection of proprietary information.

"FDA proposes to gain access to highly sensitive company information. Nutrient content and health claims based on new food ingredients and novel technologies involve one of the most competitively sensitive areas in the food industry today," said AFFI.

Finally, AFFI requested that FDA develop affirmative procedures for ensuring confidentiality of any and all records pertaining to new food ingredients, technologies

and testing procedures if the agency chooses to proceed with this "ill-advised" rulemaking.

FDA Approves Food Additive Petition for Formaldehyde

In the April 9, 1996 *Federal Register*, FDA announced that the Agency is amending the food additive regulations to provide for the safe use of formaldehyde (37 percent aqueous solution), at the rate of 5.4 pounds per ton (2.5 kilograms per ton) as an antimicrobial food additive for maintaining complete poultry feeds *Salmonella* negative for up to 14 days. This action is in response to a food additive petition held by Anitox Corp., Buford, GA.

Salmonella is known to cause animal disease. The effect of subclinical cases of *Salmonella* on animal production is difficult to quantitate. However, there are circumstantial data suggesting a potential link between the organisms in feed and organisms causing human and animal salmonellosis. For this reason in 1990, FDA announced a *Salmonella* negative goal for animal feed and feed ingredients.

The availability of compounds that can control re-contamination of a feed with *Salmonella* is important to achieving the goal of *Salmonella* negative for animal feed and feed ingredients. In the September 28, 1995 *Federal Register*, FDA defined *Salmonella* negative as 10 samples, from a production lot, testing negative for *Salmonella* using the culture procedure described in the 7th Edition of FDA's Bacteriological Analytical Manual.

FDA has evaluated the data in the food additive petition for formaldehyde and other relevant

material. The Agency concluded that formaldehyde (37 percent aqueous solution) is safe when used at the rate of 5.4 pounds (2.5 kilograms) per ton of poultry feed, and that the regulations should be amended in Title 21, Part 573.460.

Additional information on this food additive approval is available in the *Federal Register* announcement or by contacting Dr. Daniel G. McChesney, Center for Veterinary Medicine (HFV-222), Food and Drug Administration, 7500 Standish

Place, Rockville, MD 20855, 301-594-1728. Any person who will be adversely affected by this regulation may file written objections with the Dockets Management Branch (HFA-305), Food and Drug Administration, Room 1-23, 12420 Parklawn Drive, Rockville, MD 20857.

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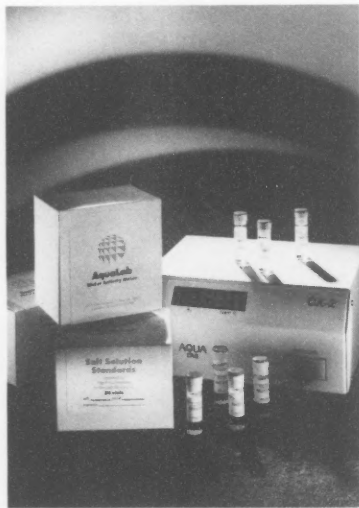
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Reader Service No. 142

Advertising Index

Applied Research Institute	364
Capitol Vial, Inc.	361
Charm Sciences Inc.	Back Cover
Copesan Services	369
DQCI Services, Inc.	408
Food and Dairy Quality Management, Inc. (QMI)	371
Food Products Laboratory, Inc.	403
Gist-brocades	Inside Front Cover
Glo Germ Company	364
Great Lakes Scientific, Inc.	392
IDEXX Laboratories, Inc.	363
Ingman Labs, Inc.	408
Michelson Laboratories, Inc.	408
Nelson-Jameson, Inc.	361
Northland Laboratories	397
Warren Analytical Laboratory	365
Weber Scientific	369

IndustryProducts



Decagon Devices, Inc.

New AquaLab Performance Verification Standards

Standard solutions for verification of AquaLab performance are now available from Decagon. Food quality scientists rely on water activity measurements (a_w) to control the quality and shelf life of food products. Factory-calibrated AquaLab guarantees $\pm 0.003 a_w$ accuracy. Users are free to run their samples following a simple verification against a known standard. Now, standard solutions, independently verified by a third party, provide improved measurement verification. All samples arrive with a Certificate of Analysis and a Material Safety Data Sheet (MSDS). Three formulas are available: 0.760 a_w 6 molal NaCl; 0.500 a_w 8.5 molal LiCl; and 0.250 a_w 13.3 molal LiCl. The color-coded standards are packaged in disposable 5ml vials. Standards sold by the case. Cases consist of three, 24-vial boxes, single or assorted formulas. Customers also receive one box of

0.760 a_w standards upon AquaLab registration.

Decagon Devices, Inc. Pullman, WA

Reader Service No. 330

IDEXX introduces SimPlate™ Test for Enumeration of Total Viable Organisms

Reduces Time to Results and Provides Easier Quantification

IDEXX Laboratories, Inc. introduces a new total plate count test for enumerating bacteria in food. The new test, called SimPlate™, improves laboratory efficiency by reducing or eliminating the most time consuming portions of the current colony-counting standard methods. The SimPlate test simplifies the task of counting, needs no media preparation, requires only 24 hours of incubation, and reduces necessary dilutions.

The test is performed by mixing dehydrated media powder with sterile water and the food sample, placing this in the sterile SimPlate device, and incubating for 24 hours. Wells containing viable bacteria produce a blue fluorescence and are easy to count without the aid of magnification or backlighting.

The SimPlate test is available in two counting ranges: 700 CFU or 1600 CFU. The smaller counting range device is similar in size to the standard pour plate. The larger plate, with a counting range over 1600 CFU, permits the user to eliminate a dilution which reduces preparation labor and use of test supplies. Both plates can be

counted in less time than existing standard colony-counting methods.

IDEXX Laboratories, Inc., Westbrook, ME

Reader Service No. 331

UV Disinfection Systems

Aquionics, specialist manufacturer of air, water and surface disinfection systems, will feature its Ultraviolet (UV) disinfection systems at the 1996 IAMFES Annual Meeting in Seattle, Washington.

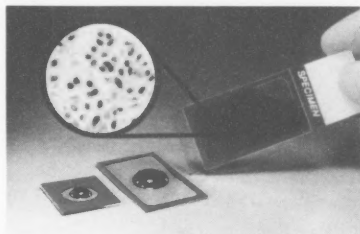
UV-V Air Space Treatment units for disinfection of air in dairy tanks and culture and filling rooms are available in three standard sizes. Designed specifically for the inactivation of bacteria in a given volume of air, the UV-V units are suitable for duct systems of moving air of 500, 2000 or 4000 cfm.

UV disinfection systems for water systems destroy bacteria, yeasts, mold viruses and *Pseudomonas* organisms in-line without chemicals or heat. These systems have proven effective in controlling contamination in cottage cheese curd washes, evaporator cow water and product water.

UV surface disinfection systems are available in both low intensity and high intensity lamp styles for a variety of disinfection needs and packaging configurations. UV units used in extended shelf-life (ESL) filling machines destroy microorganisms and bacteria commonly carried on packaging materials. Applications include disinfection of quart and half gallon paperboard beverage cartons, closures, films, foils and cream, yogurt and cottage cheese cups. Optional automatic shutter mechanisms provide optimal safety for filling lines.

Aquionics, Inc., Erlanger, KY

Reader Service No. 332



Sigma Chemical, Co.

"Press to Seal" Incubation Chambers for Microscope Slides

A ready-to-use incubation chamber that allows researchers to create sealed, water-tight chambers on microscope slides and coverslips without the use of adhesives is now available from Sigma-Aldrich Techware. Designed specifically for use in *in situ* hybridization and immunocytochemistry assays, Probe-Clip® CoverWell™ Incubation Chambers are simply pressed into place to enclose specimens and reagents for analysis. The resulting leak-free chamber prevents evaporation while preserving the kinetic (noncapillary) fluid dynamics of the cell or tissue specimen.

Ideal for imaging thick and free-floating specimens, CoverWells prevent compression and movement artifacts and can be used with both transmitted light and fluorescence microscopy. Made from ultrathin support material, they are available in 20 to 500 µl volumes and two chamber heights.

Sigma Chemical Company, St. Louis, MO

Reader Service No. 333

CoolPure™ Process Receives Favorable FDA Action

The Food and Drug Administration has advised PurePulse Technologies, Inc. that their pulsed electric field process for antimicrobial treatment of liquids and

pumpable foods (*CoolPure*™ process) does not require a food additive regulation, and assuming Good Manufacturing Practices are employed, is safe for use. Extensive scientific data submitted to the Food and Drug Administration demonstrates that the highly effective *CoolPure* process does not induce changes in foods.

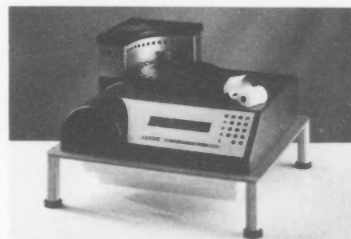
The *CoolPure* process uses short duration electric field pulses to kill vegetative microorganisms at relatively low temperatures, thereby minimizing thermal degradation of foods. The process is effective in killing microorganisms in pumpable products such as juices, beverages, sauces, dressings and liquid eggs. The process has been shown to effectively kill spoilage organisms as well as pathogenic bacteria such as *E. coli*, *Salmonella* and *Listeria*. Initially, it is expected that the *CoolPure* process will be used to treat products such as high acid sauces, dressings and fruit juices that are not regulated for specific time/temperature treatments. Near-term applications of the process also include using *CoolPure* in addition to conventional thermal treatment to provide greater microbial kill assurance than with thermal processing alone, resulting in longer shelf-life products.

While the process has potential widespread application to the food industry, the company has not yet sought modification of existing regulations that relate to specific pasteurization standards. After additional studies and review, and with the appropriate regulatory approvals, the *CoolPure* process could eventually become a lower temperature alternative to conventional pasteurization of low-acid products.

PurePulse Technologies, Inc., San Diego, CA

Reader Service No. 334

At the request of the manufacturer this is a corrected copy of the release that ran in the February 1996 DFES issue.



Perstorp Analytical

Perstorp Analytical LUMAC Introduces Biocounter M 2800

Perstorp Analytical LUMAC introduces a new instrument: the BIOCOUNTER M 2800, a versatile system that can be used for a large number of applications. The M 2800 is an automated instrument, capable of analyzing 25 samples in one batch. This makes this instrument an ideal quality assurance tool, giving a fast and reliable answer to the microbiological status of products in Dairy, Food and Beverages.

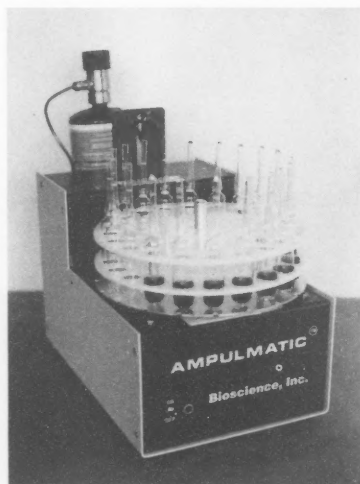
The work was initiated one year ago as a result from changing market requirements, application developments and LUMAC's continuous program of instrument improvement. These improvements make the instruments even more user friendly. Design elements from the top of the range, the fully automated M 4000, have been incorporated into this simpler bench top instrument. For example the reagents are temperature controlled for even greater stability and the cuvettes are discarded automatically and collected in a convenient, easy to clean tray beneath the instrument. This instrument is especially applicable for a sample throughput of 50 - 100 samples per day.

The BIOCOUNTER M 2800 can be used for checking incoming raw materials (e.g., raw milk, meat, water, fruit concentrates), hygiene control as well as end product testing (UHT dairy products, soups,

baby foods, fruit juices and cosmetic products...). Easy-to-use kits are available to perform the rapid microbial tests. Results are available in minutes rather than days, giving the opportunity to take corrective actions immediately and thus saving TIME and MONEY.

Perstorp Analytical, Silver Spring, MD

Reader Service No. 335



Bioscience, Inc.

Pilot Scale Glass Ampule Sealing System Offered by Bioscience, Inc.

A highly effective, semi-automated lab to pilot scale glass ampule sealing system is being offered by Bioscience, Inc. The accu-TEST™ Ampulmatic™ Ampule Sealer automatically indexes ampules into position and rotates the ampules in a propane/oxygen flame creating a perfect hemispherical seal every time. Applications include the packaging of testing standards, injectables, vaccines, pharmaceutical preparations, and quality control standards as well as chemical battery manufacturing.

The Ampulmatic can seal up to forty ampules in five minutes. It uses interchangeable racks to hold ampules in standard sizes from two

to twenty milliliters. Custom carousel racks are available for non-standard ampule sizes.

Bioscience, Inc., Bethlehem, PA

Reader Service No. 336

An Apparatus for Pasteurizing Hog Carcasses

An apparatus for pasteurizing hog carcasses is being manufactured and marketed by Stanfos Inc., of Edmonton, Alberta. The unit applies sheets of hot water to effectively heat the entire carcass surface to temperatures greater than 80°C. Equipment designed to pasteurize 1200 hogs/h is only 15 feet long and 6 feet wide and is shorter for slower line speeds, which facilitates its installation on existing lines. The water is circulated through the system at a rate of approximately 1,760 litres/min with water consumption of approximately 50 litres/100 carcasses treated. The energy consumption is considered to be low, requiring approximately 0.15 G joules/100 carcasses to heat the water.

Agriculture and Agri-Food Canada scientists carried out the original research and in-plant evaluations in commercial hog slaughter facilities on polished, unviscerated carcasses. Operating in a commercial setting, the pasteurizer achieves a more than 99% reduction in total bacterial and *E. coli* numbers.

The pasteurizer is being considered for use in beef and poultry slaughtering operations.

Stanfos Inc., Edmonton, Canada

Reader Service No. 337

New Line of Near Infrared Analyzers from LECO Corporation

LECO's new line of Near Infrared Analyzers offer virtually any combination you require in modern, high-performance analyzers for

the QC laboratory. From the simple, low-cost 10 filter analyzer for rapid constituent analysis to the 20-filter research analyzer, all models are designed with state-of-the-art electronics and software, and include many standard features usually found only as extras on other instruments.

Our product line includes diffused reflective and transmission analyzers allowing the testing of solids or liquids.

LECO Corporation, St. Joseph, MI

Reader Service No. 338

Advanced Instruments Introduces Two New Tests for the Fluorophos™ Test System

When Advanced Instruments introduced the Fluorophos Test System and the ALP (Alkaline Phosphatase) Test for completeness of pasteurization, quality control for the dairy lab was revolutionized. Because the Fluorophos Test System is designed around a microprocessor-controlled benchtop fluorometer, test results do not rely on operator interpretation. In addition, the fluorometer provides readings that are extremely sensitive and semi-quantitative. With the Fluorophos ALP Test, as little as .006% raw milk contamination can be detected, a sensitivity that far surpasses any other test available.

U.S. BetaScreen Test for Detection of Antibiotic Residues

Advanced Instruments next developed the Fluorophos BetaScreen Test for detection of antibiotic residues in milk. Initially only available to detect those antibiotics mandated by the European Union, BetaScreen will shortly be available for the U.S. market. Detecting five of the most common beta-lactam antibiotics for which the FDA requires screening, the

BetaScreen (U.S.) Test can be run in about ten minutes allowing fast off-loading of milk tankers. BetaScreen is highly sensitive and corresponds well with standard microbial inhibitor tests. Offering a streamlined protocol, the BetaScreen test is easy to perform which assures reliable, consistent results. ALP and BetaScreen were specifically developed to provide a solid foundation for quality control and HACCP programs in the dairy industry.

ACP (Acid Phosphatase) Test for Juices Because many dairies also process juices, Advanced Instruments has developed the ACP Test to detect completeness of pasteurization in juices. Properly pasteurized juice has a longer shelf life and tastes and looks better. The only commercially available test to perform this assay, the ACP Test utilizes the Fluorophos Test System to measure acid phosphatase activity as an indicator of proper pasteurization. The three-minute test is easy to use, extremely accurate, and results are consistent and reliable because readings are instrument-based.

Advanced Instruments also manufactures single-sample and multi-sample cryoscopes for detection of added water in milk.

Advanced Instruments,
Norwood, MA

Reader Service No. 339

Osmonics Introduces New Filter for Protein-rich Solutions

Osmonics announces the introduction of a new line of MEMTREX™ pleated filters that offer superior resistance to protein fouling. Constructed with an asymmetric, modified polyethersulfone membrane, MEMTREX-MP filters are very

efficient in the removal of sub-micron size particles and bacteria. Their porous structure also delivers extremely high flow at low pressure drop.

The MEMTREX-MP filters' resistance to protein binding make them ideal for applications that require filtration of fluids with a high protein content. MEMTREX-MP filters excel in applications within the pharmaceutical industry, including the filtration of protein-rich process solutions. They also deliver superior performance in applications such as the final filtration of wine or beer, or the filtration of many cosmetics and beauty care products.

Available with absolute efficiency ratings of 0.2 microns, 0.45 microns and 0.65 microns, MEMTREX-MP filters remove in excess of 99.9% of all particles of this size or larger. MEMTREX-MP pleated filters are available in 10-inch, 20-inch, 30-inch and 40-inch nominal lengths with end adapters to fit any commercially available filter housing.

Osmonics, Minnetonka, MN

Reader Service No. 340

Inspector™ Luminometer Provides Rapid Microbiological Testing for HACCP Compliance

The Inspector Luminometer from Analytical Development, Inc. is a comprehensive, rapid microbiological testing system that meets all of the requirements for implementing and maintaining a company's HACCP program. Designed to be used in the lab or the plant, the Inspector permits fast, accurate monitoring of critical control points which, in the event of contamination confirmation, allows for quick corrective action. The system records and stores test

results and provides an interface port to permit down-loading to a printer or computer.

The Inspector Luminometer is highly flexible, totally portable, and easy to operate. Automatic injection of test reagent reduces the number of assay steps and eliminates the risk of operator error. The Inspector enables a number of different tests to be performed including rapid sanitation control checks, rinse water analysis, and total bacteria screens.

Analytical Development, Inc.,
Lawrenceville, GA

Reader Service No. 341

Autoplate® 4000 Spiral Plater Increases Laboratory Productivity

The Autoplate® 4000 spiral plater increases laboratory productivity by saving time and materials when plating samples onto media for bacterial enumeration. This microprocessor-controlled dispenser accurately deposits a liquid sample onto 100 or 150 mm agar plates in a spiral pattern that creates a 3-log dilution effect, eliminating most serial dilutions necessary to plate samples. Associated disposables are reduced by about two-thirds. The Autoplate 4000 includes the patented Controlled Depletion Reservoir system for efficient "hands-free" cleaning, an easily aligned and detachable stylus, and a built-in validation routine that ensures accuracy and conformity to Good Laboratory Practice guidelines. The Casba™ 4 System is available for automatically counting colonies on both transparent and opaque media as well as yeast and mold and total count Petrifilms.

Spiral Biotech, Inc., Bethesda, MD

Reader Service No. 342

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ANNOUNCING!

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Coming Events

JULY

• **8-11, 8th Symposium of the International Society for Veterinary Epidemiology and Economics**, in Paris. For further information, contact Convergences Isvee 97, 120 avenue Gambetta, F-75020 PARIS (France), tél./phone [33-1] 43 64 77 77; fax [33-1] 40 31 01 65.

• **9-19, World's Largest International Culinary Event Scheduled to Take Place in the United States.** World Association of Cooks Societies (WACS) has scheduled the World Cooks Tour for Hunger and Culinary Arts Festival. The event will begin at Walt Disney World Resort with a five-day international culinary competition, dubbed the World Culinary Arts Festival. For further information, contact Davin Light, Marketing A La Carte at (407) 539-1459 or Keith Keogh, World President, World Assn. of Cooks Societies at (407) 560-2054.

• **12-19, Rapid Methods and Automation in Microbiology: International Workshop XVI**, Kansas State University, Manhattan, KS. A mini-symposium will occur on July 12-13. Contact Dr. Daniel Y. C. Fung, Workshop Director for further information, telephone (913) 532-5654; fax (913) 532-5681.

• **22-26, Backflow Prevention Technician Training & Certification**, in Gainesville, FL. Offered by The University of Florida's Center for Training, Research and Education for Environmental Occupations. This course provides guidelines for acceptable practices for annual testing of backflow prevention assemblies used in cross-connection control programs. Individuals wishing to register should call (352) 392-9570, ext. 112.

• **28-August 10, Health & Environment Conference to China, Mongolia & Russia**, in Beijing,

China. The Health and Environment Conference is an opportunity to be part of a commitment to finding a worldwide solution. For additional information, contact Ms. Kathleen S. Sieler, Program Coordinator or Michael D. Wacker, Director of Medical Programs at the Citizen Ambassador Program, S. 110 Ferrall St., Spokane, WA 99202; phone (509) 534-0430; fax (509) 534-5245.

SEPTEMBER

• **2-3, Symposium on Years in the Dairy Industry**, Copenhagen, Denmark. The main objective of this Symposium is to provide a comprehensive view of the role of yeasts, both positive and negative aspects, in the dairy industry. For registration information, contact Prof. M. Jakobsen, The Royal Veterinary and Agricultural University, Dept. of Dairy and Food Science, Rolighedsvej 30, DK-1958 Frederiksberg C Denmark; telephone +45 35 28 32 15; fax +45 35 28 32 14.

• **6-7, International Symposium on the Influence of Codex Standards on International Trade in Dairy Products**, Düsseldorf, Germany. The symposium is intended for: general management, product development, product manufacturing, legislation, exporters/importers, and supervising and food inspection authorities. For additional information, contact Th. Kützemeier (Chair), German NC, Tel.: +49 228 98 24 3-0, fax: +49 228 98 24 3-20.

• **10-12, Producing Safe Dairy Products Workshop**, hosted by The Wisconsin Center for Dairy Research in Madison, WI. Two days will be devoted to discussing the microbiology and control of dairy pathogens; one day will be dedicated to HACCP

and other sanitation methods used in dairy plants and food processing systems. For more information, contact Sara Quinones at (608) 262-2217; fax (608) 262-1578; e-mail: quinones@ahabs.wisc.edu, 1605 Linden Dr., Madison, WI 53706.

• **10-14, The 11th International Packaging & Food Processing Machinery and Materials Exhibition**, Jakarta, Indonesia. For further information, telephone +44 (0)171 486 1951; fax +44 (0)171 486 8773 or +44 (0)171 413 8222.

• **11-12, 75th Anniversary of the Vermont Dairy Industry Association**, held at the Ramada Inn, S. Burlington, VT. For further information, contact Mr. Byron Moyer at 116 State St., Drawer 20, Montpelier, VT 05620-2901 or phone (802) 828-2433; fax (802) 828-2361.

• **12-13, HACCP Program Presents Hands-on Workshop**, in Chicago, IL. This workshop provides for an intensive day and a half evaluation of HACCP principles and elements for developing a successful program. Participants evaluate their HACCP plan against those designed by the experts. For additional information or to enroll, contact AIB, 1213 Bakers Way, Manhattan, KS 66502; phone (913) 537-4750; fax (913) 537-1493.

• **15-19, American Association of Cereal Chemists to Hold 81st Annual Meeting**, in Baltimore, MD at the Baltimore Convention Center. The annual meeting includes a technical program, technical and poster sessions, table-top exhibits, new products/services sessions, educational short courses and social events. Annual Meeting registration materials are available after May 1, 1996, from AACC headquarters, 3340 Pilot Knob Road, St. Paul, MN 55121-2097; telephone (612) 454-7250; fax (612) 454-0766.

• **24-26, New York State Association of Milk & Food Sanitarians Annual Conference**, Sheraton Inn, Liverpool, NY. For further information/details, contact Janene Lucia at: (607) 255-2892; fax (607) 255-7619; e-mail: jgg3@cornell.edu.

• **25-27, South Dakota Assn. of Healthcare Organizations 70th Annual Convention**, Rapid City, SD. Please direct all questions or comments to: Bud Jones or Suzanne Paracis, SDAHO, 3708 Brooks Place, Suite #1, Sioux Falls, SD 57106; phone (605) 361-2281; fax (605) 361-5175.

• **30-Oct. 4, Upakovka '96 and Agroprodmasch '96 to be held concurrently**, in Moscow, Russia. Organized by NOWEA International, the foreign subsidiary of the Düsseldorf Trade Fair Company in Germany. The Düsseldorf Trade Fair Company is renowned as the organizer of interpack, the world's largest trade show for packaging machinery and materials and confectionery machinery. For further information, contact Düsseldorf Trade Shows, New York, 70 West 36th St., Suite 605, New York, NY 10018; telephone (212) 356-0400; fax (212) 356-0404 or visit the web site at <http://www.dtsusa.com/dts/>.

OCTOBER

• **2-4, International Conference on New Developments in Refrigeration for Food Safety and Quality Call for Papers**, Co-sponsored by IAMFES. Lexington, KY. Conference papers are sought from all areas of food refrigeration. The purpose of this conference is to provide an opportunity for food technologists, food processors, and refrigeration engineers from around the world to exchange current information on the role of refrigeration in the food chain. For further information, contact Food Refrigeration Conference, Univ. of Kentucky, 128 Agriculture Engineering Bldg., Lexington, KY 40546-0276; phone (606) 257-3000 ext. 111; fax (606) 257-5671; e-mail wmurphy@bae.uky.edu.

• **8-12, 1st World Congress on Calcium and Vitamin D in Human Life**, Rome, Italy. Discussion will in-

clude the need to protect consumers through improved food quality and measures to enhance the quality and safety of food. Emphasis will be given to public communication and education, including reaching high-risk groups. For further information, contact Congress Secretariat, Maxitraveland s.r.l.-Via Zoe Fontana 220, 00131 Rome, Italy; tel. +39.6.4131415; fax +39.6.4191868.

• **9-10, Iowa Association of Milk, Food and Environmental Sanitarians, Inc. Annual Conference**, Waterloo, IA at the Starlight Best Western. For further information, contact Janet Burns at (319) 927-3212.

• **15-16, Symposium on Microbial Food Spoilage**, Copenhagen, Denmark. Participants are invited to present posters related to microbial food spoilage. An abstract of maximum one page should be sent before September 1 to: Lene Jensen, Danish Institute of Fisheries Research, Dept. of Seafood Research, Technical University of Denmark, Bldg. 221, DK-2800 Lyngby, Denmark; phone +45 4525 2580; fax +45 4588 4774; e-mail: lej@ffl.min.dk. For further information on registration phone +45 88 33 22; fax +45 45 88 47 74; e-mail: fish@ffl.min.dk.

• **16-18, 16th-Food Microbiology Symposium and Workshop**, Univ. of Wisconsin, River Falls, WI. The workshop is designed to provide practical demonstrations and discussion of various tests and instruments available for rapid detection, isolation and characterization of food-borne pathogens and toxins as well as prediction of shelf-life and checking hygiene and sanitation in food processing facilities. For further information, contact Dr. Purnendu C. Vasavada, Dept. of Animal and Food Science, Univ. of Wisconsin-River Falls, River Falls, WI 54022 or phone (715) 425-3150; fax (715) 425-3785; internet: purnendu.c.vasavada@uwrf.edu.

• **20-23, The 1996 International Exposition for Food Processors* (IEFP) will host "El Congreso de las Americas,"** at San Francisco's Moscone Center. IEFP attracts visitors from around the world

in every segment of the processing industry, including canning and freezing, dairy, beverages, meat, pharmaceuticals and other industry segments. For more information, contact Janet Palmisano, Communications Coordinator at (703) 684-1080.

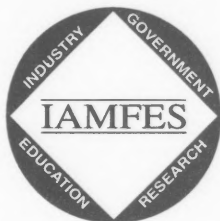
• **27-29, International Whey Conference**, sponsored jointly by the American Dairy Products Institute (ADPI), the U.S. National Committee of IDF (USNAC), and the International Dairy Federation (IDF) at the Westin Hotel O'Hare, Rosemont, IL. This international conference will bring together manufacturers of whey and whey products, firms manufacturing equipment used in whey processing, business leaders of the industry, and government and university researchers from throughout the world to discuss current topics of interest relating to the production, research, marketing and utilization of whey and whey products. Anyone interested in presenting papers at the conference should contact Dr. Warren S. Clark, Jr., Chief Executive Officer, American Dairy Institute, 130 N. Franklin St., Chicago, IL 60606; phone (312) 782-5455; fax (312) 782-5299.

• **30-Nov. 2, Worldwide Food Expo '97**, to be held in Chicago, IL. The Dairy & Food Industries Supply Association (DFISA) the International Dairy Foods Association (IDFA) and the National Food Processors Association (NFPA), have Worldwide Food Expo positioned as the one trade show to encompass the entire product supply and service world of the food processing industry. For further information, contact Dairy and Food Industries Supply Assn., 1451 Dolley Madison Blvd., McLean, VA 22101-3850; telephone (703) 761-2600 or fax (703) 761-4334.

• **31-Nov. 2, NAMA National Convention and Exhibition**, Cervantes Convention Center, St. Louis, MO. Exhibitors of vending machines, food products and services related to the industry. For additional information, contact Larry Eils at (312) 346-0370.

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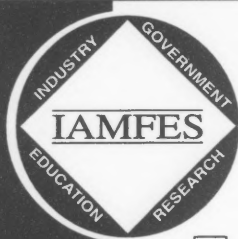
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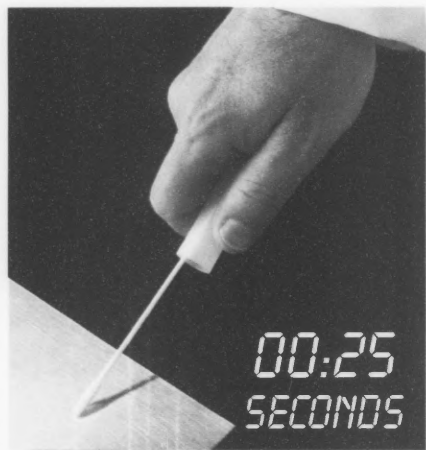
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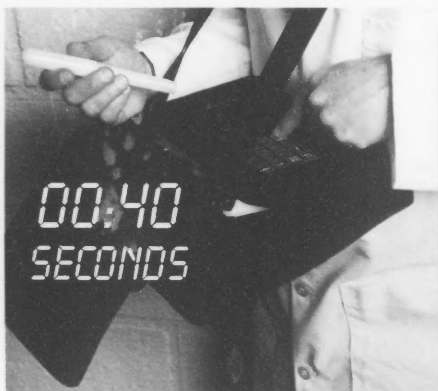
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