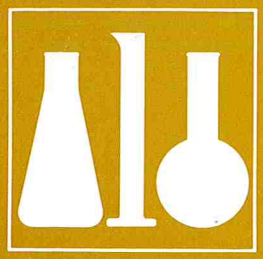
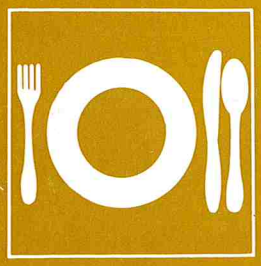
November, 1978, Vol. 41, No. 11: 845-940





November, 1978
Vol. 41, No. 11
Pages 845-940
CODEN: JFPRDR 41 (11): 845-940
ISSN: 0362-028X

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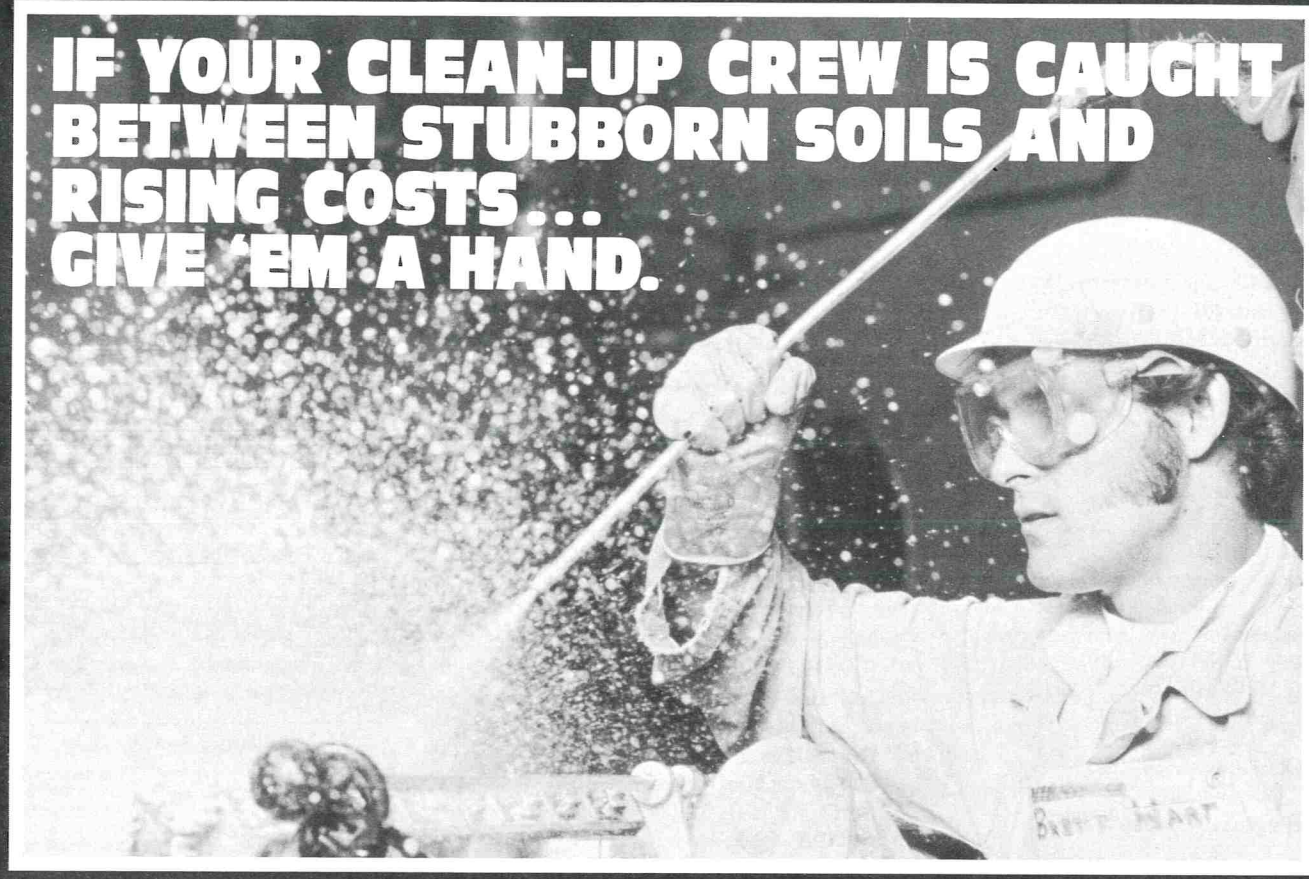

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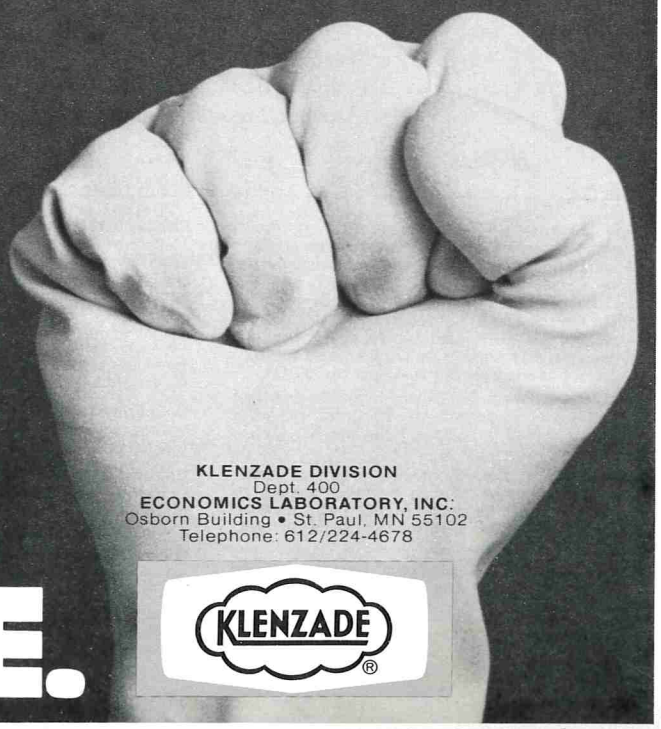

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The Journal of Food Protection is issued monthly beginning with the January number. Each volume comprises 12 numbers. Published by the International Association of Milk, Food and Environmental Sanitarians, Inc. with executive offices of the Association, 413 Kellogg Ave., P.O. Box 701, Ames, Ia. 50010. Printed by Heuss Printing and Signs, Inc., 911 Second St., Ames, Iowa 50010.
2nd Class postage paid at Ames, Ia. 50010.

Editorial Offices: Dr. Elmer H. Marth, Dept. of Food Science, University of Wisconsin, Madison, Wis. 53706. Earl O. Wright, P.O. Box 701, Ames, Ia. 50010.

Manuscripts: Correspondence regarding manuscripts and other reading material should be addressed to Dr. Elmer H. Marth, Dept. of Food Science, University of Wisconsin, Madison, Wis. 53706.

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Journal of Food Protection

(Formerly Journal of Milk and Food Technology)

Official Publication
International Association of Milk, Food, and Environmental Sanitarians, Inc., Reg. U.S. Pat. Off.

Vol. 41 November 1978 No. 11

Research Papers

General Interest

*Asterisk designates person to whom inquiries regarding the paper should be addressed

Journal of Food Protection Vol. 41, No. 11, Pages 848-850 (November 1978)

Number of *Clostridium botulinum* Spores in Honey

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(Received for publication July 31, 1978)

ABSTRACT

A dialysis-enrichment culture method for detecting *Clostridium botulinum* spores in honey is described. The method was used to survey 55 honey samples representative of 53 lots being sold at retail and 186 honey collections from 154 individual producers. Based on finding the organism in at least one of three 25-g test portions of a sample, one type A and one type B positive were found among the retail samples. Type A spores were found in collections of five different producers and type B in those of five others. Five of 13 different lots from one producer were positive for type A spores. One producer sample had both types A and B spores. Maximum most probable number by the five-tube method was seven botulinum spores (upper 95% confidence limit of 17) per 25 g of sample.

At least 58 (33 type A and 25 type B) cases of human infant botulism have been identified in the United States since the disease was recognized in 1976 as a distinct entity (*4*). One type A case has been found in England (*11*). The illness apparently starts when *Clostridium botulinum*, most likely the spore form, is swallowed and initiates an intraintestinal infection with accompanying toxin production (*2,8*). This etiology differs from that of the classical botulism food poisoning in which the toxin is already formed in the peccant food. Some of the infant crib deaths may be a form of infant botulism (*3*) having rapid onset and sudden death.

Botulinum spores are naturally present in soils (*9*) so that they may be in foods that are exposed to the environment. Infants might acquire the spores with any such foods but of those known to have been fed to the victims, the spores have been found only in honey (*4,5*). Although not proven, the limited data suggest a possible correlation between type B infant botulism cases and the feeding of honey (*5*). An association of honey producers has considered the possible health implications and with the public interest in mind has issued a press release about the presently known facts (*6*).

We report here on a study done to determine the incidence of *C. botulinum* types A and B spores in honey samples and to gain some idea of their concentrations in positive samples.

MATERIALS AND METHODS

Honey samples from a leading cooperative of honey producers were representative of crude honey lots collected in 32 states of the U.S. and of honey being sold by the cooperative in retail stores. Included were 55 retail samples of 53 different lots and 186 samples representing honey collections from 154 individual producers. Specimens were in jars containing 0.5 to 2.0 lb (227 to 908 g).

Testing was based on the principle that botulinum toxin is produced in enrichment cultures that are made of samples containing *C. botulinum* (*7*). Because of indications that low concentrations of the organism might be encountered, 25-g test portions were tried. Growth from an experimental botulinum spore inoculum was significantly suppressed when this amount of honey was cultured in 300 ml of culture medium. Since the inhibition was probably due to the high sugar concentration resulting from the sample, honey was dialyzed before being cultured.

Honey in the shipping jar was warmed to 45 C and then mixed to distribute organisms through the sample. Full jars were inverted about 50 times; vigorous shaking was used when there was sufficient headspace. A 25-g portion was then weighed into a sterile beaker and diluted with 20 ml of sterile distilled water to permit easier handling. The thinned honey was transferred aseptically, along with a 5-ml water rinse of the beaker, into a 1.75-inch (44 mm) flat width dialysis sac that had been tied off at one end before being sterilized (120 C, 20 min) in water contained in a beaker. All manipulations were done with precautions to avoid contaminating the honey; e.g., beakers were sterilized with covers of aluminum foil and were uncovered only when necessary.

The open end of the filled sac was closed by ties to leave a working length of about 45 cm. Up to 15 such filled sacs were suspended in a 15-liter capacity container with the sample columns submerged in unsterilized distilled water. Dialysis was done in a 4-C cold room with water cooled to 10 C or lower. During the approximate 24-h dialysis, water changes were made at 2, 2, and 15-h intervals. Sample volumes after dialysis were approximately 140 ml.

Enrichment cultures were made in 300-ml capacity, screw-capped prescription bottles in which about 5 g of cooked meat particles (Difco Lab., Detroit, Mich.) had been moistened with a small amount of water and sterilized. The area around one end of the sac was sanitized by swabbing with 5% hypochlorite solution and the sac cut so that the content could be poured into such a bottle. Fluid level was brought to the 150-ml mark with sterile water. The inside of the sac was rinsed twice with 60-ml volumes of double strength TPGY (trypsin omitted from TPGYT of ref. *7*) and the rinsings added to the bottle. Final volume was made to 300 ml with the medium. TPGY was adjusted to pH 7.2 before sterilization and was at 80 C when used.

Bottles were immediately placed in an 80-C water bath and held for

25 min to select for heat resistant spores such as those of *C. botulinum*. After incubating for 4 days at 37 C, portions of cultures were clarified by centrifugation and tested by injecting 0.5 ml intraperitoneally into a mouse. Those that killed mice within 4 days were retested in mice unprotected, protected with type A and protected with type B antitoxin (*7*). Deaths from nonbotulinal agents were not a problem.

Routine examination of a honey specimen consisted of three separate tests done at different times with a 25-g portion. A positive sample was one in which *C. botulinum* was identified in at least one of these tests. When a positive result was obtained, other 25-g units were tested so that a total of five such amounts would be examined. Additionally, enrichment cultures were prepared with five portions of 2.5 g and five of 0.25 g by adding honey, without dialysis, to separate tubes containing 35 and 20 ml, respectively, of cooked meat medium (*7*). The botulinum toxicity results were used as a 5-tube most probable number (MPN) test (*1*) to determine the number of *C. botulinum* in 25 g of honey.

RESULTS

Sensitivity of the dialysis-enrichment procedure for detecting samples containing botulinum spores was tested with a type A spore suspension whose viable count was known (*10*). Ten honey samples, in which the botulinum organism had not been found, were chosen at random and an estimated one spore was added to each of a 25-g honey portion being readied for dialysis. Six of the 10 resulting enrichment cultures contained the expected type of botulinum toxin. Of 10 tubes of cooked meat medium, each inoculated with the same spore suspension volume added to the honey samples, seven developed toxin. The number of positive tests in the two culture sets indicated the culturing method would identify honey containing small numbers of *C. botulinum* spores.

Possibility of contamination was examined. Periodically during the survey, a 25-ml volume of sterilized water was dialyzed and cultured as if it was a honey sample. None of 25 such controls showed growth.

The results are not reported specifically, but all samples were tested at least once, and most two or more times, with modified procedures. The common procedural variations were (*a*) dialyzing at room temperature, (*b*) heating at 60 C for 15 min, or omitting heating, preparatory to incubation for toxin production, (*c*) incubating culture at 30 C, and (*d*) collecting the precipitate formed during dialysis on a membrane filter (Millipore) with pores of 0.45-μm diameter and culturing membrane and precipitate together in cooked meat medium. None of these methods seemed superior to that used as the routine test procedure; when a positive result was obtained with a modification, the sample was positive by the routine method.

Of the 241 samples tested, 18 had *C. botulinum* spores (Table 1). The preponderance of type A over B was due to five and two type A positives among the 13 samples from each of two different producers. When these two positive groups are considered as representing only two producing areas, types A and B were found with similar frequencies. Both types were present in a producer sample. Positive samples originated in the states of California, Florida, Iowa, Michigan, Minnesota, Nebraska, Tennessee, Texas and Washington.

TABLE 1. *Number of spores of* C. botulinum *types A and B in honey.*

Samples	No. tested[a]	Positives		
		No. specimens	Type	MPN/25 g[b]
Retail	55[c]	1	A	7 (1-17)
		1	B	2 (<0.5-7)
Producer	186[d]	2	A	7 (1-17)
		1	A	5 (<0.5-13)
		4	A	4 (<0.5-11)
		3	A	2 (<0.5-7)
		1	B	5 (<0.5-13)
		1	B	4 (<0.5-11)
		3	B	2 (<0.5-7)
		1	A and B	Each, 2 (<0.5-7)

[a]Each tested with three 25-g portions.
[b]Most probable number by 5-tube method; ( ) = 95% confidence limits.
[c]Includes three of same lot.
[d]Includes 3, 8, 13 and 13 different collections of four separate producers; Type A in five of 13 from one producer and two of 13 from a different producer.

The highest MPN was seven botulinum spores per 25 g with upper 95% confidence limit of 17. Because of these small numbers, some positives were not identified as containing botulinum spores until the third replicate test.

Botulinum spores in a large bulk volume of honey may be unevenly distributed. The type A positive retail sample was a mixture of lots which included the positive ones from the same producer; these had MPN of type A per 25 g of seven in two lots, four in one lot, and two in three others. Nevertheless, two other jars of the same retail lot did not have botulinum spores when five 25-g portions of each were examined. Similarly, the botulinum organism was not detected in two other sampling units (each tested with five 25-g portions) of a producer lot whose first sample unit had four type B spores per 25 g.

DISCUSSION

This study confirms the report that *C. botulinum* is present in some retail honey samples (*2,5*) and suggests that positive samples are likely to be found among honey produced in most, if not all, states of the U.S. when sufficient numbers of different lots are examined. Because of the toxico-infection basis of infant botulism, a theoretical hazard exists in feeding honey to infants (*5*) of up to 26 weeks old when the illness is known to occur (*4*). However, actual danger has not been established. The assessment depends on two important factors: the number of botulinum spores in honey and, as yet totally unknown, the number of spores required to infect an infant.

An upper limit of 17 botulinum spores per 25 g of honey was enumerated by the MPN tests. The number of botulinum spores necessary to intraintestinally infect 50% of an infant mouse group was, per animal, 700 (95% confidence range of 170 to 3,000) spores of one type A strain (*10*) and 170 (80 to 360 range) spores of a different type A culture (unpublished data). The dose response curves were such that in the infant mouse population with normal distribution of susceptibilities to infection, a few

individuals were infected with a dose of 10 to 20 spores. The validity of extrapolating the mouse data to humans can be questioned but the available information does not as yet rule out the possibility of human infants having comparable susceptibility. By this assumption, some human infants could be infected by the number of botulinum spores present in one, or several closely spaced, feeding(s) of some of the honey samples encountered in the present survey. A similar potential problem would exist with other substances containing the spore load of honey.

The opposite viewpoint can be argued if the observed maximum botulinum spore concentrations holds for all lots. Honey would not be of danger provided that human infants have some natural resistance against intra-intestinal colonization by *C. botulinum*. Older people probably swallow these spores occasionally without suffering ill effects (*9,10*).

ACKNOWLEDGMENTS

This research was supported by the College of Agricultural and Life Sciences, University of Wisconsin-Madison and by the Research Division, Sioux Honey Association, Sioux City, Iowa. D.C.M. is post-doctoral trainee on Grant T32-ESO7015 from National Institute of Environmental Health Sciences to the Center for Environmental Toxicology, University of Wisconsin-Madison.

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Journal of Food Protection Vol. 41 No. 11, Pages 851-862 (November 1978)

Significance of Abuse Chemical Contamination of Returnable Dairy Containers: Pesticide Storage and Detector Evaluation

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(Received for publication May 3, 1978)

ABSTRACT

LEXAN ® resin, polyethylene plastic and glass returnable dairy containers were exposed to 85 dissimilar pesticides to determine storage effects. The method used to select the 85 pesticides from a list of 426 available for purchase by consumers is described. After 3 and 10 days of storage, approximately 30% of the pesticide products were incompatible with LEXAN resin. Good compatibility of stored pesticides with polyethylene plastic and glass was demonstrated. After commercial dairy washing, the three container types were examined for presence of visual residues. The LEXAN resin and polyethylene plastic containers were evaluated by an in-line contaminant detector. Incompatibility of stored pesticides with LEXAN resin is more effective in detecting and discarding misused containers than is the detection device for polyethylene plastic containers.

Several trends in dairy packaging have been taking place in the last two decades. Popularity of larger containers has increased. In 1964, 53% of milk was packaged in ½-gal. containers, but only 16% was packaged in 1-gal. containers. By 1975, ½-gal. packaging had declined to 31% and 46% of milk was packaged in 1-gal. containers. During this same period home delivery sales by dairies, 28% in 1964, declined to 7% in 1975. With these trends (*4*) in container size preference and type of sales there have been changes in container requirements. The glass container was particularly suited to home delivery, and its use has declined. Increase in container volume resulted from the consumer making less frequent purchases of milk. Paper containers are quite popular in the ½-gal. size, and single-service high density polyethylene (HDPE) plasic containers are quite popular in gallon size. The popularity of single-service milk containers may be partially attributed to deficiencies in the performance properties of returnable containers for milk. Lower rates of trippage and safety concerns associated with container breakage have served to discourage or limit usage of glass containers.

The early 1960's saw development and introduction of a returnable HDPE plastic dairy container. In 1965 the United States Public Health Service approved the unlimited use of this package provided certain provisions of the *Grade "A" Pasteurized Milk Ordinance -- 1965 Recommendations* of the USPHS were met. One of the seven safeguards (*7*) for use of a returnable plastic container has received sustained attention:

> "4. A device shall be installed in the filling line capable of detecting in each container before it is filled, volatile organic contaminants in amounts that are of public health significance..."

It was recognized at the outset that HDPE plastic might have problems from absorption and retention of certain types of chemicals. Developers of the HDPE plastic returnable dairy container believed that non-polar materials such as gasolines and some solvents would be problematical if these materials were stored in the container. An electromechanical device utilizing a rapid-responding gas chromatograph to detect contamination was developed for use. It is commonly called the "snifter" and has been employed with returnable HDPE plastic containers since approximately 1965.

Notwithstanding the possible problem of storing abuse chemicals, the HDPE plastic returnable container was introduced to improve on the performance of the returnable glass container. Use of the former has been moderately successful.

Use of HDPE plastic returnable milk containers has not been without controversy. Bodyfelt et al. (*1*) recently summarized experiences with abuse of the container in Oregon. There have been, they reported, consumer complaints associated with use of the HDPE plastic returnable container. Off-flavor and foreign objects were frequently mentioned. Some causes of off-flavor were identified and associated with introduction and temporary storage of substances such as orange and grape juice and miscellaneous household chemicals in the milk containers. Also, foreign objects such as toys, money, and mold growth on retained milk residues in the bottoms of the containers constituted other observed problems. These complaints, and problems with gasoline storage in returnable plastic milk containers, led to a study of 16 chemical substances used for treatment or simulated

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chemical contamination of HDPE multiuse milk containers. The conclusions of the study by Bodyfelt et al. (*1*) questioned the compliance of the HDPE returnable milk container with the aforementioned USPHS guidelines.

Landsberg et al. (*3*) treated glass, HDPE plastic and polycarbonate resin (LEXAN) containers with 29 common household chemicals to simulate consumer abuse. Results of this study confirmed the inability of the in-line contaminant detector ("snifter") to detect and puncture all laboratory treated and abused containers. Compliance of HDPE plastic and polycarbonate resin containers with appropriate parts of the USPHS Grade "A" PMO was questioned by Landsberg et al. (*3*).

The LEXAN polycarbonate resin returnable dairy container was developed in the early 1970's. LEXAN resin was an ideal packaging material choice. A lengthy history of food contact applications to its credit, LEXAN resin is manufactured in compliance with applicable FDA regulations governing food contact, lightweight, virtually shatterproof, clear, meets 3A dairy sanitary standards, is environmentally desirable from an energy use and solid waste reduction standpoint, and returnable. LEXAN resin offers the advantages of glass and HDPE plastic without the disadvantages.

Garden State Farms began the integration of LEXAN resin containers from their manufacture into their glass float in 1975. Detergent development preceded use of the new container, and Pennwalt Chemical Company's PBS detergent proved most reliable of the products tested for washing the LEXAN resin container. After 2 years of internal use of the container, Garden State Farms' subsidiary, Superjug(TM), Inc., introduced the container officially to the dairy industry at the Dairy and Food Industry Suppliers' Association (DFISA) trade exposition in Atlantic City, New Jersey, November, 1976.

The Garden State Farms dairy operation has never used an in-line detection device to identify and cull misused LEXAN resin containers. The decision not to use the "snifter" was based on a specific and reliable response of LEXAN resin to abuse chemical storage and a washing regimen not previously employed for returnable dairy containers. Much of this sentiment tionally, Garden State Farms Dairy obtained a developmental waiver from the State of New Jersey and USPHS to use LEXAN resin containers without the "snifter". The "snifter" requirement has been identified as an impediment by many U.S. fluid milk processing firms that have expressed an interest in the LEXAN resin returnable dairy containers. Much of this sentiment results from the fact that this contaminant detection device is available from a single source and is considered expensive.

The purpose of this publication is to report the results of (*a*) a pesticide product survey by enumerating those products which might be purchased by the consumer through the garden supply trade (to include nurseries and chain store operations); (*b*) a pesticide product storage test in HDPE plastics, LEXAN resin and glass returnable dairy containers by noting instances of incompatibility of diluted stored products with container materials and the presence of visual residues after washing; and (*c*) an examination of the in-line detection device, the "snifter", from the standpoint of its ability to detect and cull laboratory-prepared abused containers from a dairy packaging system after conventional bottle washing.

MATERIALS AND METHODS

Abuse chemicals survey and selection

A survey of eight home and garden pesticides manufacturers (Table 1) frequently mentioned as having major market shares resulted in providing 426 products for screening. More products, 246 (62%), were formulated for direct application than were formulated for dilution, 180 (38%), before application. The purpose of this survey was to identify those pesticide products that had to be diluted before application as that would require some container to mix the requisite concentrations per label directions. Of the 180 products requiring dilution before application, liquid concentrates were predominant (129 or 72%) and powder concentrates less prevalent (51 or 28%). Reconciliation of ingredients and concentrations resulted in 85 dissimilar products (Table 2), of which 60 (71%) were liquid concentrates and 25 (29%) were powder concentrates. This study surveyed predominantly pesticides that might be available through the garden supply/nursery retail trade and nationwide department store chains.

TABLE 1. *Abuse chemicals manufacturers and survey.*

Company	Total products	Products requiring dilution	Powders	Liquids
Ortho Division of Chevron Chemical	86	37	9	28
Pratt Division of Gabriel Chemicals	60	36	11	25
Amchem Products	22	10	2	8
Science Products	58	32	13	19
Bonide Chemical Company	78	33	9	24
Black Leaf Products	70	31	7	24
Ciba-Geigy	52	1[a]	—	1
Boile-Midway[b]	—	—	—	—
Totals	426	180	51	129

[a] = Ciba-Geigy manufactures many products for commercial application. (Concentrate quantities are 5-gallons and 55-gallons.)
[b] = All products manufactured for direct application as formulated.

Container preparation

Garden State Farms, Midland Park, New Jersy, supplied commmercially washed new LEXAN resin and used glass returnable ½-gal. dairy containers. Washed new HDPE plastic returnable ½-gal. dairy containers were secured from a Massachusetts dairy. Pesticides were prepared at dilution levels recommended on the label. Diluted products were thoroughly mixed in capped containers. Each diluted product was stored at ambient (70±5 F) temperature for 3 and 10 days. In the former instance, container contents were mixed by shaking initially and on the second day of storage. For the containers to be stored for 10 days mixing was undertaken initially by shaking, and the container contents were mixed every other day. At the conclusion of the respective storage times the containers were emptied and rinsed with two volumes of cold tap water. Prewash observations were made. If a container was cracked and/or grossly clouded, defined as incompatibility, the container was removed from further experimental consideration. Notation was made of all products leaving prewash visual residues on container walls after rinsing with tap water. Containers were conventionally washed at Garden State Farms Dairy. The washing regimen employed was that used on a daily basis at this dairy, which utilized 3.5% of Pennwalt Chemical Company's PBS Detergent. The soak tank temperature was 155±5 F while the three rinses of water were 120, 115, and 75 F. The final rinse contained 50 ppm chlorine. Visual

TABLE 2. *Pesticide products selected for container treatment.*

Product and manufacturer	Type[a]	Concentration[b]	Active ingredients (%)
Fungicides			
Maneb, Black Leaf	P	1/2 T	Maneb (80)
Flotox, Ortho	P	1-1/4 T	Sulfur (90)
Phaltan, Ortho	P	1 T	Folpet (75)
Orthocide, Ortho	P	1-2/3 T	Captan (50)
Orthorix, Ortho	L	2 T	Calcium Polysulfides (26)
Dyrene, Ortho	P	14.2 g	Anilazine (50)
Copper Fungicide, Black Leaf	L	3 T	Copper Salts of Fatty Acids (48)
Bordo-Mix, Pratt	P	4 T	Copper (12.75)
Beneamyl 50W, Pratt	P	1/4 T	Beneamyl (50)
Zineb, Science	P	1/2 T	Zineb (50)
Lawn Fungicide, Bonide	P	37.0 g	Cadmium Chloride (7.5) Thiram (6.4) Zineb (50)
Herbicides			
Ammate-X, Bonide	P	200 g	Ammonium Sulfamate (95)
Amitrol-T, Amchem	L	1 oz	Amitrole (21.6)
Weed-B-Gon, Ortho	L	2 t	2, 4-D (17.8) Silvex (8.4)
Triox, Ortho	L	180 ml	Pramitol (1.86) PCP (0.68)
Brush Killer-A, Ortho	L	1-1/2 C	Ammonium Sulfamate (43)
Contax, Ortho	L	1/2 C	Sodium Dimethylarsinate (10.4) Dimethylarsinic Acid (1.77)
Crab Grass/Dandelion, Ortho	L	1-1/2 T	Dodecylammonium Methanearsonate (8) Octylammonium Methanearsonate (8) Octylammonium Salt of 2,4-D (8.16)
Chickweed/Clover, Ortho	L	1/2 T	Isooctyl Ester of Silvex (13.8)
Super-D Weedone, Amchem	L	1/2 T	Diethanol Amine Salt of 2,4-D (20.3) Diethanol Amine Salt of Dicamba (1.9)
Nu-Lawn Weeder, Amchem	L	1 oz	Bromoxynil (8.4)
Weedazol Herbicide, Amchem	P	36.0 g	Amitrole (50)
3-D Weedone, Amchem	L	1-1/2 oz	Butoxyethanol Ester of 2,4-D (17.7) Butoxyethanol Ester of Silvex (8.3) Dicamba (1.5)
Weedone Crabgrass, Amchem	L	2-2/3 oz	Calcium Acid Methanearsonate (10.3)
X-All, Amchem	L	8 oz	Amitrole (1) Simazine (3)
Turf Herbicide 6000, Pratt	L	1 oz	MCPP (2.77) 2, 4-D (6.1) Dicamba (0.63)
NA Weed Killer, Pratt	L	1 Pint	Pramitol (3.5) 2,4-D (1.5)
Insecticides			
Methoxychlor 25% E, Bonide	L	1 T	Methoxychlor (25)
Malathion 25W, Agway	P	3 T	Malathion (25)
Ortho-Klor 44, Ortho	L	1 T	Chlordane (44)
Isotox, Ortho	L	1-1/2 T	Meta-Systox R (5) Carbaryl (5) Kelthane (5)
Malathion 50, Ortho	L	2 oz	Malathion (50)
Fruit & Vegetable, Ortho	L	1 t	Diazinon (25)
Sevin, Ortho	P	1 T	Carbaryl (50)
Volck, Ortho	L	1-1/2 oz	Petroleum Oil (97)
Rotenone, Ortho	P	4 T	Rotenone (1)
Lindane, Ortho	L	1/2 T	Lindane (20)
Home Orchard, Ortho	P	2-1/2 T	Captan (15) Malathion (7.5) Methoxychlor (15)
Diazinon, Ortho	L	1/2 T	Diazinon (25)
Sevin, Ortho	L	1/4 oz	Carbaryl (27)
Orthene, Ortho	L	3/8 oz	Acephate (15.6)
Ortho-Klor 74, Ortho	L	3/4 oz	Chlordane (74)
Sod Webworm, Ortho	L	3/8 oz	Aspon (13)
Cinch Bug, Ortho	L	3/8 oz	Aspon (13)
Lawn Insect Control, Ortho	L	1/2 T	Dursban (5.3)
Ortho-Klor 10, Ortho	P	1 T	Chlordane (10)
Malathion 50 E, Ortho	L	1 t	Malathion (50)
Rose/Garden Spray, Black Leaf	L	3 T	Carbaryl (10) Captan (10) Dinitro Crotonates (0.9) Kelthane (0.5) Malathion (1)

Vapam Soil Fumigant, Black Leaf	L	8 t	Sodium Methyldithiocarbamate (32.7)
Black Leaf 40, Black Leaf	P	1-1/2 t	Nicotine (40)
Spectracide, Ciba-Geigy	L	1 oz	Diazinon (25)
Scalecide, Pratt	L	2-1/2 T	Petroleum Oil (98)
6E Oil Spray, Pratt	L	1-1/4 oz	Petroleum Oil (96) Ethion (2)
Cyron Systemic, Pratt	L	1 t	Dimethoate (23.4)
Red Arrow, Pratt	L	1-1/2 oz	Pyrethrins (0.5) Rotenone (1.5) Piperonyl Butoxide (3)
Thuricide HPC, Pratt	L	2 t	*Bacillus thuringiensis* (0.8)
Tomato/Vegetable Dust/Spray, Pratt	P	4 T	Rotenone (0.75) Copper (7)
Rose/Flower Dust/Spray, Pratt	P	4 T	Carbaryl (3) Malathion (4) Folpet (5) Kelthane (1.5)
Mite Spray, Pratt	L	1 t	Kelthane (18.5)
Noculate 3, Pratt	P	1-1/2 T	Meta-Systox R (6) Methoxychlor (5) Kelthane (0.9)
Imidan 12.5WP, Pratt	P	1-1/2 T	Phosmet (12.5)
505K Insect Spray, Pratt	L	2 t	Methoxychlor (24) Malathion (13) Kelthane (3)
Dursban, 135EC, Pratt	L	1/3 oz	Dursban (13.5)
Tomato/Vegetable Insect Spray, Pratt	L	0.4 oz	Methoxychlor (20) Diazinon (10)
Fruit/Nut/Garden Spray, Science	L	1 T	Diazinon (8.3) Kelthane (3.2)
Multi-Purpose Garden Dust or Spray, Science	P	5 T	Methoxychlor (5) Malathion (5) Captan (5)
Gladiolus/Bulb Dust or Spray, Science	P	40 g	Thiram (50) Methoxychlor (5)
Methoxychlor 50 WP, Science	P	1 T	Methoxychlor (50)
Zectran, Science	L	1 T	Zectran (12.8)
Rose Spray, Bonide	L	2-1/2 T	Carbaryl (10) Captan (10) Dinitro Crotonates (0.9) Kelthane (0.5) Malathion (1)
Flower/Vegetable 4 in 1, Bonide	L	5 T	Malathion (9.4) Methoxychlor (9.4) Dinitro Crotonates (1.4)
Fertilizers			
Ortho-Grow, Ortho	L	15 ml	N (12) P_2O_5 (6) K_2O (6) Fe (0.5) Zn (0.1) EDTA (4)
Fish Emulsion, Ortho	L	1/2 T	Fish Scrap
Rose/Flower, Ortho	L	1 oz	N (8) P_2O_5 (12) K_2O (4) EDTA (0.84)
Evergreen/Azalea, Ortho	L	1 T	N (10) P_2O_5 (8) K_2O (7) B^2 (0.02) Fe (0.4) Mn (0.05) Mo (0.0008) Zn (0.1) EDTA (4)
Tomato/Vegetable, Ortho	L	1 T	N (6) P_2O_5 (18) K_2O (6)
Greenol, Ortho	L	1 T	S (3.64) Cu (0.13) Fe (6.13) Zn (0.1) EDTA (5)
Up-Start, Ortho	L	1-1/2 oz	N (5) P_2O_5 (15) K_2O (5) Indole-3-butyric Acid (0.003)

Other			
Fumasol-S, Amchem (Rodenticide)	P	3 oz	Substituted Hydroxycoumarin (0.14)
Folicote, Pratt (Moisture Suppressant)	L	3 oz.	Waxes
Spreader/Sticker, Pratt (Surfactant)	L	1/2 t	Soybean Oil Ethylene Dichloride Alkyd Resin
Animal Repellent, Pratt	L	1 Qt	Thiram (20)
Blossom Set, Science (Growth Regulator)	L	2 oz	ENOA (0.1389)
Hedge-Trim, Science (Growth Regulator)	L	2 T	Maleic Hydrazide (30)
Wonder-Brel, Science (Growth Regulator)	L	1 oz	Potassium Gibberellate (0.0857)

[a] = "P" for powder concentrate and "L" for liquid concentrate.
[b] = Quantity diluted with 1/2 gallon water.

inspection of containers after washing was completed, noting the removal or retention of prewash residues.

Contamination detection by an in-line detector

The conventionally washed containers were evaluated by a Graham Polytrip Contaminant Detector, manufactured by Graham Polytrip Corporation, York, Pennsylvania, at United Dairy Farmers Cooperative Dairy, Pittsburgh, Pennsylvania. Before container testing proper adjustment of the detector was confirmed by a Pennsylvania dairy sanitarian and the dairy quality control person in attendance. Due to the particular design of this instrument, glass containers would not pass beneath the instrument because of the dimensions of the Midwest finish on the glass bottles. Hence glass containers were not tested. The detector gave a control response of 0.25 milliamps on a 10.0-milliamp scale for a new conventionally washed LEXAN resin and HDPE plastic container that had not been exposed to pesticides. At this instrument setting a response greater than 7.0 milliamps was required for activation of the bottle punch. All pesticide exposed and previously washed LEXAN resin and HDPE plastic containers found compatible during pesticide storage were evaluated by the detection device.

RESULTS AND DISCUSSION

Pesticide products survey and selection

One purpose of this study was to determine those pesticide products that might be purchased by the consumer that would require dilution in some vessel, thus creating the possibility that a returnable dairy container might be chosen as the mixing and storage container. The emphasis on pesticides as opposed to other types of abuse chemicals such as household detergents and soaps, foodstuffs, body wastes and automotive products has a specific intent. While any number of materials might be considered abuse chemicals as far as a returnable container is concerned, pesticides represent potentially the most hazardous substances with which a returnable container might be used. Pesticides are economic poisons, and small quantities possess potential for more harm than other types of abuse chemicals. The other substances may cause an off-taste but no significant health hazard.

While there may be many methods of selecting the products to test, a survey of manufacturers who concentrate at least some portion, if not all, of their efforts in the consumer-oriented pesticide market seemed appropriate. Purchasing items to test at one or two local nurseries or garden supply outlets, while certainly an approach, was not used in this study because of the obvious limitations in sample selection.

In this survey of eight major manufacturers, a total of 426 total pesticide products were noted (Table 1). This number was reduced to 85 products to test by first eliminating those products which did not require dilution before application, and then eliminating the duplicate formulations. Product formulations and concentration levels used by licensed pest control operators (PCO's) and commercial farmers were not considered in this study by design. Pest control companies have equipment specifically designed for diluting and spraying pesticides, which argues against contamination from that source. Commercial farmers purchase larger quantities of liquid and powder concentrates (typically 5-gal. metal or HDPE plastic blow molded containers, or 55-gal. metal drums) for dilution in yet larger stainless steel or polyolefin rotationally molded tanks, which are usually part of a spray unit pulled by or mounted on a tractor. The gallon returnable dairy containers would not be a likely container for diluting quantities needed in commercial farming. In addition, PCO's and commercial farmers are much more knowledgeable than consumers regarding proper handling of chemicals. They are required to take courses via agricultural extension agents or their employers to become familiar with proper handling, storage and application of pesticides, and they must be certified.

The survey conducted as described is believed to include all of the ingredients found in consumer-oriented pesticides, and there is duplication in addition for ingredients found in powder concentrates and liquid concentrates. The survey was independent of geography and point-of-sale or type of retail store.

By comparison, there have been few studies whose specific design was to detail pesticide usage in the home. The U.S. Department of Health, Education, and Welfare, 1969, reported (*6*) on pesticides and their relation to environmental health. That document briefly addressed household use of pesticides. Three studies of usage levels, i.e. "pesticides": (*a*) Salt Lake County, Utah, (*b*) Arizona State Study, and (*c*) Charleston, South Carolina, were discussed, but the paucity of information led to incomplete findings. Commercial pest control operator application of pesticides was more fully discussed.

The Environmental Protection Agency (*5*) classified the percentage of domestic use of pesticides by principal kinds of use for the years 1968-1970. That information is below:

Use	All Pesticides (%)
Farm	55
Urban-suburban	15
Industry	20
Federal, State and Local Government	10
Total	100

The urban-suburban use of pesticides, about 15% of total usage, while a small fraction of total usage, represents the largest population of milk sales.

One generally finds a small number of active ingredients in home and garden formulations (Table 2). While there are many different commercial products, they represent variations in ingredient concentrations and combinations.

Comparison of the results of this survey with the individual products registered for use within the State of California for home and garden application (*2*), (675 individual products) shows that the additional products may be attributed to availability of like products from different manufacturers rather than new product formulations.

Pesticide product storage

The purpose of the storage test (Table 3) with the diluted pesticide products was one of noting the instances of compatibility or incompatibility of the stored products with container materials.

Under conditions of exposure generally encountered in household usage of pesticides, high temperatures of solubilization and/or storage are not typical. At temperature ranges approximately room temperature, HDPE resin and glass would be expected to be compatible - not craze, crack, etch, cloud, stain - with diluted pesticides. Compatibility observations discussed here do not include absorption of stored products.

Of the containers tested, glass showed no instances of incompatibility confirming conjecture. HDPE resin had no instances of incompatibility at the 3-day period of diluted pesticide exposure. However, one instance was noted at 10-day storage. Greenol severely stained the HDPE resin container in which it was stored. This is the only instance, regardless of bottle material, where a positive "stain" response was judged sufficient to remove the treated container from further testing. In other instances where positive staining was noted, there was a conjunctive reason for removing the container from further testing, such as gross cracking or clouding.

For LEXAN resin containers after 3 days of diluted pesticides storage, 26 formulations were judged incompatible; and after 10 days of storage, 28 products were judged incompatible with the resin. In the instance of two pesticides not indicating resin incompatibility after 3 days of storage, distinct incompatibility was noted after 10 days of storage.

The degree of incompatibility bears consideration. The cracking and clouding that developed in the containers was not marginal in degree, but quite substantial. A cracked container would not retain milk and most likely such a damaged container would be discarded before it was returned to the dairy, either by the customer or dairy distribution personnel. Clouding was not a slight degree of hazing, detectable only to the trained eye. The LEXAN resin changed in appearance from a clear transparent material to an opaque whitish material. Incompatibility of this nature and degree would not be mistaken for milk residues.

Results of substantial incompatibility are several, and they are all positive signals for public health protection. For LEXAN resin, incompatibility develops rapidly, and

TABLE 3. *Pesticide products storage test results.*

Product and manufacturer	Container material					
	LEXAN		HDPE		GLASS	
	3 Day	10 Day	3 Day	10 Day	3 Day	10 Day
Fungicides						
Maneb, Black Leaf	C[a]	C	C	C	C	C
Flotox, Ortho	C	C	C	C	C	C
Phaltan, Ortho	C	C	C	C	C	C
Orthocide, Ortho	C	C	C	C	C	C
Orthorix, Ortho	C	C	C	C	C	C
Dyrene, Ortho	C	C	C	C	C	C
Copper Fungicide, Black Leaf	C	I	C	C	C	C
Bordo-Mix, Pratt	C	C	C	C	C	C
Beneamyl 50W, Pratt	C	C	C	C	C	C
Zineb, Science	C	C	C	C	C	C
Lawn Fungicide, Bonide	C	C	C	C	C	C
Herbicides						
Ammate-X, Bonide	C	C	C	C	NT	NT
Amitrol-T, Amchem	C	C	C	C	C	C
Weed-B-Gon, Ortho	C	C	C	C	C	C
Triox, Ortho	I[b]	I	C	C	C	C
Brush Killer-A, Ortho	C	C	C	C	C	C
Contax, Ortho	C	C	C	C	C	C
Crab Grass/Dandelion, Ortho	C	C	C	C	C	C
Chickweed/Clover, Ortho	C	C	C	C	C	C
Super-D Weedone, Amchem	C	C	C	C	C	C
Nu-Lawn Weeder, Amchem	I	I	C	C	C	C
Weedazol Herbicide, Amchem	C	C	C	C	C	C
3-D Weedone, Amchem	C	C(?)[c]	C	C	C	C
Weedone Crabgrass, Amchem	C	C	NT[d]	C	C	NT
X-All, Amchem	C	C	C	C	C	C
Turf Herbicide 6000, Pratt	C	C	C	C	C	C
NA Weed Killer, Pratt	I	I	C	C	C	C

Insecticides						
Methoxychlor 25% E, Bonide	I	I	C	C	C	C
Malathion 25W, Agway	I	I	C	C	C	C
Ortho-Klor 44, Ortho	C	C	C	C	C	C
Isotox, Ortho	I	I	C	C	C	C
Malathion 50, Ortho	I	I	C	C	C	C
Fruit & Vegetable, Ortho	I	I	C	C	C	C
Sevin, Ortho	C	C	C	C	C	C
Volck, Ortho	C	C	C	C	C	C
Rotenone, Ortho	C	C	C	C	C	C
Lindane, Ortho	I	I	C	C	C	C
Home Orchard, Ortho	I	I	C	C	C	C
Diazinon, Ortho	I	I	C	C	C	C
Sevin, Ortho	C	C	C	C	C	C
Orthene, Ortho	C	C	C	C	C	C
Ortho-Klor 74, Ortho	C	C	C	C	C	C
Sod Webworm, Ortho	I	I	C	C	C	C
Cinch Bug, Ortho	I	I	C	C	C	C
Lawn Insect Control, Ortho	C	C	C	C	C	C
Ortho-Klor 10, Ortho	C	C	C	C	NT	NT
Malathion 50E, Ortho	I	I	C	C	C	C
Rose Garden Spray, Black Leaf	I	I	C	C	C	C
Vapam Soil Fumigant, Black Leaf	C	C	C	C	C	C
Black Leaf 40, Black Leaf	C	C	C	C	C	C
Spectracide, Ciba-Geigy	I	I	C	C	C	C
Scalecide, Pratt	C	C	C	C	C	C
6E Oil Spray, Pratt	C	C	C	C	C	C
Cygon Systemic, Pratt	I	I	C	C	C	C
Red Arrow, Pratt	I	I	C	C	C	C
Thuricide HPC, Pratt	C	C	NT	C	C	C
Tomato/Vegetable Dust/Spray, Pratt	C	C	C	C	C	C
Rose/Flower Dust/Spray, Pratt	C(?)	C(?)	C	C	C	C
Mite Spray, Pratt	I	I	C	C	C	C
Inoculate 3, Pratt	I	I	C	C	C	C
Imidan 12.5 WP, Pratt	C	C	C	C	C	C
505K Insect Spray, Pratt	I	I	C	C	C	C
Dursban 135EC, Pratt	I	I	C	C	C	C
Tomato/Vegetable Insect Spray, Pratt	I	I	C	C	C	C
Fruit/Nut/Garden Spray, Science	I	I	C	C	C	C
Multi-Purpose Garden Dust or Spray, Science	C	C(?)	C	C	C	C
Gladiolus/Bulb Dust or Spray, Science	C	C	C	C	C	C
Methoxychlor 50 WP, Science	C	C	C	C	C	C
Zectran, Science	C	C	C	C	C	C
Rose Spray, Bonide	I	I	C	C	C	C
Flower/Vegetable 4 in 1, Bonide	I	I	C	C	C	C
Fertilizers						
Ortho-Grow, Ortho	C	C	C	C	C	C
Fish Emulsion, Ortho	C	C	C	C	C	C
Rose/Flower, Ortho	C	C	C	C	C	C
Evergreen/Azalea, Ortho	C	C	C	C	C	C
Tomato/Vegetable, Ortho	C	C	C	C	C	C
Greenol, Ortho	C	I	C	I	C	C
Up-Start, Ortho	C	C	C	C	C	C
Other						
Fumasol-S, Amchem	C	C	C	C	C	C
Folicote, Pratt	C	C	NT	NT	C	C
Spreader/Sticker, Pratt	C	C	C	C	C	C
Animal Repellent, Pratt	C	C	C	C	C	C
Blossom Set, Science	C	C	C	C	C	C
Hedge-Trim, Science	C	C	C	C	C	C
Wonder-Brel, Science	C	C	C	C	C	C
TOTALS	C = 59 I = 26	C = 57 I = 28	C = 82 I = 0	C = 83 I = 1	C = 83 I = 0	C = 82 I = 0

[a] = Compatible.
[b] = Incompatible (Readily discernible clouding/cracking).
[c] = Questionably compatible (slight clouding).
[d] = Not tested (lack of sufficient concentrate to make up test solution).

while not noted in the results of this study, many cases of plasticization of the resin and resulting whitening were observed immediately (at the time of mixing). Containers do not need to be stored for lengthy periods before incompatibility develops.

It is noteworthy that a container constructed of LEXAN resin may function as an indicator of exposure to abuse chemical environments. This built-in self-destruct mechanism may protect against refilling. When a dairy uses a deposit-return incentive for milk containers it does not have to absorb the costs of container replacement for such chemically abused containers.

Those containers judged positive for visual incompatibility were not considered further in the testing scheme. Three instances of slight hazing or clouding, compared to 28 cases of severe clouding, were noted on close examination of the LEXAN resin containers, side-by-side with a control container. These containers continued to be included in the test scheme (Amchem's 3-D Weedone, Pratt's Rose/Flower Dust/Spray and Science's Multi-Purpose Garden Dust or Spray).

It was not possible to detect visual residues before or after washing in HDPE resin containers through the container wall due to the opacity of the material. Visual residues may well have been there, but there was not any method of knowing. Residues were observed visually (Table 4) after tap water washing with two volumes of water in the case of glass and LEXAN resin containers.

The products leaving visual residues in glass containers and LEXAN resin containers after conventional washing were the same, Orthorix, and Bordo-Mix. In either case, Orthorix deposit or Bordo-Mix deposit, an unclean bottle after washing, and filling with milk, would be evident, because of the nature of the deposit. Orthorix's active ingredient is calcium polysulfide, and the bath-tub-type deposit ring forms at the air/liquid interface on storage. A white background would accentuate the ring, leading to non-consumption of product. The bluish-white powdery deposit left by Bordo-Mix in glass and LEXAN resin containers would be as obvious.

To further emphasize the incompatibility of LEXAN resin with various solvents, the following information summarizes previous experiences of compatibility testing. When a substance containing solvent comes into contact with LEXAN resin's surface there follows one of several actions: (*a*) LEXAN resin is dissolved or degraded, (*b*) LEXAN resin stress cracks or crazes, (*c*) LEXAN resin crystallizes, changing from a clear and ductile material to an opaque and brittle material, or (*d*) there are various degrees of compatibility, dependent on time, temperature, concentration and stress level in the molded part.

For usual plastic material applications compatibility is tested by exposing stressed Izod impact bars to the solvent in question. This immersion test is conducted at four temperatures (Table 7). The highest stress level in the LEXAN resin where there is not any indication of incompatibility is recorded. A dairy container, while it initially has from 500-1000 psi of molded-in stress achieved by annealing the molded container, may well develop more stress due to knocks and bangs in handling. Using 1000 psi and room temperature as a guideline, one finds that most solvents tested to date would not be considered compatible with LEXAN resin. Those that are compatible at this condition, while common solvents, are not typically used by pesticide formulators, i.e., the alcohols, diethyl ether, and the low-boiling aliphatics. The heavily used aromatic compounds, as heavy aromatic naphtha, are not compatible with LEXAN resin at room temperature.

TABLE 4. *Visual residues remaining after cold water rinse/washing.*

	Lexan resin		HDPE plastic		Glass	
Product (Manufacturer)	3 Day	10 Day	3 Day	10 Day	3 Day	10 Day
Maneb (Black Leaf)	-	-	ND[a]	ND	-[c]	+
Rotenone (Ortho)	-	+	ND	ND	-	-
Phaltan (Ortho	-	+	ND	ND	-	-
Orthorix (Ortho)	+[b]	+	ND	ND	+[b]	+[b]
Sevin (Ortho)	+	+[b]	ND	ND	-	-
Dyrene (Ortho)	+	+	ND	ND	-	-
Ortho-Klor 10 (Ortho)	-	+	ND	ND	-	-
Fish Emul (Ortho)	+	+	ND	ND	-	-
Scalecide (Pratt)	-	+	ND	ND	-	-
Bordo-Mix (Pratt)	+[b]	+[b]	ND	ND	+[b]	+[b]
Folicote (Pratt)	+	+	ND	ND	-	+
Animal Repellent (Pratt)	+	+	ND	ND	-	-
TOTALS						
Visual residues before washing	7	11	ND	ND	2	4
Visual residues after washing	2	2	ND	ND	2	4

[a]Not determinable (due to the opacity of the HDPE plastic container).
[b] = Orthorix and Bordo-Mix remained in LEXAN resin and glass containers after commercial dairy washing. Remainder of prewash residues removed.
[c] = No visual residues present before washing.

TABLE 5. *In-line contaminant detector response to washed containers.*

Product and manufacturer	Container material			
	LEXAN Resin		HDPE Plastic	
	3 Day	10 Day	3 Day	10 Day
Fungicides				
Maneb, Black Leaf	0.25[a]	0.25	0.25	0.25
Flotox, Ortho	0.25	0.25	0.25	0.25
Phalton, Ortho	0.25	0.25	0.25	0.25
Orthocide, Ortho	0.25	0.25	0.25	0.25
Orthorix, Ortho	0.25	0.25	0.25	1.0/NP[d]
Dyrene, Ortho	0.25	0.25	0.25	0.25
Copper Fungicide, Black Leaf	0.25	I[b]	0.25	1.0/NP
Bordo-Mix, Pratt	0.25	0.25	0.25	0.25
Beneamyl 50W, Pratt	0.25	0.25	0.25	0.25
Zineb, Science	0.25	0.25	0.25	0.25
Lawn Fungicide, Bonide	0.25	0.25	0.25	0.25
Herbicides				
Ammate-X, Bonide	0.25	0.25	0.25	0.25
Amitrol-T, Amchem	0.25	0.25	0.25	0.25
Weed-B-Gon, Ortho	0.25	0.25	0.25	1.5/NP
Triox, Ortho	I	I	10.0+/P[c]	10.0+/P
Brush Killer-A, Ortho	0.25	0.25	0.25	1.0/NP
Contax, Ortho	0.25	0.25	0.25	0.5/NP
Crab Grass, Dandelion, Ortho	0.25	0.25	0.25	0.25
Chickweed/Clover, Ortho	0.25	0.25	0.25	0.25
Super-D Weedone, Amchem	0.25	0.25	0.25	0.25
Nu-Lawn Weeder, Amchem	I	I	0.25	0.25
Weedazol Herbicide, Amchem	0.25	0.25	0.25	0.25
3-D Weedone, Amchem	0.25	0.25	0.25	0.25
Weedone Crabgrass, Amchem	0.25	0.25	NT[e]	0.25
X-All, Amchem	0.25	0.25	0.25	0.25
Turf Herbicide 6000, Pratt	0.25	0.25	0.25	0.25
NA Weed Killer, Pratt	I	I	1.5/NP	6.0/NP
Insecticides				
Methoxychlor 25% E, Bonide	I	I	10.0+/P	10.0+/P
Malathion 25W, Agway	I	I	0.25	0.25
Ortho-Klor 44, Ortho	0.25	0.25	0.25	0.25
Isotox, Ortho	I	I	10.0+/P	10.0+/P
Malathion 50, Ortho	I	I	9.0/P	10.0+/P
Fruit & Vegetable, Ortho	I	I	3.0/NP	9.0/p
Sevin, Ortho	0.25	0.25	0.25	0.25
Volck, Ortho	0.25	0.25	0.25	1.0/NP
Rotenone, Ortho	0.25	0.25	0.25	0.5/NP
Lindane, Ortho	I	I	10.0+/P	10.0+/P
Home Orchard, Ortho	I	I	0.25	0.25
Diazinon, Ortho	I	I	2.0/NP	8.0/P
Sevin, Ortho	0.25	0.25	0.25	0.25
Orthene, Ortho	0.25	1.0/NP	1.0/NP	2.5/NP
Ortho-Klor 74, Ortho	0.25	0.25	0.25	2.0/NP
Sod Webworm, Ortho	I	I	10.0+/P	10.0+/P
Cinch Bug, Ortho	I	I	10.0+/P	10.0+/P
Lawn Insect Control, Ortho	0.25	0.25	0.25	0.25
Ortho-Klor 10, Ortho	0.25	0.25	0.25	0.25
Malathion 50E, Ortho	I	I	7.0/P	10.0+/P
Rose/Garden Spray, Black Leaf	I	I	0.25	1.5/NP
Vapam Soil Fumigant, Black Leaf	0.25	0.25	0.25	0.25
Black Leaf 40, Black Leaf	0.25	0.25	0.25	0.25
Spectracide, Ciba-Geigy	I	I	0.5/NP	1.5/NP
Scalecide, Pratt	0.25	0.25	0.25	0.25
6E Oil Spray, Pratt	0.25	0.25	0.25	0.25
Cygon Systemic, Pratt	I	I	0.25	0.25
Red Arrow, Pratt	I	I	2.5/NP	7.0/NP
Thuricide HPC, Pratt	0.25	0.25	NT	0.25
Tomato/Vegetable Dust/Spray, Pratt	0.25	0.25	0.25	0.25
Rose/Flower Dust/Spray, Pratt	0.25	0.25	0.25	0.25
Mite Spray, Pratt	I	I	0.25	2.0/NP
Nodulate 3, Pratt	I	I	1.0/NP	4.0/NP
Imidan 12.5 WP, Pratt	0.25	0.25	0.25	0.25
505K Insect Spray, Pratt	I	I	0.5/NP	2.5/NP
Dursban 135EC, Pratt	I	I	1.5/NP	2.5/NP
Tomato/Vegetable Insect Spray, Pratt	I	I	1.0/NP	2.5/NP
Fruit/Nut/Garden Spray, Science	I	I	1.0/NP	1.0/NP

Multi-Purpose Garden Dust or Spray, Science	0.25	0.25	0.25	0.25
Gladiolus/Bulb Dust or Spray, Science	0.25	0.25	0.25	0.25
Methoxychlor 50 WP, Science	0.25	0.25	0.25	0.25
Zectran, Science	0.25	0.25	0.25	0.25
Rose Spray, Bonide	I	I	0.25	0.25
Flower/Vegetable 4 in 1, Bonide	I	I	0.25	0.25
Fertilizers				
Ortho-Grow, Ortho	0.25	0.25	0.25	0.25
Fish Emulsion, Ortho	0.25	0.25	0.25	0.25
Rose/Flower, Ortho	0.25	0.25	0.25	0.25
Evergreen/Azalea, Ortho	0.25	0.25	0.25	0.25
Tomato/Vegetable, Ortho	0.25	0.25	0.25	0.25
Greenol, Ortho	0.25	I	0.25	I
Up-Start, Ortho	0.25	0.25	0.25	0.25
Other				
Fumasol-S, Amchem	0.25	0.25	0.25	0.25
Folicote, Pratt	0.25	0.25	NT	NT
Spreader/Sticker, Pratt	0.25	0.25	0.25	0.25
Animal Repellent, Pratt	0.25	0.25	0.25	0.25
Blossom Set, Science	0.25	0.25	0.25	0.25
Hedge-Trim, Science	0.25	0.25	0.25	0.25
Wonder-Brel, Science	0.25	0.25	0.25	0.25
Total test cases	59	57	82	83
Control response/No puncture	59	56	63	54
Positive response — no puncture	0	1	11	19
Positive response — puncture	0	0	8	10

[a] =Control Detector Response (milliamps).
[b] =Pesticide Product Storage Test resulted in incompatibility.
[c] =Detector response was positive and degree of response resulted in puncture (P).
[d] =Detector response was positive but degree of response did not result in puncture (NP).
[e] =Not tested.

TABLE 6. *Compatibility of common solvents with LEXAN resin.*

Solvent	Type	73 F	120 F	158 F	185 F
Acetone	Ketone	0000	0000	0000	0000
Allyl alcohol	Alcohol	1700	1700	1000	0000
Amyl alcohol	Alcohol	1700	1700	1000	0000
Aniline	Amine	0000	0000	0000	0000
Anti-freeze	Automotive	0000	0000	0000	0000
Benzene	Aromatic	0000	0000	0000	0000
Butyl cellosolve acetate	Ester	0000	0000	0000	0000
Butyl cellosolve	Ester	1700	—	—	—
Carbon tetrachloride	Chlorinated	0650	0000	0000	0000
Chlorobenzene	Chlorinated aromatic	0000	0000	0000	0000
Chlorobutane-1	Chlorinated aliphatic	0000	0000	0000	0000
Chloroform	Chlorinated aliphatic	0000	0000	0000	0000
Chlorothene	Chlorinated aliphatic	0000	0000	0000	0000
Cyclohexanone	Ketone	0000	0000	0000	0000
Dichlorethane	Chlorinated aliphatic	0000	0000	0000	0000
Dichloromethane	Chlorinated aliphatic	0000	0000	0000	0000
Diethyl ether	Ether	1700	0000	0000	0000
Ethyl acetate	Ester	0000	0000	0000	0000
Ethyl alcohol	Alcohol	3400	2000	1000	0000
Ethylene glycol	Alcohol	0000	0000	0000	0000
Heavy aromatic naphtha	Mixture	0000	0000	0000	0000
Heptane	Aliphatic	2000	1700	1000	1000
Hexane	Aliphatic	2000	1700	1000	1000
Isopropanol	Alcohol	3400	2500	2000	1700
Methanol	Alcohol	3400	2000	1000	0000
Methyl cellosolve	Ester	0000	0000	0000	0000
Methylene chloride	Chlorinated aliphatic	0000	0000	0000	0000
Naphtha	Mixture	1700	1000	0000	0000
Octyl alcohol	Alcohol	2000	2000	2000	2000
Orthodichloro benzene	Chlorinated aromatic	0000	0000	0000	0000
THG	Ether	0000	0000	0000	0000
Toluene	Aromatic	0000	0000	0000	0000
Turpentive (mineral spirits)	Mixture	1000	0000	0000	0000
VM&P naphtha	Mixture	1000	0000	0000	0000

TABLE 7. *Numerical summary of test responses.*

Test response description	LEXAN		HDPE		Glass	
	3 Day	10 Day	3 Day	10 Day	3 Day	10 Day
Compatibility						
Products tested	85	85	82	84	83	82
Minus incompatible products	-26	-28	-0	-1	-0	-0
Compatible products	59	57	82	83	83	82
Residues						
Products tested	59	57	ND[a]	ND	83	82
No visual residues before washing	52	46	ND	ND	81	78
Visual residues before washing	7	11	ND	ND	2	4
Products tested	59	57	ND	ND	83	82
No visual residues after washing	57	55	ND	ND	81	80
Visual residues after washing	2	2	ND	ND	2	2
Detector						
Products tested	59	57	82	83	83	82
Negative response - no puncture	59	56	63	54	ND	ND
Positive response - no puncture	0	1	11	19	ND	ND
Positive response - puncture	0	0	8	10	ND	ND

[a] = Not determined.

Quite clearly, those pesticides tested in this study that were found incompatible with LEXAN resin, owe part of the incompatibility to the solvent carriers.

Generally, LEXAN resin is readily dissolved by certain halogenated solvents as methylene chloride, 1,3 dichlorethane and chloroform. Plasticization and crystallization can result from contact with partial solvents such as low molecular weight aldehydes and ethers, ketones, esters, aromatic hydrocarbons and perchlorinated hydrocarbons. Chemical attack ranging from partial to complete destruction of molded parts occurs in contact with strong alkali, alkaline salts, and amines. Stress crazing and cracking may occur at low stress levels when carbon tetrachloride, acetone, and xylene come into contact with LEXAN resin's surface.

By way of comparison, HDPE plastic has good compatibility with a variety of concentrated and diluted chemicals, as evidenced by the fact that HDPE plastic is used for corrosive waste piping, gasoline tanks, point-of-sale containers for chemicals and pesticides concentrates. If HDPE plastic had poor compatibility with chemicals and pesticides it could not be used for this purpose.

Contaminant detector testing

Following pesticide storage and washing, all containers found compatible were tested by the in-line contaminant detector. Unfortunately, the "snifter" was adjusted to receive HDPE plastic containers and LEXAN resin containers, but not glass. The wide Midwest-type finish on the glass containers would not allow them to fit through the centering guide of the "snifter".

There are actually three types of responses that the "snifter" can give. But, the "snifter" only has two courses of action. The container is punctured by the dagger when the response is positive, indicating a contaminated container, and when that response is of sufficient magnitude. In other words, there must be direction and degree. This response and puncture action is what the "snifter" is designed to do -- cull out containers that are chemically contaminated or abused.

The other course of action for the detector is not to puncture the container, and that essentially implies it is not acceptable for filling. The problem arises in that there are two responses that may precede the action step. One of these is a negative response, or control response. The other response is a positive response, indicating possible contamination after washing, but the degree of the response is insufficient to trigger the puncture mechanism. Since the "snifter" was recalibrated before this testing scheme, the three types of responses are felt to be reliable and reproducible.

With HDPE resin containers, the "snifter" functioned as it was designed to do for eight diluted products stored for 3 days, and for 10 diluted products stored for 10 days (Table 5). There were consequently two products which were sufficiently absorbed following longer exposure to activate the puncture mechanism. In looking at the other courses of action available to the "snifter", letting the bottles continue to the filler, for HDPE resin containers there were 63 cases of negative or no response after 3-day storage and 54 cases of negative or no response after 10 days of storage. The reason there was a reduction of no response cases at 10 days is that there was almost a doubling of the second type of response mentioned for this action course - a positive response indicating failure to clean the container, but not strong enough to activate the puncture mechanism. This happened in 11 instances after 3-day storage and 19 instances after 10-day storage.

The LEXAN resin containers found incompatible were never washed, so were not analyzed by the "snifter" (Table 5). For the remaining 59 products diluted and stored in LEXAN resin containers for 3 days there were not any instances of a positive "snifter" response. After 10 days of storage one product gave a positive "snifter" response, but the degree was insufficient to activate the puncture mechanism.

The self-destruct fail-safe mechanism of the LEXAN resin container does a better job of rejecting misused LEXAN containers than the "snifter" does in culling misused HDPE plastic containers following 3 and 10

days of pesticide product storage. For LEXAN resin incompatibility rejected all pesticide products for which puncture occurred for HDPE plastic (Table 6). In addition, incompatibility culled "snifter" accepted but not punctured HDPE plastic pesticide product storage cases (Table 7).

CONCLUSIONS

The Grade "A" Pasteurized Milk Ordinance -- 1965 Recommendations of the USPHS contains seven safeguards for the use of plastic returnable dairy containers. The recommendations were developed 10 years before the LEXAN resin container was introduced to the dairy industry. Safeguards for returnable plastic dairy containers should not be independent of container material. The requirement of an in-line detection device for the LEXAN resin container appears to be of little value. Incompatibility is a superior culling mechanism for LEXAN resin. It is more reliable than the "snifter" in culling misused containers. A continued recommendation of "snifter" use with LEXAN resin containers should rely on instances where it has shown to safeguard public health, and no such instances have been described since there were not any cases of "snifter" detection and puncture for LEXAN resin. Most importantly, the incompatibility capability of LEXAN resin is inherent in the plastic resin itself, not subject to adjustment or human error as is a machine, and the ability to self-destruct is present in the containers at every container trip to the consumer.

ACKNOWLEDGMENTS

The author thanks Joseph F. Mizia, Senior Technical Specialist, LEXAN Products Department, for his technical support, and John A. Rock and Glenn W. Roy for sample preparation. The assistance of Rich Ver Hage and Glenn Ver Hage, Garden State Farms, is also acknowledged.

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Journal of Food Protection Vol. 41 No. 11, Pages 863-877 (November 1978)

Significance of Abuse Chemical Contamination of Returnable Dairy Containers: Sensory and Extraction Studies

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(Received for publication May 3, 1978)

ABSTRACT

LEXAN® resin, polyethylene plastic, and glass returnable dairy containers were exposed to 85 dissimilar pesticides. Following exposure, all containers found compatible with stored pesticides were conventionally washed. Sensory testing of washed containers was more effective in detection of off-odors than was the contaminant detection device. All three types of containers exhibited off-odors when they contained pesticide and then were washed. Milk stored in washed containers, previously exposed to pesticides for 10 days, extracted the pesticide ingredient in 6 out of 85 instances for LEXAN resin and 22 out of 85 instances for polyethylene plastic. This investigation examined additional relationships between pesticide storage, specific contaminant detector responses, sensitivity of organoleptic evaluation and chemical extraction studies of milk.

A previous study by Gasaway (*4*) established a list of 85 dissimilar pesticide products available for consumer purchase. Storage of these products, diluted to label-recommended concentration in returnable dairy containers, validated the incompatibility response of LEXAN resin to these chemicals and the good compatibility with them of high density polyethylene (HDPE) plastic and glass. After conventional washing, evaluation of containers by the in-line contamination detector showed no instances of positive response and container puncture for LEXAN resin. The detector did not always function as a fail-safe device for HDPE plastic containers; it detected the presence of some contaminants, but at a response level insufficient to activate the puncture mechanism and hence negate use of the bottle. The incompatibility of stored pesticides with LEXAN resin containers was shown to be more effective in detecting misused containers than was the detection device for HDPE plastic containers.

Landsberg et al. (*5*) also demonstrated that the in-line contaminant detector failed to always function as an adequate fail-safe device. A significant proportion of washed containers, previously exposed to household chemicals, was "accepted" by the detector, yet the containers imparted off-odors to milk subsequently stored in them.

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The purpose of this publication is to report the results of: (*a*) sensory testing of washed returnable dairy containers manufactured from LEXAN resin, HDPE plastic, and glass, that had been abused by pesticides; (*b*) extraction-testing of pesticide-exposed and commercially washed returnable dairy containers manufactured from LEXAN resin and HDPE plastic; and (*c*) a comparison of previously reported contamination detection study results with organoleptic and extraction testing results.

MATERIALS AND METHODS

Contaminate detection by sensory testing

Those returnable LEXAN resin, HDPE plastic and glass containers previously exposed and found compatible with 85 pesticide products (Table 2), and commercially washed in Pennwalt Chemical Company's PBS detergent, were examined for off-odors. The sensory evaluation was conducted at room temperature (70 F) and judged against containers not previously exposed to pesticides (Table 1).

Contaminant detection by extraction methods

Following sensory evaluation, all LEXAN resin containers found compatible during pesticide product storage were recapped with new closures and forwarded to the Wisconsin Alumni Research Foundation Institute, Inc., WARF, Madison, Wisconsin, for milk-extraction testing. Those HDPE plastic containers judged compatible during pesticide product storage, but not punctured during the contaminant detector test and judged to have an off-odor by sensory testing were recapped and forwarded as well. Those HDPE plastic containers judged compatible during pesticide product storage, but not punctured by the contaminant detector and judged to have no off-odor by sensory evaluation were not forwarded to WARF for milk extraction testing. No extraction tests were conducted with glass containers.

For pesticide extraction studies, LEXAN resin and HDPE plastic containers were filled with homogenized milk and stored at 37.5±1 F. When the LEXAN resin container was studied, milk was analyzed for pesticide residues after 3 and 10 days of storage in containers that previously held the pesticide for 3 or 10 days. For the HDPE plastic container, milk was analyzed for pesticide residues only after 10 days of storage in containers that previously held the pesticide for 3 and 10 days. This resulted in the following pesticide exposure/extraction testing scheme:

		Milk Extraction Time	
		3 Days	10 Days
Pesticide Storage Time	3 Days	LEXAN	LEXAN & HDPE
	10 Days	LEXAN	LEXAN & HDPE

The methodology used to detect pesticide residues in stored milk was selected by WARF (*8-64*). Because 56 individual pesticide ingredients were involved, the specific methodology used in each instance is not presented. WARF was instructed to use the most recently developed techniques of pesticide residues testing resulting in the greatest likelihood for detection of the chemicals at the lowest practical concentrations. Where methodology was not available for detecting a specific pesticide in milk, water was substituted as the extraction medium (Table 3). In five instances no pesticide ingredient methodology existed.

RESULTS AND DISCUSSION

Sensory evaluation of washed containers

Sensory evaluation of washed containers was undertaken for several reasons. Bodyfelt et al. (*1*) and Landsberg et al. (*5*) reported that sensory evaluation was more effective than the contaminant detector ("snifter") for identifying those washed containers that had off-odors. The human nose is a very discriminating detection device. From the standpoint of consumption of dairy products held in a washed container, the human nose in conjunction with the taste mechanism determines the suitability of a product before consumption or at the first drink. The taste and smell mechanisms are the final test before consumption and operate independently from any fail-safe devices that might be used before filling a washed container. This study confirms that the human nose is the best detection device.

All three types of treated dairy containers were judged by sensory evaluation to have some degree of off-odor for certain pesticide products. Regardless of the container material, there were more containers judged by olfactory test to have an off-odor than were detected (or rejected) by the "snifter".

For LEXAN resin container (Table 1), after 3 days of storage of diluted pesticide products, followed by conventional dairy bottle washing, there were eight positive sensory responses for off-odors, or 9% of the total 85 pesticide cases tested. Since there were 26 pesticide products found incompatible with the container resin during pesticide product storage, the net frequency was 8/59 × 100%, or 14%. After 10 days of storage of dilute pesticides and washing the containers, there were 12 positive sensory responses for off-odor, or 14% of the 85 pesticide cases tested. Again, since there were 28 pesticide products found incompatible during pesticide product storage, the net frequency was 12/57 × 100%, or 21%.

For HDPE plastic containers, after 3 days of storage and commercial washing, there were 35 positive sensory responses for off-odors out of 82 products tested, or 43%. However, there were instances where the "snifter" removed from further consideration certain products. For 3-day pesticide storage there were 8 cases of puncture recorded. The net frequency of off-odors thus becomes for 3-day pesticide storage 38-8/82-8 × 100%, or 41%. For 10 days of storage, there were 48 positive sensory responses for off-odor out of 83 pesticide product cases, or 58%. After allowance for the 10 containers eliminated by the contaminant detector, a net frequency of 52% (48-10/83-10 × 100%) positive responses for off-odor was noted.

TABLE 1. *Sensory responses for pesticide-treated and washed containers.*

Product and manufacturer	Container material					
	LEXAN Resin		HDPE Plastic		Glass	
	3 Day	10 Day	3 Day	10 Day	3 Day	10 Day
Fungicides						
Maneb, Black Leaf	-[a]	+[b]	-	-	-	-
Flotox, Ortho	-	-	-	-	-	-
Phaltan, Ortho	-	+	+	+	-	-
Orthocide, Ortho	+	+	+	+	-	-
Orthorix, Ortho	-	+	-	+	+	+
Dyrene, Ortho	-	-	-	-	-	-
Copper Fungicide, Black Leaf	-	I[c]	-	+	-	-
Bordo-Mix, Pratt	-	-	-	-	-	-
Beneomyl 50W, Pratt	-	-	-	-	-	-
Zineb, Science	-	-	-	-	-	-
Lawn Fungicide, Bonide	-	-	-	-	-	-
Herbicides						
Ammate-X, Bonide	-	-	-	-	-	-
Amitrol-T, Amchem	-	-	-	-	-	-
Weed-B-Gon, Ortho	-	-	-	+	-	-
Triox, Ortho	I	I	+	+	-	-
Brush Killer-A, Ortho	-	-	-	-	-	-
Contax, Ortho	-	-	-	+	-	-
Crab Grass/Dandelion, Ortho	-	-	-	+	-	-
Chickweed/Clover, Ortho	-	-	-	+	-	-
Super-D Weedone, Amchem	-	-	-	+	-	-
Nu-Lawn Weeder, Amchem	I	I	+	+	-	-
Weedazol Herbicide, Amchem	-	-	-	-	-	-
3-D Weedone, Amchem	+	+	+	+	-	-
Weedone Crabgrass, Amchem	-	-	NT[d]	-	NT	NT
X-All, Amchem	-	-	-	-	-	-
Turf Herbicide 6000, Pratt	-	-	-	+	-	-
NA Weed Killer, Pratt	I	I	+	+	-	-

Insecticides						
Methoxychlor 25%E, Bonide	I	I	+	+	-	-
Malathion 25W, Agway	I	I	-	+	-	-
Ortho-Klor 44, Ortho	-	-	-	+	-	-
Isotox, Ortho	I	I	+	+	-	-
Malathion 50, Ortho	I	I	+	+	-	-
Fruit & Vegetable, Ortho	I	I	+	+	-	-
Sevin, Ortho (powder)	-	-	-	-	-	-
Volck, Ortho	-	-	-	+	-	-
Rotenone, Ortho	-	-	-	-	-	-
Lindane, Ortho	I	I	+	+	-	-
Home Orchard, Ortho	I	I	+	+	-	-
Diazinon, Ortho	I	I	+	+	-	-
Sevin, Ortho (liquid)	-	-	-	-	-	-
Orthene, Ortho	+	+	+	+	-	-
Ortho-Klor 74, Ortho	+	+	+	+	-	-
Sod Webworm, Ortho	I	I	+	+	-	-
Cinch Bug, Ortho	I	I	+	+	-	-
Lawn Insect Control, Ortho	-	-	-	+	-	-
Ortho-Klor 10, Ortho	-	-	-	-	NT	NT
Malathion 50E, Ortho	I	I	+	+	-	-
Rose/Garden Spray, Black Leaf	I	I	+	+	-	-
Vapam Soil Fumigant, Black Leaf	-	-	-	-	-	-
Black Leaf 40, Black Leaf	-	-	-	-	-	-
Spectracide, Ciba-Geigy	I	I	+	+	-	-
Scalecide, Pratt	-	-	-	-	-	-
6E Oil Spray, Pratt	-	-	-	-	-	-
Cygon Systemic, Pratt	I	I	+	+	-	-
Red Arrow, Pratt	I	I	+	+	-	-
Thuricide HPC, Pratt	-	-	NT	-	-	-
Tomato/Vegetable Dust/Spray, Pratt	+	+	-	-	-	-
Rose/Flower Dust/Spray, Pratt	-	+	+	+	-	-
Mite Spray, Pratt	I	I	+	+	-	-
Noculate 3, Pratt	I	I	+	+	-	-
Imidan 12.5 WP, Pratt	+	+	+	+	-	-
505K Insect Spray, Pratt	I	I	+	+	-	-
Dursban 135EC, Pratt	I	I	+	+	-	-
Tomato/Vegetable Insect Spray, Pratt	I	I	+	+	-	-
Fruit/Nut/Garden Spray, Science	I	I	+	+	-	-
Multi-Purpose Garden Dust or Spray, Science	+	+	+	+	-	-
Gladiolus/Bulb Dust or Spray, Science	-	-	-	-	-	-
Methoxychlor 50 WP, Science	-	-	-	-	-	-
Zectran, Science	-	-	-	+	-	-
Rose Spray, Bonide	I	I	+	+	-	-
Flower/Vegetable 4 in 1, Bonide	I	I	+	+	-	-
Fertilizers						
Ortho-Grow, Ortho	-	-	-	-	-	-
Fish Emulsion, Ortho	+	+	+	+	-	-
Rose/Flower, Ortho	-	-	-	-	-	-
Evergreen/Azalea, Ortho	-	-	-	-	-	-
Tomato/Vegetable, Ortho	-	-	-	-	-	-
Greenol, Ortho	-	I	-	I	-	-
Up-Start, Ortho	-	-	-	-	-	-
Other						
Fumasol-S, Amchem	-	-	-	-	-	-
Folicote, Pratt	-	-	NT	NT	-	-
Spreader/Sticker, Pratt	-	-	+	+	+	+
Animal Repellent, Pratt	-	-	-	-	-	-
Blossom Set, Science	-	-	-	-	-	-
Hedge-Trim, Science	-	-	-	-	-	-
Wonder-Brel, Science	-	-	-	-	-	-
TOTALS						
Products To Test	85	85	82	84	83	82
Incompatible Product Storage	26	28	0	1	0	0
Net Products To Test	59	57	82	83	83	82
Positive Organoleptic Response	8	12	35	48	2	2
Negative Organoleptic Response	51	45	47	35	81	80

[a] = No off-odor in washed container.
[b] = Off-odor in washed container.
[c] = Pesticide product storage resulted in incompatibility.
[d] = Not tested (NT).

For glass containers there were two positive sensory responses for off-odor following washing of containers exposed to diluted pesticides for either 3 or 10 days. This is a 2-3% positive response and represents evidence of the phenomenon happening even in glass.

Extraction studies on washed containers

There were two purposes for storage of milk (or water in those instances where a methodology for pesticide residues in milk was not available) in pesticide-exposed and washed returnable dairy containers. The first was to determine whether active ingredients of pesticide formulations could be detected in milk (or water), and to compare the analytical approach of noting the presence or absence of pesticide residues in containers or product with the other two methods of detection (contaminant detector and sensory evaluation). The second purpose for conducting milk storage studies was to attempt to quantify the amounts, or potential levels, of active ingredients of pesticides reabsorbed into milk from pesticide (diluted) treated, washed milk containers.

The selection of ½-gal. containers for the entire testing scheme was convenient and appropriate, due to surface-to-volume ratios. Use of ½-gal. containers represents a more rigorous test than the 1-gal. container because the surface-to-volume ratio for ½-gal. containers is 0.079 in.²/ml (150 in 2/1,893 ml), compared to the 1-gal. container at 0.062 in.²/ml (236 in 2/3,785 ml).

HDPE. The WARF extraction work with HDPE plastic was an abbreviated study. The deciding factor was the sensory testing result. If a container was judged to have an off-odor in this test, it was subjected to the milk extraction test. The test was conducted for 10 days for containers previously exposed to pesticide products for 3 or 10 days.

After 3-day storage of milk in HDPE plastic containers analysis was not possible for one product of 27 due to lack of methodology. For the remaining 26 products actually tested for extraction, 21 (81%) showed positive extraction, and five (19%) showed no extraction at the respective levels of detection employed by WARF (Table 2).

For 10-day storage of 38 diluted pesticides in HDPE plastic containers analysis was not possible for one product due to lack of methodology for milk or water. For the remaining 37 products actually tested for extraction, 25 (68%) showed extraction, and 12 (32%) showed no extraction at the respective levels of detection used (Table 2).

LEXAN. If a specific pesticide product (diluted) passed the compatibility portion of the storage test previously reported by Gasaway (*4*), the pesticide product was tested for extraction, except in instances of no

TABLE 2. *Milk [water] extraction test results for HDPE plastic containers [ppm].*

Product and manufacturer		Pesticide exposure time	
		3 Days	10 Days
		Milk extraction time	
Ingredients (%)	M/W[a]	10 Days	10 Days
Fungicides			
Maneb, Black Leaf			
Maneb (80)	_b	–	–
Flotox, Ortho			
Sulfur (90)	–	–	–
Phaltan, Ortho			
Folpet (75)	M	0.006	0.008
Orthocide, Ortho			
Captan (50)	M	<0.005	<0.005
Orthorix, Ortho			
Calcium Polysulfides [Control Milk = 245 ppm S]	M	–	265
Dyrene, Ortho			
Anilazine (50)	–	–	–
Copper Fungicide, Black leaf			
Copper Salts of Fatty Acids (48) [Control Water = 0.13 ppm Cu]	W	–	0.20
Bordo-Mix, Pratt			
Copper (12.75)	–	–	–
Beneomyl 50W, Pratt			
Beneomyl (50)	–	–	–
Zineb, Science			
Zineb (50)	–	–	–
Lawn Fungicide, Bonide			
Cadmium Chloride (7.5)	–	–	–
Thiram (6.4)	–	–	–
Zineb (50)	–	–	–
Herbicides			
Ammate-X, Amchem			
Ammonium Sulfamate (95)	–	–	–
Amitrol-T, Amchem			
role (21.6)	–	–	–
3-Gon, Ortho			
D (17.8)	M	–	0.29
ex (8.4)	M	–	0.04

Triox, Ortho		P[c]	P
Pramitol (1.86)	–	–	–
PCP (0.68)	–	–	–
Brush Killer-A, Ortho			
Ammonium Sulfamate (43)	–	–	–
Contax, Ortho			
Sodium Dimethylarsinite (10.4)	M		<0.03
Dimethylarsinic Acid (1.77)	M		
Crab Grass/Dandelion, Ortho			
Dodecylammonium Methanearsonate (8.0)	M	–	<0.03
Octylammonium Methanearsonate (8.0)	M		
Octylammonium Salt of 2,4-D (8.16)	M	–	<0.05
Chickweed/Clover, Ortho			
Isooctyl Ester of Silvex	M	–	<0.02
Super-D Weedone, Amchem			
Diethanol Amine Salt of 2,4-D (20.3)	W	–	<0.004
Diethanol Amine Salt of Dicamba (1.9)	W	–	<0.001
Nu-Lawn Weeder, Amchem			
Bromoxynil (8.4)	W	0.04	0.06
Weedazol Herbicide, Amchem			
Amitrole (50)	–	–	–
3-D Weedone, Amchem			
Butoxyethanol Ester of 2,4-D (17.7)	M	0.26	0.44
Butoxyethanol Ester of Silvex (8.3)	M	0.07	0.10
Dicamba (1.5)	M	<0.05	<0.05
Weedone Crabgrass, Amchem			
Calcium Acid Methanearsonate (10.3)	–	NT[d]	–
X-All, Amchem			
Amitrole (1.0)	–	–	–
Simazine (3.0)	–	–	–
Turf Herbicide 6000, Pratt			
MCPP (2.77)	W	–	<0.05
2,4-D (6.1)	W	–	<0.004
Dicamba (0.63)	W	–	<0.001
NA Weed Killer, Pratt			
Pramitol (3.5)	M	<0.02	<0.02
2,4-D (1.5)	M	<0.05	<0.05
Insecticides			
Methyxychlor 25% E, Bonide		P	P
Methoxychlor (25)	–	–	–
Malathion 25W, Agway			
Malathion (25)	M	–	0.17
Ortho-Klor 44, Ortho			
Chlordane (44.0)	M	–	1.16
Isotox, Ortho		P	P
Meta-Systox R (5)	–	–	–
Carbaryl (5)	–	–	–
Kelthane (5)	–	–	–
Malathion 50, Ortho		P	P
Malathion (50)	–	–	–
Fruit & Vegetable, Ortho			P
Diazinon (25)	M	0.39	–
Sevin, Ortho			
Carbaryl (50)	–	–	–
Volck, Ortho			
Petroleum Oil (97.0)	W	–	2.0
Rotenone, Ortho			
Rotenone (1)	–	–	–
Lindane, Ortho		P	P
Lindane (20)	–	–	–
Home Orchard, Ortho			
Captan (15)	M	<0.005	<0.005
Malathion (7.5)	M	0.08	0.10
Methoxychlor (15)	M	0.015	0.034
Diazinon, Ortho			P
Diazinon (25)	M	0.29	–
Sevin, Ortho			
Carbaryl (27)	–	–	–
Orthene, Ortho			
Acephate (15.6)	M	<0.01	<0.01
Ortho-Klor 74, Ortho			
Chlordane (74)	M	0.84	1.91
Sod Webworm, Ortho		P	P
Aspon (13)	–	–	–
Cinch Bug, Ortho		P	P
Aspon (13)	–	–	–
Lawn Insect Control, Ortho			
Dursban (5.3)	M	–	0.18

Ortho-Klor 10, Ortho			
Chlordane (10)	–	–	–
Malathion 50E, Ortho		P	P
Malathion 50	–	–	–
Rose/Garden Spray, Black Leaf			
Carbaryl (10)	W	<0.05	<0.05
Captan (10)	W	<0.005	<0.005
Dinitro Crotonates (0.9)	W	<0.05	<0.05
Kelthane (0.5)	–	–	–
Malathion (1.0)	W	0.75	0.40
Vapam Soil Fumigant, Black Leaf			
Solid Methyldithiocarbamate (32.7)	–	–	–
Black Leaf 40, Black Leaf			
Nicotine (40)	–	–	–
Spectracide, Ciba-Geigy			
Diazinon (25)	M	0.48	0.61
Scalecide, Pratt			
Petroleum Oil (98)	–	—	–
6E Oil Spray, Pratt			
Petroleum Oil (96)	–	–	–
Ethion (2)	–	–	–
Cygon Systemic, Pratt			
Dimethoate (23.4)	M	0.01	<0.01
Red Arrow, Pratt			
Pyrethrins (0.5)	W	<0.10	<0.10
Rotenone (1.5)	W	<0.05	<0.05
Piperonyl Butoxide (3)	W	<0.5	<0.5
Thuricide HPC, Pratt			
Bacillus thuringiensis (0.8)	–	NT	–
Tomato/Flower Dust/Spray, Pratt			
Rotenone (0.75)	–	–	–
Copper (7)	–	–	–
Rose/Flower Dust/Spray, Pratt			
Carbaryl (3)	M	<0.05	<0.05
Malathion (4)	M	0.04	0.09
Folpet (5)	M	<0.005	<0.01
Kelthane (1.5)	M	0.02	0.04
Mite Spray, Pratt			
Kelthane (18.5)	M	0.02	0.55
Noculate 3, Pratt			
Meta-Systox R (6)	M	<0.005	<0.005
Methoxychlor (5)	M	0.11	0.14
Kelthane (0.9)	–	–	–
Imidan 12.5WP, Pratt			
Phosmet (12.5)	M	0.10	0.11
505K Insect Spray, Pratt			
Methoxychlor (24)	M	0.14	0.14
Malathion (13)	M	0.10	0.06
Kelthane (3)	M	<0.01	0.02
Dursban 135 EC, Pratt			
Dursban (13.5)	M	0.36	0.09
Tomato/Vegetable Insect Spray, Pratt			
Methoxychlor (20)	M	0.079	0.10
Diazinon (10)	M	0.15	0.28
Fruit/Nut Garden Spray, Science			
Diazinon (8.3)	M	0.02	0.51
Kelthane (3.2)	M	0.06	–
Multi-Purpose Garden Dust or Spray, Science			
Methoxychlor (5)	M	0.024	0.036
Malathion (5)	M	<0.01	0.05
Captan (5)	M	0.009	<0.005
Gladiolus/Bulb Dust or Spray, Science			
Thiram (50)	–	–	–
Methoxychlor (5)	–	–	–
Methoxychlor 50 WP, Science			
Methoxychlor (50)	–	–	–
Zectran, Science			
Zectran (12.8)	W	–	<0.01
Rose Spray, Bonide			
Carbaryl (10)	W	<0.05	<0.05
Captan (10)	M	<0.005	<0.005
Dinitro Crotonates (0.9)	W	<0.05	<0.05
Kelthane (0.5)	M	<0.01	0.02
Malathion (1)	W	0.02	0.06
Flower/Vegetable : 4 in 1, Bonide			
Malathion (9.4)	M	0.13	0.15
Methoxychlor (9.4)	M	0.11	0.18
Dinitro Crotonates (1.4)	–	–	–

Fertilizers			
Ortho-Grow, Ortho			
N (12)	—	—	—
P_2O_5 (6)	—	—	—
K_2O (6)	—	—	—
Fe (6)	—	—	—
Zn (0.1)	—	—	—
EDTA (4)	—	—	—
Fish Emulsion, Ortho			
Fish Scrap	—	AI[e]	AI
Rose/Flower, Ortho			
N (8)	—	—	—
P_2O_5 (12)	—	—	—
K_2O (4)	—	—	—
EDTA	—	—	—
Evergreen/Azalea, Ortho			
N (10)	—	—	—
P_2O_5 (8)	—	—	—
K_2O (7)	—	—	—
B (0.02)	—	—	—
Fe (0.4)	—	—	—
Mn (0.05)	—	—	—
Mo (0.0008)	—	—	—
Zn (0.1)	—	—	—
EDTA (4)	—	—	—
Tomato/Vegetable, Ortho			
N (6)	—	—	—
P_2O_5 (18)	—	—	—
K_2O (6)	—	—	—
Greenol, Ortho			
S (3.64)	—	—	—
Cu (0.13)	—	—	—
Fe (6.13)	—	—	—
Zn (0.1)	—	—	—
EDTA (5)	—	—	—
Up-Start			
N (5)	—	—	—
P_2O_5 (15)	—	—	—
K_2O (5)	—	—	—
Indole-3-butyric acid (0.003)	—	—	—
Other			
Fumasol-S, Amchem (Rodenticide)			
Substituted Hydroxycoumarin (0.14)	—	—	—
Folicote, Pratt (Moisture Suppressant)			
Waxes	—	NT	NT
Spreader/Sticker, Pratt (Surfactant)			
Soybean Oil	W	<20.0	<20.0
Ethylene Dichloride	W	<0.1	<0.1
Alkyd Resin	—	—	—
Animal Repellent, Pratt			
Thiram (20)	—	—	—
Blosson Set, Science (Growth Regulator)			
BNOA (0.1389)	—	—	—
Hedge-Trim, Science (Growth Regulator)			
Maleic Hydrazide (30)	—	—	—
Wonder-Brel, Science (Growth Regulator)			
Potassium Gibberellate (0.0857)	—	—	—

TOTALS		
Products To Test	82	84
Incompatible Product Storage	0	1
Negative Organoleptic Response - No Off-Odor	47	35
Net Products To Test (Positive Organoleptic Testing Responses)	35	48
Punctured (P) During In-Line Detector Test	8	10
Analysis Not Possible - No Methodology (AI)	1	1
Product Cases Showing Extraction	21	25
Product Cases Showing No Extraction	5	12
Total Number of Ingredients Found Extracting	29	35
Chemically Different Ingredients Found Extracting	13	14

[a] = "M" for Milk and "W" for Water used as extraction medium.
[b] = "I" for product incompatible during storage test.
[c] = "NT" Not tested.
[d] = Negative organoleptic response, therefore excluded from extraction test.
[e] = "AI" for analysis not possible - no methodology.
[f] = "P" for punctured in "snifter" test.

methodology, spillage and duplication of petroleum oil testing.

For 3-day storage of 59 diluted pesticides in LEXAN resin containers analysis was not possible for five products due to lack of methodology. Analysis had to be omitted for one product due to accidental spillage and duplicate analyses were not conducted for two petroleum oil products. Of the remaining 51 products tested for extraction, six (12%) showed extraction, and 45 (88%) showed no extraction at the respective levels of detection used (Table 3).

For 10-day storage of 57 diluted pesticides in LEXAN resin containers analysis was not possible for five products and petroleum oil was not determined in two cases. Of the remaining 50 products actually tested for extraction, six (12%) showed extraction, and 44 (88%) showed no extraction at the detection levels employed. (Table 3).

Analysis of milk for pesticide residues was done after two periods of exposure in pesticide-treated milk containers; 3 and 10 days, respectively. The previous treatment of containers with diluted pesticides encompassed two storage periods also, 3 or 10 days. The reason for two extraction tests for each pesticide exposure time was to identify time-dependent extraction processes. In general, the amounts of pesticide ingredients extracting after 10 days of milk storage were greater than amounts after 3 days, although there were exceptions. (Table 3).

Summary of pesticide ingredients extracted into milk

For HDPE plastic following 3 days of dilute pesticide storage, washing and 10 days of milk storage, 13 ingredients were found to extract from 21 pesticide products. The number of times a specific ingredient was found to extract is shown in parenthesis. They were Folpet (1), Bromoxymil (1), 2,4-D (1), Silvex (1), Diazinon (5), Malathion (6), Methoxychlor (6), Dimethoate (1), Kelthane (3), Phosmet (1), Chlordane (1), Dursban (1), and Captan (1). In other words, there were 29 positive extraction due to multiple ingredient products.

For HDPE plastic after 10 days of diluted pesticide storage, washing and 10 days of milk storage, 14 ingredients were found to extract from 25 pesticide products. They were: Folpet (1), calcium polysulfides (1), copper salts of fatty acids (1), 2,4-D (2), Silvex (2), Bromoxynil (1), Malathion (8), Chlordane (2), petroleum oil (1), Methoxychlor (6), Diazinon (3), Dursban (2), Kelthane (4), and Phosment (1). There were 35 instances of measurable extraction, due to multiple ingredient products.

For LEXAN resin following 3 days of dilute pesticide storage, commercial dairy washing and 3 or 10 days of

TABLE 3. *Milk (water) extraction test results for Lexan resin containers (ppm).*

Product and manufacturer / Ingredients (%)	M/W[a]	Pesticide exposure time: 3 Days — Milk extraction time: 3 Days	3 Days — 10 Days	10 Days — 3 Days	10 Days — 10 Days
Fungicides					
Maneb, Black Leaf Maneb (80)	M	<1.0	<1.0	<1.0	<1.0
Flotox, Ortho Sulfur (90) [Control Milk = 245 ppm]	M	154	204	270	245
Phaltan, Ortho Folpet (75)	M	<0.005	<0.005	<0.005	<0.005
Orthocide, Ortho Captan (50)	M	<0.002	<0.002	<0.002	<0.002
Orthorix, Ortho Calcium Polysulfides	M	<1.0	<1.0	<1.0	<1.0
Dyrene, Ortho Anilazine (50)	W	<0.0005	<0.0005	<0.0005	<0.0005
Copper Fungicide, Black Leaf					I[b]
Copper Salts of Fatty Acids (48) [Control Water = 0.13 ppm Cu]	W	0.12	0.14	—	—
Bordo-Mix, Pratt Copper (12.75) [Control Water = 0.13 ppm Cu]	W	Sample Spilled - NT		0.11	0.15
Beneomyl 50W, Pratt Beneomyl (50)	M	<0.1	<0.1	<0.1	<0.1
Zineb, Science Zineb (50)	M	<1.0	<1.0	<1.0	<1.0
Lawn Fungicide, Bonide Cadmium Chloride (7.5)	M	<0.01	<0.01	<0.01	<0.01
Thiram (6.4)	M	<1.0	<1.0	<1.0	<1.0
Zineb (50)	M	<1.0	<1.0	<1.0	<1.0
Herbicides					
Ammate-X, Bonide Ammonium Sulfmate (95)	W	0.4	1.1	<0.2	<0.2
Amitrol-T, Amchem Amitrole (21.6)	M	<0.2	<0.2	<0.2	<0.2
Weed-B-Gon, Ortho 2,4-D (17.8)	M	<0.05	<0.05	<0.05	<0.05
Silvex (8.4)	M	<0.02	<0.02	<0.02	<0.02

Triox, Ortho			I		I
Pramitol (1.86)	–	–	–	–	–
PCP (0.68)	–	–	–	–	–
Brush Killer-A, Ortho					
Ammonium Sulfamate (43)	W	0.2	0.2	<0.2	<0.2
Contax, Ortho					
Sodium Dimethylarsinate (10.4)	M	<0.03	<0.03	<0.03	<0.03
Dimethylarsinic Acid (1.77)	M				
Crab Grass/Dandelion, Ortho					
Dodecylammonium Methanearsonate (8.0)	M	<0.03	<0.03	<0.03	<0.03
Octylammonium Methanearsonate (8.0)	M				
Octylammonium Salt of 2,4-D (8.16)	M	<0.05	<0.05	<0.05	<0.05
Chickweed/Clover, Ortho					
Isooctyl Ester of Silvex (13.8)	M	<0.02	<0.02	<0.02	<0.02
Super-D Weedone, Amchem					
Diethanol Amine Salt of 2,4-D (20.3)	W	<0.004	<0.004	<0.004	<0.004
Diethanol Amine Salt of Dicamba (1.9)	W	<0.001	<0.001	<0.001	<0.001
Nu-Lawn Weeder, Amchem			I		I
Bromoxynil (8.4)	–	–	–	–	–
Weedazol Herbicide, Amchem					
Amitrole (50)	M	<0.2	<0.2	<0.2	<0.2
3-D Weedone, Amchem					
Butoxyethanol Ester of 2,4-D (17.7)	M	0.44	0.48	0.59	0.48
Butoxyethanol Ester of Silvex (8.3)	M	0.10	0.14	0.31	0.10
Dicamba (1.5)	M	<0.05	<0.05	<0.05	<0.05
Weedone Crabgrass, Amchem					
Calcium Acid Methanearsonate (10.3)	M	<0.03	<0.03	<0.03	<0.03
X-All, Amchem					
Amitrole (1.0)	–	–	–	–	–
Simazine (3.0)	M	<0.05	<0.05	<0.05	<0.05
Turf Herbicide 6000, Pratt					
MCPP (2.77)	W	<0.05	<0.05	<0.05	<0.05
2,4-D (6.1)	W	<0.004	<0.004	<0.004	<0.004
Dicamba (0.63)	W	<0.001	<0.001	<0.001	<0.001
NA Weed Killer, Pratt			I		I
Pramitol (3.5)	–	–	–	–	–
2,4-D (1.5)	–	–	–	–	–
Insecticides					
Methoxychlor 25% E, Bonide			I		I
Methoxychlor (25)	–	–	–	–	–
Malathion 25W, Agway			I		I
Malathion (25)	–	–	–	–	–
Ortho-Klor 44, Ortho					
Chlordane (44.0)	M	<0.01	<0.01	<0.01	<0.01
Isotox, Ortho			I		I
Meta-Systox, R (5)	–	–	–	–	–
Carbaryl (5)	–	–	–	–	–
Kelthane (5)	–	–	–	–	–
Malathion 50, Ortho			I		I
Malathion (50)	–	–	–	–	–
Fruit & Vegetable, Ortho			I		I
Diazinon (25)	–	–	–	–	–
Sevin, Ortho					
Carbaryl (50)	M	<0.05	<0.05	<0.05	<0.05
Volck, Ortho					
Petroleum Oil (97.0)	NT[c]	–	–	–	–
Rotenone, Ortho					
Rotenone (1)	W	<0.05	<0.05	<0.05	<0.05
Lindane, Ortho			I		I
Lindane (20)	–	–	–	–	–
Home Orchard, Ortho			I		I
Captan (15)	–	–	–	–	–
Malathion (7.5)	–	–	–	–	–
Methoxychlor (15)	–	–	–	–	–
Diazinon, Ortho			I		I
Diazinon (25)	–	–	–	–	–
Sevin, Ortho					
Carbaryl (27)	M	<0.05	<0.05	<0.05	<0.05
Orthene, Ortho					
Acephate (15.6)	M	<0.05	<0.05	<0.05	<0.05
Ortho-Klor 74, Ortho					
Chlordane (74)	M	0.55 (AVG)[d]	1.30 (AVG)	0.66 (AVG)	2.06 (AVG)
Sod Webworm, Ortho			I		I
Aspon (13)	–	–	–	–	–
Cinch Bug, Ortho			I		I
Aspon (13)	–	–	–	–	–

Lawn Insect Control, Ortho								
Dursban (5.3)	M	<0.02		<0.02	<0.02		<0.02	
Ortho-Klor 10, Ortho								
Chlordane (10)	M	<0.01		<0.01	<0.01		<0.01	
Malathion 50E, Ortho			I			I		
Malathion 50	–	–		–	–		–	
Rose/Garden Spray, Black Leaf			I			I		
Carbaryl (10)	–	–		–	–		–	
Captan (10)	–	–		–	–		–	
Dinitro Crotonates (0.9)	–	–		–	–		–	
Kelthane (0.5)	–	–		–	–		–	
Malathion (1.0)	–	–		–	–		–	
Vapam Soil Fumigant, Black Leaf								
Sodium Methyldithiocarbamate (32.7)	M	<3.0		<3.0	<3.0		<3.0	
Black Leaf 40, Black Leaf								
Nicotine (40)	W	<0.1		<0.1	<0.1		<0.1	
Spectracide, Ciba-Geigy			I			I		
Diazinon (25)	–	–		–	–		–	
Scalecide, Pratt								
Petroleum Oil (98)	NT	–		–	–		–	
6E Oil Spray, Pratt								
Petroleum Oil (96)	W	<2.0		<2.0	<2.0		4.0	
Ethion (2)	W	<0.0015		<0.0015	<0.0015		<0.0015	
Cygon Systemic, Pratt			I			I		
Dimethoate (23.4)	–	–		–	–		–	
Red Arrow, Pratt			I			I		
Pyrethrins (0.5)	–	–		–	–		–	
Rotenone (1.5)	–	–		–	–		–	
Piperonyl Butoxide (3)	–	–		–	–		–	
Thuricide HPC, Pratt			AI[e]			AI		
Bacillus thuringiensis (0.8)	–	–		–	–		–	
Tomato/Flower Dust/Spray, Pratt								
Rotenone (0.75)	W	<0.05		<0.05	<0.05		<0.05	
Copper (7) [Control Water = 0.13 ppm Cu]	W	0.12		0.13	0.11		0.13	
Rose/Flower Dust/Spray, Pratt								
Carbaryl (3)	M	<0.05		<0.05	<0.05		<0.05	
Malathion (4)	M	<0.01		<0.01	<0.01		<0.01	
Folpet (5)	M	0.017		0.091	0.013		0.015	
Kelthane (1.5)	M	0.047		0.044	<0.01		0.02	
Mite Spray, Pratt			I			I		
Kelthane (18.5)	–	–		–	–		–	
Noculate 3, Pratt			I			I		
Meta-Systox R (6)	–	–		–	–		–	
Methoxychlor (5)	–	–		–	–		–	
Kelthane (0.9)	–	–		–	–		–	
Imidan 12.5WP, Pratt								
Phosmet (12.5)	M	<0.01		0.11	0.13		0.09	
505K Insect Spray, Pratt			I			I		
Methoxychlor (24)	–	–		–	–		–	
Malathion (13)	–	–		–	–		–	
Kelthane (3)	–	–		–	–		–	
Dursban 135 EC, Pratt			I			I		
Dursban (13.5)	–	–		–	–		–	
Tomato/Vegetable Insect Spray, Pratt			I			I		
Methoxychlor (20)		–		–	–		–	
Diazion (10)	–	–		–	–		–	
Fruit/Nut Garden Spray, Science			I			I		
Diazinon (8.3)	–	–		–	–		–	
Kelthane (3.2)	–	–		–	–		–	
Multi-Purpose Garden Dust or Spray, Science								
Methoxychlor (5)	M	0.042		0.072	0.025		0.121	
Malathion (5)	M	<0.01		<0.01	<0.01		<0.01	
Captan (5)	M	<0.005		<0.005	<0.005		0.009	
Gladiolus/Bulb Dust or Spray, Science								
Thiram (50)	M	<1.0		<1.0	<1.0		<1.0	
Methoxychlor (5)	M	<0.005		<0.005	<0.005		<0.005	
Methoxychlor 50 WP, Science								
Methoxychlor (50)	M	<0.05		0.19	<0.005		<0.005	
Zectran, Science								
Zectran (12.8)	W	<0.01		<0.01	<0.01		<0.01	
Rose Spray, Bonide			I			I		
Carbaryl (10)	–	–		–	–		–	
Captan (10)	–	–		–	–		–	
Dinitro Crotonates (0.9)	–	–		–	–		–	
Kelthane (0.5)	–	–		–	–		–	
Malathion (1)	–	–		–	–		–	
Flower/Vegetable 4 in 1, Bonide			I			I		
Malathion (9.4)	–	–		–	–		–	

Methoxychlor (9.4)	–	–		–	–		–	–	
Dinitro Crotonates (1.4)	–	–		–	–		–	–	
Fertilizers									
Ortho-Grow, Ortho									
N (12)	W	<1.0		<1.0	<1.0		<1.0		
P_2O_5 (6) [Control Water = 0.01 ppm P]	W	0.01		0.02	0.05		0.04		
K_2O (6)	–	–		–	–		–		
Fe (0.5)	–	–		–	–		–		
Zn (0.1)	–	–		–	–		–		
EDTA (4)	–	–		–	–		–		
Fish Emulsion, Ortho			AI			AI			
Fish Scrap	–	–		–	–		–		
Rose/Flower, Ortho									
N (8)	W	<1.0		<1.0	<1.0		<1.0		
P_2O_5 (12)	–	–		–	–		–		
K_2O (4) [Control Water = 0.0241 ppm K]	W	0.0132		0.0265	0.0168		0.0277		
EDTA	–	–		–	–		–		
Evergreen/Azalea, Ortho									
N (10)	–	–		–	–		–		
P_2O_5 (8)	–	–		–	–		–		
K_2O (7) [Control Water = 0.0241 ppm K]	W	0.0156		0.0205	0.0144		0.0193		
B (0.02)	–	–		–	–		–		
Fe (0.4)	–	–		–	–		–		
Mn (0.05)	–	–		–	–		–		
Mo (0.0008)	–	–		–	–		–		
Zn (0.1)	–	–		–	–		–		
EDTA (4)	–	–		–	–		–		
Tomato/Vegetable, Ortho									
N (6)	–	–		–	–		–		
P_2O_5 (18)	–	–		–	–		–		
K_2O (6) [Control Water = 0.0241 ppm K]	W	0.0193		0.0289	0.0229		0.0156		
Greenol, Ortho						I			
S (3.64)	W	<1.0		<1.0	–		–		
Cu (0.13) [Control Water = 0.13 ppm Cu]	W	0.11		1.12	–		–		
Fe (6.13)	W	<0.005		<0.005	–		–		
Zn (0.1) [Control Water = 0.03 ppm Zn]	W	0.02		0.02	–		–		
EDTA (5)	–	–		–	–		–		
Up-Start									
N (5)	–	–		–	–		–		
P_2O_5 (15)	W	<0.01		<0.01	0.02		0.01		
K_2O (5)	–	–		–	–		–		
Indole-3-Butyric Acid (0.003)	–	–	AI	–	–	AI	–		
Other									
Fumasol-S, Amchem (Rodenticide)									
Substituted Hydroxycoumarin (0.14)	W	<0.2		<0.2	<0.2		<0.2		
Folicote, Pratt (Moisture Suppressent)			AI			AI			
Waxes	–	–		–	–		–		
Spreader/Sticker, Pratt (Surfactant)									
Soybean Oil	W	<20.0		<20.0	<20.0		<20.0		
Ethylene Dichloride	W	<0.1		<0.1	<0.1		<0.1		
Alkyd Resin	–	–		–	–		–		
Animal Repellent, Pratt									
Thiram (20)	M	<1.0		<1.0	<1.0		<1.0		
Blossom Set, Science (Growth Regulator)			AI			AI			
BNOA (0.1389)	–	–		–	–		–		
Hedge-Trim, Science (Growth Regulator)									
Maleic Hydrazide (30)	M	<2.5		<2.5	<2.5		<2.5		
Wonder-Brel, Science (Growth Regulator)									
Potassium Gibberellate (0.0857)	W	<0.01		<0.01	<0.01		<0.01		

Totals		
Products To Test	85	85
Incompatible Product Storage	26	28
Net Products To Test	59	57
Products Not Tested	3	2
Analysis Not Possible - No Methodology	5	5
Products Cases Showing Extraction	7	6
Product Cases Not Showing Extraction	44	44
Total Number Of Ingredients Found Extracting	9	9
Chemically Different Ingredients Found Extracting	8	9

[a] = "M" for milk and "W" for water used as extraction medium.
[b] = "I" Product was incompatible during storage test.
[c] = "NT" Not tested.
[d] = Average of several chlordane analyses.
[e] = Analysis impossible - no methodology.

milk storage, eight ingredients were found to extract from seven pesticide products. They were ammonium sulfamate (1), 2,4-D (1), Silvex (1), Chlordane (1), Folpet (1), Kelthane (1), Phosmet (1), Methoxychlor (2). 2,4-D and Silvex extracted from a single product, as did Folpet and Kelthane.

For LEXAN resin following 10 days of dilute pesticide storage, commercial dairy washing and 3 or 10 days of milk storage, nine ingredients were found to extract from 6 pesticide products. They were: 2,4-D (1), Silvex (1), Chlordane (1), petroleum oil (1), Folpet (1), Kelthane (1), Phosmet (1), Methoxychlor (1), and Captan (1). 2,4-D and Sivex, Folpet and Kelthane, and Methoxychlor and Captan migrated from single products.

While glass containers previously exposed to pesticides were not tested for extraction by milk storage in this study, Landsberg et al. (*5*) reported that Chlordane was found to extract into milk from a container previously exposed to Ortho-Klor 74. Pesticide ingredients have been shown to extract (3) from glass returnable containers previously exposed to pesticide formulations and commercially washed using a caustic spray. Based on a confidential report (*7*) to the author by a national company, the following pesticide ingredients were reported to extract from glass containers: Chlordane, Lindane, Methoxychlor, 2,4-D, 2,4,5-T, and Silvex. Hence the extraction of pesticide residues from washed containers is not just a returnable plastic phenomenon, and not a returnable glass happenstance. Extraction has been shown to take place for returnables in general, independent of container construction.

Comparison of the contaminant detector, sensory and extraction methods

A final summary of all test response (Table 4) is presented, which includes results reported here and those previously reported by Gasaway (*1*).

The relationship between the in-line contamination detector responses and extraction responses is presented (Tables 5-8). In the one instance where a treated LEXAN resin container effected a positive response by the contaminant detector (Table 7) but no puncture, chemical analysis indicated a no-extraction status. In general there is a much greater likelihood that misuse of an HDPE plastic container will result in extraction for the

TABLE 4. *Numerical summary of test responses.*

Test response description	LEXAN		HDPE		Glass	
	3 Day	10 Day	3 Day	10 Day	3 Day	10 Day
Pesticide product storage						
Products tested	85	85	82	84	83	82
Minus incompatible products	-26	-28	- 0	- 1	- 0	- 0
Compatible products	59	57	82	83	83	82
Residues						
Products tested	59	57	ND[a]	ND	83	82
No visual residues before washing	52	46	ND	ND	81	78
Visual residues before washing	7	11	ND	ND	2	4
Products tested	59	57	ND	ND	83	82
No visual residues after washing	57	55	ND	ND	81	80
Visual residues after washing	2	2	ND	ND	2	2
In-Line contamination detector						
Products tested	59	57	82	83	83	82
Negative response - no puncture	59	54	63	54	NT[b]	NT
Positive response - no puncture	0	1	11	19	NT	NT
Positive response - puncture	0	0	8	10	NT	NT
Organoleptic						
Products to test	85	85	82	84	83	82
Incompatible product storage	26	28	0	1	0	0
Net products to test	59	57	82	83	83	82
Positive response - off-odor	8	12	35	49	2	2
Negative response - no off-odor	51	45	47	34	81	80
Extraction						
Products to test	85	85	82	84	NT	NT
Incompatible product storage	26	28	0	1	NT	NT
Negative organoleptic response - no off-odor	-[c]	-	47	35	NT	NT
Net products to test	59	57	35	48	NT	NT
Punctured during in-line detector test	0	0	8	10	NT	NT
Products not tested	3	2	0	0	NT	NT
Analysis not possible - no methodology	5	5	1	1	NT	NT
Product cases showing extraction	7	6	21	25	NT	NT
Product cases not showing extraction	44	44	5	12	NT	NT
Total number of ingredients found extracting	9	9	29	35	NT	NT
Chemically different ingredients found extracting	8	9	13	14	NT	NT

[a] = Not determined because of opacity of container.
[b] = Not tested
[c] = In contrast to HDPE plastic containers, the organoleptic response, positive or negative had nothing to do with the selection of those products to test in the extraction scheme.

TABLE 5. *Comparison of in-line contamination detector responses with extraction responses after 3 days of dilute pesticide product storage in Lexan resin containers.*

Extraction test responses	Negative response - No puncture	Positive response - No Puncture	Positive response - Puncture
Net products to test	59	0	0
Products not tested	3	–	–
Punctured during in-line detector test	0	–	–
Analysis not possible - no methodology	5	–	–
Net frequency	51 (100%)	–	–
Product cases showing extraction	7 (14%)	–	–
Product cases not showing extraction	44 (86%)	–	–

TABLE 6. *Comparison of in-line contamination detector responses with extraction responses after 3 days of dilute pesticide product storage in HDPE plastic containers.*

Extraction test responses	Negative response - No puncture	Positive response - no puncture	Positive response - puncture
Net Products to test	63	11	8
Products not tested	47	0	0
Punctured during in-line detector test	0	0	8
Analysis not possible - no methodology	1	0	–
Net frequency	15 (100%)	11 (100%)	–
Product cases showing extraction	13 (87%)	8 (73%)	–
Products cases not showing extraction	2 (13%)	3 (27%)	–

TABLE 7. *Comparison of in-line contamination detector responses with extraction response after 10 days of dilute pesticide product storage in Lexan resin containers.*

Extraction test responses	Negative response - no puncture	Positive response - no puncture	Positive response - puncture
Net products to test	56	1	0
Products not tested	2	0	–
Punctured during in-line detector test	0	0	–
Analysis not possible - no methodology	5	0	–
Net frequency	49 (100%)	1 (100%)	–
Product cases showing extraction	6 (12%)	0	–
Product cases not showing extraction	43 (88%)	1 (100%)	–

TABLE 8. *Comparison of in-line contamination detector responses with extraction responses after 10 days of dilute pesticide product storage in HDPE plastic containers.*

Extraction test responses	Negative response - no puncture	Positive response - no puncture	Positive response - puncture
Net products to test	54	19	10
Products not tested	33	2	0
Punctured during in-line detector test	0	0	10
Analysis not possible - no methodology	1	0	–
Net frequency	20 (100%)	17 (100%)	–
Product cases showing extraction	12 (60%)	13 (76%)	–
Product cases not showing extraction	8 (40%)	4 (24%)	–

containers tested. The sensitivity and/or adequacy of the in-line contaminant detector in detecting and culling misused, abused milk containers was not demonstrated in this study.

The relationship between sensory responses and extraction results is presented (Tables 9-12). Extraction results did not confirm positive sensory responses in all cases. There were many more instances of positive sensory responses for a contaminant in HDPE plastic containers than in LEXAN resin containers.

CONCLUSIONS

Sensory evaluation of pesticide-exposed and washed containers has been shown to be more effective in detecting instances of off-odors than was the in-line contamination detector. Extraction studies have confirmed the presence of pesticide residues in stored milk or water in laboratory abused containers; however these studies did not confirm the presence of pesticide ingredients in all instances where there were positive sensory responses for off-odors. Conversely, extraction has been demonstrated in instances where LEXAN resin containers had no off-odors following commercial washing, and from previously obtained information showed a control response for the in-line detector examination. It is reasonable to expect that HDPE plastic containers would have shown some instances of extraction as well had the negative sensory response containers been tested. Glass has been reported to behave in a similar manner. Hence, misuse of containers intended for return and refilling has implications for all material types - LEXAN resin, HDPE plastic, and glass.

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TABLE 9. *Comparison of sensory responses with extraction responses after 3 days of dilute pesticide storage in Lexan resin containers.*

Extraction test responses	Negative sensory responses	Positive sensory responses
Net products to test	51	8
Products not tested	3	0
Punctured during in-line detector test	0	0
Analysis not possible - no methodology	4	1
Net frequency	44 (100%)	7 (100%)
Product cases showing extraction	3 (7%)	4 (57%)
Product cases not showing extraction	41 (93%)	3 (43%

TABLE 10. *Comparison of sensory responses with extraction after 3 days of dilute product storage in HDPE plastic containers.*

Extraction test responses	Negative sensory responses	Positive sensory responses
Net product to test	47	35
Products not tested	47	0
Punctured during in-line detector test	-	8
Analysis not possible - no methodology	-	1
Net frequency	-	26 (100%)
Product cases showing extraction	-	21 (81%)
Product cases not showing extraction	-	5 (19%)

TABLE 11. *Comparison of sensory responses with extraction responses after 10 days of dilute pesticide product storage in Lexan resin containers.*

Extraction test responses	Negative sensory responses	Positive sensory responses
Net products to test	45	12
Products not tested	2	0
Punctured during in-line detector test	0	0
Analysis not possible - no methodology	4	1
Net frequency	39 (100%)	11 (100%)
Product cases showing extraction	1 (3%)	5 (45%)
Product cases not showing extraction	38 (97%	6 (55%)

TABLE 12. *Comparison of sensory responses with extraction responses after 10 days of dilute pesticide product storage in HDPE plastic containers.*

Extraction test responses	Negative sensory responses	Positive sensory responses
Net products to test	35	48
Product not tested	35	0
Punctured during in-line detector test	-	10
Analysis not possible - no methodology	-	1
Net frequency	-	37 (100%]
Product cases showing extraction	-	25 (68%)
Product cases not showing extraction	-	12 (32%)

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Journal of Food Protection Vol. 41 No. 11, Pages 878-880 (November 1978)

Influence of Continuous Versus Intermittent Tumbling on Brine (Salt, Sugar and Nitrite) Diffusion in Porcine Tissue [1]

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(Received for publication October 25, 1977)

ABSTRACT

Increased tumbling time and intermittent tumbling (10 min per hour for 18 h of tumbling) when compared (on a tumbling time basis) to continuous tumbling (3 h), both increase migration of individual cure components (sodium chloride, dextrose, sodium nitrite) as well as average brine (average migration of these components) in tumbled porcine muscle. In most instances the difference between intermittent and continuous tumbling became apparent at 1-1/2 to 2 h of tumbling time and remained significantly higher for the intermittent tumbling technique for the remainder of the 3-h tumbling treatment. Tumbling time for both continuous and intermittent tumbling increased cure migration but these results indicate that continuous tumbling did not have the same influence on cure ingredient migration as equivalent tumbling time delivered intermittently.

Tumbling is generation of impact energy on muscle tissue as meat falls in a rotating drum (*14,15*). Its purpose is to produce a protein exudate that will promote cohesion, enhance tenderness, insure juiciness, develop a uniform product with desirable slicing characteristics and increase yield (*4,5,7-12,16*). Viskase Limited (*16*) noted a more even distribution of cure and Krause (*3*) found more diffusion of salt and nitrite after 18 h (10 min/h) of tumbling. Vartorella (*13*) found an improvement in cohesion but no improvement in yield after 30 min of tumbling. Krause (*3*) reported that 3 h of continuous tumbling did not produce as high a yield as tumbling for 10 min per hour for 18 h. Cassidy (*1*) found greater histological cell disruption with intermittent tumbling (10 min per hour for 18 h) than with continuous tumbling (3 h).

The purpose of this project was to compare continuous versus intermittent tumbling on a constant tumbling time basis. This was accomplished by monitoring the diffusion rate of sodium chloride, sodium nitrite and dextrose in continuous tumbling for 3 h compared with intermittent tumbling of 10 min per hour for 18 h (total of 3 h tumbling time).

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MATERIALS AND METHODS

Eight porcine semimembranosus muscles from eight hams were each divided equally into two pieces by cutting parallel to the bone. Each muscle piece received a 6%, by weight, injection of brine. The injection was made parallel to the muscle fibers and delivered by a stitch needle drilled with additional holes in an attempt to deposit a core of cure in the center of the muscle. The brine was composed of the following ingredients by weight: 76.8% water, 16.5% sodium chloride, 6.6% dextrose and 0.092% sodium nitrite. After injection, one-half of all the semimembranosus muscle pieces were randomly assigned to a 3-h continuous tumbling treatment and the other half to a 10-min per hour — 18 h tumbling treatment (total of 3 h of tumbling time). Tissue was tumbled in an Ohio State University constructed rotating stainless steel drum (56 cm diameter, 85 cm depth, 3 baffles) at 12 revolutions per minute. Both tumbling and resting periods were at 2 ± 2 C. The tissue for each treatment was sampled at 0 h and at each 30-min tumbling interval thereafter (every 3 h of elapsed time for intermittent tumbling) for the duration of the treatment. Sufficient 1-cm slices were taken perpendicular to the cure injection core to have a freshly cut internal surface for each analysis. The experiment was repeated seven times.

Areas of diffusion of brine ingredients were measured by the technique developed by Ockerman and Organisciak (*6*). Salt was determined by Whatman number 42 filter paper treated with silver nitrate and color was developed by exposure to ultraviolet light. The gray-black silver chloride spot was traced on acetate paper and area measured with a compensating polar planimeter. The injection procedure and measurement technique resulted in a standard deviation of 0.24 cm^2 at zero time. Dextrose was determined by a similar technique using filter paper dipped in Fehling's solution and tracing and measuring the yellow color (cuprous oxide) area (standard deviation of 0.72 cm^2 at zero time). Nitrite migration was determined by baking the sample for 15 min in a 121-C oven and measuring the pinkish-red cured pigment (nitrosohemochrome) with a compensating polar planimeter after tracing on acetate paper (standard deviation of 0.68 cm^2 at zero time).

The areas from sodium chloride, dextrose and sodium nitrite were averaged to yield an average brine area (standard deviation of 0.31 cm^2 at zero time).

Analysis of variance (*2*) of the total experiment was used to determine the effects of tumbling sequence, time (linear, quadratic, or cubic) and their interaction. This analysis was also repeated for each one-half hour and adjusted for time effects to evaluate when tumbling schedules became significantly different. The same least squares analysis technique was used to fit curves to the data.

RESULTS AND DISCUSSION

Equations for the best fitting curves for salt (sodium chloride), dextrose, nitrite (sodium nitrite) and average brine of continuous and intermittent tumbled muscle are shown in Table 1. These curves are graphed in Fig. 1 (salt), 2 (dextrose), 3 (nitrite), and 4 (average brine). Data were handled on a tumbling time basis and therefore the intermittent treatment had the advantage of a longer total time for cure migration. Table 2 shows the significance tests for continuous versus intermittent tumbling at each time interval.

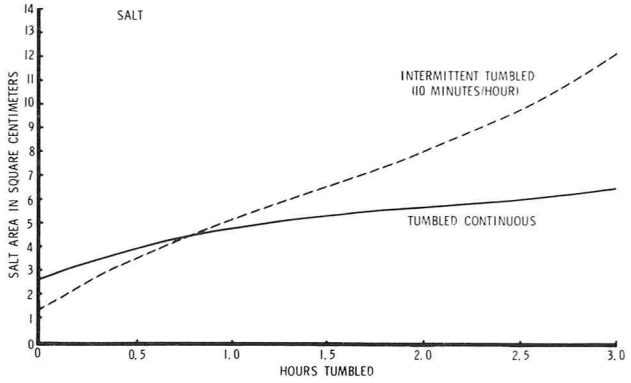

Figure 1. *Area of salt during curing process.*

Salt migration was not different ($P < .05$) between continuous and intermittent tumbled tissue through 1-1/2 h of tumbling time but the intermittent tumbling area became larger ($P < .01$) at the 2-h sampling period and remained significantly larger during the remainder of the experiment. This may help explain why Krause (*3*) found a significant advantage for yield when an 18-h intermittent tumbling schedule was compared to a 3-h continuous schedule. This slower rate of salt migration in continuous tumbled tissue may also explain why Vartorella (*13*) found no significant difference for yield between 30-min tumbled and non-tumbled tissue. Time had a linear effect ($P < .01$) on salt area.

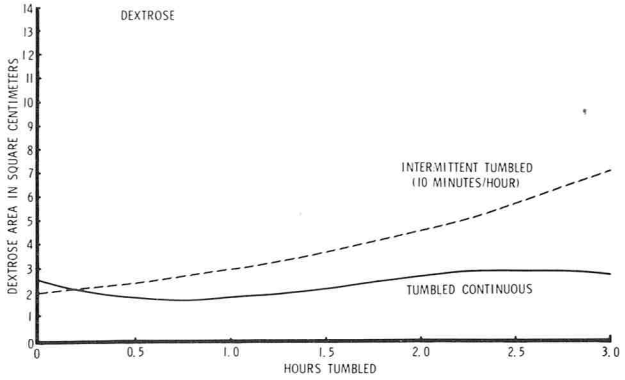

Figure 2. *Area of dextrose during curing process.*

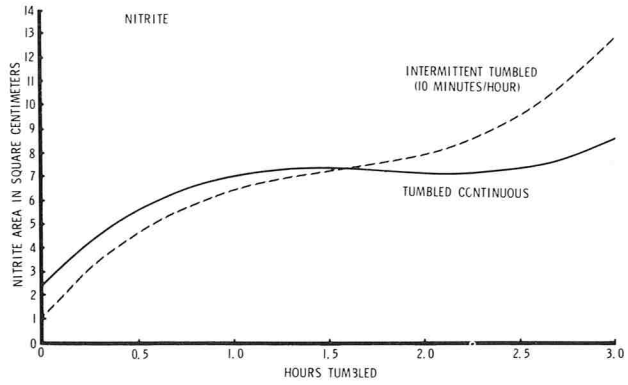

Figure 3. *Area of nitrite during curing process.*

TABLE 1. *Polynomial curves for salt, dextrose, nitrite and brine.*

Ingredient	Treatment	Equation[1]
Salt	Continuous	Square centimeters of area = 2.6773 + 2.9818 (hours) − 1.0625 (hours)² + 0.1594 (hours)³
	Intermittent	= 1.4096 + 4.7265 (hours) − 1.3373 (hours)² + 0.3187 (hours)³
Dextrose	Continuous	Square centimeters of area = 2.5217 − 2.2513 (hours) + 1.9522 (hours)² − 0.3911 (hours)³
	Intermittent	= 2.0426 + 0.5768 (hours) + 0.3697 (hours)² + 0.0010 (hours)³
Nitrite	Continuous	Square centimeters of area = 2.3932 + 8.6459 (hours) − 5.0141 (hours)² + 0.9419 (hours)³
	Intermittent	= 1.1104 + 9.3543 (hours) − 5.2531 (hours)² + 1.1483 (hours)³
Average brine	Continuous	Square centimeters of area = 2.6109 + 3.1238 (hours) − 1.3748 (hours)² + 0.2368 (hours)³
	Intermittent	= 1.8810 + 4.8583 (hours) − 2.0457 (hours)² + 0.4832 (hours)³

[1]All b values are significant ($P < .05$)

TABLE 2. *Significance[1] of intermittent tumbling compared to continuous tumbling at 30-minute sampling intervals*

Ingredient	Tumbling Time — Hours						
	0	0.5	1	1.5	2	2.5	3
Salt	NS	NS	NS	NS	* *	* *	* *
Dextrose	NS	NS	*	* *	* *	* *	* *
Nitrite	NS	NS	NS	NS	*	* *	* *
Average brine	NS	NS	NS	* *	* *	* *	* *

[1]NS - Non-significant ($P > .05$); * Significant at $P < .05$; * * Significant at $P < .01$

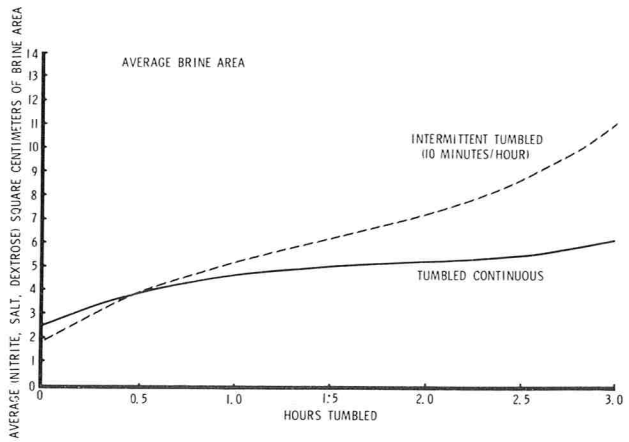

Figure 4. *Area of brine during curing process.*

Dextrose migration for intermittently tumbled tissue was significantly more rapid than for continuously tumbled tissue at 1 h and remained significantly more extensive throughout the remainder of the experiment. Time had a linear ($P < .01$) effect on dextrose diffusion.

Nitrite was not different ($P < .05$) between intermittent and continuous tumbled samples through 1-1/2 h of tumbling time but the area became larger ($P < .05$) for intermittent tumbled samples at the 2-h sampling period and remained larger ($P < .01$) during the remainder of the experiment. Time has a cubic ($P < .01$) effect on nitrite migration.

The average area for brine (average of three curing ingredients) was larger ($P < .01$) at 1-1/2 h for the intermittent tumbled samples. Migration patterns of curing ingredients may help explain Casidy's (*1*) histological differences of greater disorganization of nuclei in both surface and deep samples and less clarity of striation in deep intermittent tumbled and cooked tissue. The average brine area also remained significantly higher for the remainder of the experiment. Time also was significant for average brine and was linear ($P < .01$) in nature. This would suggest that compressing the time tumbled is not equivalent to intermittent tumbling.

ACKNOWLEDGMENTS

The authors thank Mr. Gary L. Bennett for his statistical assistance.

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Journal of Food Protection Vol. 41 No. 11, Pages 881-884 (November 1978)

Lactic Acid, pH and Bacterial Values of Dry Fermented Salami Containing Mechanically Deboned Beef and Structured Soy Protein Fiber [1]

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(Received for publication January 30, 1978)

ABSTRACT

Various combinations of mechanically deboned beef (MDB) and structured soy protein fiber (SSPF) were used at 15 and 30% levels in formulation of dry fermented salami. Lactic acid, pH and bacterial assessments were conducted at 24-h intervals during the pan-curing stage and at 15-day intervals during the 60-day drying period. The substitution of MDB or SSPF in the 11 separate salami treatments had no effect upon pH, lactic acid content or growth of various bacteria. Bacterial evaluation included determination of total aerobic plate counts, *Lactobacillus, Staphylococcus* and psychrotrophic bacteria. Lactic acid content and pH values were within ranges typical for dry fermented salami. Lactic acid content increased as a function of increased *Lactobacillus* numbers resulting in lowered pH values. Total aerobic plate and psychrotrophic numbers paralleled to some degree the *Lactobacillus* counts over the entire study. A low incidence of non-mannitol fermenting-coagulase positive *Staphylococcus* was observed. It would appear that MDB and SSPF can be successfully substituted at elevated levels in dry fermented salami from a microbiological standpoint, while not interfering in lactic acid production needed for flavor and preservation.

Muscle tissue imparts stability, texture, color and flavor in addition to providing high quality protein to sausage products. Both the rising cost and limited supply of muscle protein are problems that force the meat industry to seek substitute materials in the manufacture of sausage products. An example of this is mechanically deboned meat (MDM), which is derived through a process which separates meat and some of the bone marrow from bones (*4*). Potential microbiological problems are inherent to MDM obtained from bones not refrigerated and deboned immediately following removal from the carcass. In addition, MDM has a very fine particle size, thus yielding an increased surface area which is highly susceptible to bacterial growth (*5*). When strict storage times and proper temperatures are employed, the microbiological quality of MDM compares favorably to that of hand boned meat (*4,6*).

Addition of soy to beef patties has been shown to have little effect on microbial counts following 7 days of storage (*7*). However, limited information is available regarding the fermentative and microbial aspects of dry fermented salami containing mechanically deboned beef (MDB) and/or structured soy protein fiber (SSPF). Thus this study was conducted to determine the pH, lactic acid and bacterial characteristics of dry fermented salami made with elevated levels of MDB and SSPF.

MATERIALS AND METHODS

Sausage formulation and processing

Mechanically deboned beef (MDB) and structured soy protein fiber (Ralcon SPF-200) were substituted both separately and in combination for lean beef trimmings (7.8% fat) and certified pork trimmings (42.0% fat) according to the formulation treatments depicted in Table 1. The MDB (18% fat) was derived from U.S. Utility cow neck, plate and rib bones, while the beef trimmings were obtained from U.S. Utility cow chucks, rounds and shanks. The MDB was processed through a 0.45-mm diameter aperture on a Beehive Model AU 4171 mechanical deboning machine. Two batches were processed per treatment. All formulations were manufactured to contain approximately 15% fat in the mixed non-fermented form.

All trimmings were initially ground through a 1.3-cm plate, then mixed in a ribbon blender for 4 min with seasonings, cure, salt, starter culture (Lactacel DS, Merck and Co., Rahway, New Jersey) and MDB and SSPF if they were included in that treatment. The starter culture contained *Lactobacillus plantarum* and was added at a level of 0.6% when diluted on a basis of one part starter culture to three parts cold water. Frozen blocks of MDB and SSPF were broken up in a silent cutter just before the mixing step to facilitate their handling and blending into the formulations. Each batch was held at - 34 C for 10 min before regrinding through a 0.32-cm plate. Batches were placed in 10.3-cm layers and stored in separate tubs for 48 h at 6 C and 85% relative humidity for curing purposes. The salami mixes were stuffed into 2.58-cm natural hog casings, 30 cm in length.

Protocol for fermentation and heating was: (*a*) 32 C for 12 h with dense hickory wood smoke and 90% relative humidity and, (*b*) 5.5-C increases every 2 h with decreasing smoke density and humidity until the internal temperature was 54 C (6.5 additional hours).

The drying period was 60 days at 12 C. The relative humidity was set at 85% for the first 15 days and 65% for the remaining 45 days of drying. Approximately 7-10 air changes per hour occurred in the drying room.

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TABLE 1. *Formulations for dry fermented salami containing SSPF and MDB.*

Level of SSPF (%)[a]	Level of MDB (%)	Beef trimmings (%)	Pork trimmings (%)	Starter culture (%)	Salt (%)	Dextrose (%)	Spices[b] (%)	Sodium nitrate (ppm)	Sodium nitrite (ppm)
0	0	70.5	22.5	0.6	2.5	0.8	3.1	1000	130
15	0	52.5	25.5	0.6	2.5	0.8	3.1	1000	130
30	0	33.5	29.5	0.6	2.5	0.8	3.1	1000	130
0	15	60.6	17.4	0.6	2.5	0.8	3.1	1000	130
0	30	49.5	13.5	0.6	2.5	0.8	3.1	1000	130
15	15	41.7	21.3	0.6	2.5	0.8	3.1	1000	130
15	30	31.0	17.0	0.6	2.5	0.8	3.1	1000	130
30	15	23.4	24.6	0.6	2.5	0.8	3.1	1000	130
30	30	12.8	20.2	0.6	2.5	0.8	3.1	1000	130

[a]The level of SSPF is expressed on a 1:1 rehydrated basis with cold water. Na_2CO_3 was used as a buffer in the following amounts:
1) pH 5.2-3.0 g Na_2CO_3 in 100 ml H_2O/100 g SSPF.
2) pH 5.8-0.3 g Na_2CO_3 in 100 ml H_2O/100 g SSPF.
3) pH 6.2-0.1 g Na_2CO_3 in 100 ml H_2O/100 g SSPF.

[b]Heller's salami seasoning. Ingredients in formulation: corn syrup solids, mustard, spices, dextrose, monosodium glutamate, garlic powder, sodium erythrobate and tricalcium phosphate. B. Heller and Co. Chicago, Ill.

Bacterial counts

Bacterial assessments were made at 0 and 24 h of pan-curing (before fermentation and smoking) and after 0, 15, 30, 45 and 60 days of drying (post smoking). Two salami sticks per treatment batch yielded samples for bacterial determinations. For each sample, 10 g were blended with 90 ml of Butterfield's phosphate buffer as the diluent. Dilutions (10^4, 10^5) were mixed with Plate Count Agar (Difco) for psychrotrophic and total plate counts. Incubation temperatures and times were 5 C for 10 days and 35 C for 48 h for psychrotrophic and total plate counts, respectively.

Non-mannitol fermenting, coagulase positive *Staphylococcus* organisms were isolated using Vogel-Johnson (Tellurite Glycine Red Agar) selective agar (BBL). This medium also allowed early detection of coagulase positive and mannitol fermenting *Staphylococcus aureus* (*13*). Bacteria were enumerated following a 48-h incubation at 35 C. Lactic acid bacteria, the primary organisms present in fermented products, were selectively isolated using LBS agar (BBL). Bacteria were counted after pour plates were incubated 48 h at 35 C. Numbers of bacteria were recorded as logs of bacteria per gram of salami sample.

Titratable acidity and pH determinations

Titratable acidity and pH of the salami was measured at 15-day storage intervals (*1*). The acid in sample extracts was assumed to be lactic acid (*9*). Therefore, percent lactic acid was obtained following pH determinations. The acid present in the slurry was titrated to pH 7.0 using 1 N NaOH. Percent lactic acid was derived and calculated (*2*).

Statistical analyses

Statistical analyses included analysis of variance, while Tukey's ω -test (HSD) was used to statistically separate mean differences (*14*).

RESULTS AND DISCUSSION

Table 2 presents the results for pH, lactic acid content and *Lactobacillus* counts for salami treatments with all storage times combined. While nonsignificant ($P>0.05$) differences in pH occurred between treatments, the values are within the typical range for fermented sausage (*8,11*). However, values 0.6 pH unit lower have been reported (*11*) for pepperoni prepared with 5% soy as compared to an all-beef control pepperoni. Similar trends for lactic acid as for pH were found among the salami treatments. These values are generally higher than others reported (*1,15*) in 30- and 60-day dried summer sausage where lactic acid contents of .5-.75 % were found. Significant differences ($P<0.05$) occurred in *Lactobacillus* counts for treatments containing either 15 or 30% soy versus 30% MDB salami.

TABLE 2. *Effects of treatment on* Lactobacillus, *pH, and lactic acid contents in dry fermented salami.*

Treatment		pH value[f]	Lactic acid (%)[f]	*Lactobacillus* bacteria (log_{10}) per g
% SSPF	% MDB			
0	0	4.6	.92	6.42^{de}
15[a]	0	4.7	.93	6.20^{d}
15[b]	0	4.7	1.00	6.11^{d}
15[c]	0	4.4	.93	6.45^{de}
30	0	4.7	1.00	6.10^{d}
0	15	4.9	.88	6.50^{de}
0	30	4.9	.86	6.93^{e}
15	15	4.8	1.00	6.44^{de}
15	30	4.9	.86	6.73^{de}
30	15	4.4	1.10	6.59^{de}
30	30	4.8	.98	6.68^{de}

[a]pH of SSPF was buffered to be 5.2.
[b]pH of SSPF was buffered to be 5.8.
[c]pH of SSPF was buffered to be 6.2.
[de]Means in the same column bearing the same superscripts are not significantly different ($P>0.05$).
[f]Analysis of variance revealed no significant differences between treatments ($P>0.05$).

Total aerobic bacterial numbers increased between 0 and 15 days of drying, but decreased between the 15- and 60-day drying period (Table 3). These total aerobic plate counts were similar to reported values (*3*) in fermented summer sausage (log 6.0 bacteria per gram). The increase in aerobic bacteria was possibly due to the increase of *Lactobacillus* organisms introduced by addition of starter culture. Minimal differences in aerobic plate counts and *Lactobacillus* numbers for pepperoni during 40 days of drying have been noted (*9*); however, *Lactobacillus* counts were 2 log units higher

TABLE 3. *Effects of storage on bacterial growth and moisture content in dry fermented salami.*

Bacterial types[f]	Curing time, h		Drying time, days				
	0	24	0	15	30	45	60
Total aerobic	—	—	6.18^{b}	7.46^{a}	6.85^{ab}	6.59^{ab}	6.30^{b}
Psychrotrophic	—	—	0.71^{a}	4.49^{b}	6.25^{b}	4.56^{b}	4.43^{b}
Lactobacillus	6.65^{b}	5.57^{d}	6.86^{b}	7.72^{a}	8.50^{a}	6.37^{bc}	5.87^{cd}
Moisture, %			47.2^{a}	45.2^{b}	35.0^{c}	25.2^{d}	23.2^{e}

[abcde]Means in the same line bearing the same superscripts are not significantly different ($P>0.05$).
[f]Values are reported as logs of bacteria per gram of sample.

during the entire drying time than those reported in Table 3. Total bacterial numbers increased during a 10-day aging period of salted meat used in the processing of Lebanon bologna (*13*) while decreases in total bacterial numbers following heat processing and drying of summer sausage have been observed (*15*).

Extremely low numbers of psychrotrophic bacteria were found at the 0-day drying time or completion of fermentation (Table 3). Between 0 and 15 days of drying number of psychrotrophic bacteria increased substantially ($P<0.05$) with no significant differences noted in counts between 15, 30, 45 and 60 days of drying. These results indicate that numbers of psychrotrophic bacteria were reduced during heating, but these bacteria were not totally eliminated. The temperature (12 C) used during drying of the product was certainly conducive to growth of psychrotrophic bacteria as illustrated by the normal logarithmic growth pattern in the salami before drying. Psychrotrophic and aerobic counts probably included *Lactobacillus* bacteria. Although not presented in tabular form, numbers of *Staphylococcus* did not differ substantially between drying periods. The *Staphylococcus* organisms which were present were non-pathogenic, non-mannitol fermenting coagulase positive bacteria.

The lower *Lactobacillus* numbers found at the 24-h curing time versus the end of fermentation (0-day drying) may be attributed to the low temperature of 5 C used in curing and the subsequent fermentation during heating and smoking. In an investigation using a temperature cycle similar to the present study, comparable *Lactobacillus* numbers were produced (*3*). In our study, a substantial increase ($P < 0.05$) in *Lactobacillus* growth was found between 0 versus 15 and 30 days of drying while counts progressively decreased at 45 and 60 days of drying. These results perhaps indicate that following the 30-day drying period, available moisture and carbohydrate became limiting factors for *Lactobacillus* growth. A 9.8% reduction in moisture content occurred between 30 and 45 days of drying. Reduced numbers of lactic acid bacteria have been reported (*15*) following heat processing and during the drying stages of summer sausage.

The mild initial heat processing procedure (fermentation stage) for the salami of the present study was conducive to *Lactobacillus* growth and resultant lactic acid formation past heat processing (Fig. 1). No differences in pH values were noted between 0 and 24 h of curing at 5 C. Limited changes in pH values during 4 days of fermentation at 35 C for Lebanon bologna have been reported (*13*). The pH values (5.2) of the present study obtained at 0 and 24 h of curing were lower than the pH values of 6.2-6.6 found in fermented sausages (*3*) cured under similar time and temperature conditions, but without use of starter culture. However, pH values of 4.7 have been reported in pepperoni (*10*) inoculated with *L. plantarum* and *Pediococcus cerevisiae* and heated to a temperature (55.5 C) similar to that in our study. The pH values declined and lactic acid content increased between the 24-h curing stage and the completion of heat processing due to rapid growth and subsequent acid production by *Lactobacillus*. Following the 0-day drying time, pH values increased and remained constant during 30, 45 and 60 days of drying. An increase in pH values in summer sausage following fermentation has been attributed to an increase in basic NPN compounds accumulated during heat processing and drying (*15*). However, a decrease in pH values as a function of drying has also been reported (*10*). As expected, lactic acid values paralleled those of pH and were similar to the growth curves of *Lactobacillus* (Fig. 1). Lactic acid contents in the present study were higher following fermentation than those (.7-.9) previously reported (*1,15*) following the fermentation stage of summer sausage. These differences may be a result of differences in processing procedures and *Lactobacillus* growth rates; however, both lactic acid and pH values were within the range established (*9*) for pepperoni during fermentation. Surprisingly, the salami incurred a loss in lactic acid content and subsequent increase in pH during 60 days of drying. This phenomenon may be attributed to: (*a*) an unidentified bacterium which utilized the lactic acid as a growth substrate, metabolizing it to a non-acid product, (*b*) salt in the salami formulation becoming more concentrated during drying and thus, acting as a buffer forming other salts (sodium lactate), or (*c*) oxidation and subsequent volatilization of lactic acid (*11*).

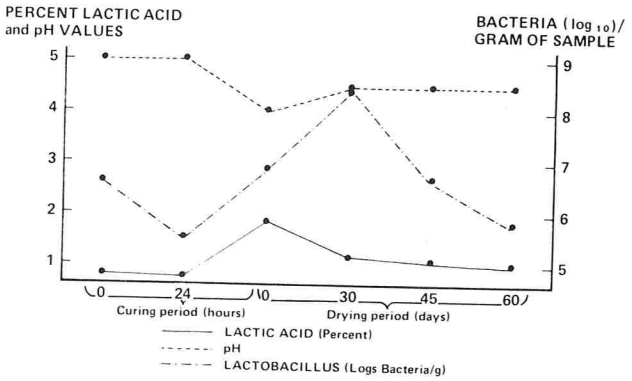

Figure 1. *Lactic acid, pH and* Lactobacillus *values during 60 days storage of dry fermented salami.*

CONCLUSIONS

Addition of MDB or SSPF did not affect aerobic, mesophilic or psychrotrophic bacterial growth or proliferation of *Lactobacillus* in dry fermented salami. The pH values and production of lactic acid by *Lactobacillus* were also not affected by substitution of MDB and SSPF in the salami formulation. Lactic acid production and pH values were similar to those normally occurring in dry fermented salami.

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Journal of Food Protection Vol. 41 No. 11, Pages 885-890 (November 1978)

Patulin Production by Some Fungal Species in Relation to Water Activity and Temperature

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(Received for publication February 17, 1978)

ABSTRACT

The combined effects of water activity (a_w) and temperature on growth and patulin production by strains of *Penicillium expansum, Penicillium patulum*, and *Aspergillus clavatus* were determined. Malt agar media were used, in which the a_w was adjusted by addition of sucrose or glycerine. The minimum a_w values for patulin production by *P. expansum, P. patulum,* and *A. clavatus* were 0.99, 0.95, 0.99, respectively. The temperature ranges for patulin production by *P. expansum, P. patulum,* and *A. clavatus* were 0-24, 4-31, and 12-24 C, respectively. The optimum temperatures for patulin production by *P. expansum* and *A. clavatus* were low compared with those for growth. Optimum temperatures for patulin production at high a_w by *P. patulum* varied with the strain tested and were 8 or 31 C. The temperature range for patulin production in apples by *P. expansum* was determined. The minimum temperatures for rotting and patulin production were 1 C in Cox Orange cv. and 4 C in Golden Delicious cv. The amount of patulin accumulating in rotten tissue of six apple varieties differed greatly. The invasiveness of and patulin production by various strains of four patulin-producing fungal species were tested. All *P. expansum* strains tested caused rot containing patulin. The increase of rot and patulin production by *P. crustosum* and *A. clavatus* depended on the strains tested. None of the *P. patulum* strains was able to invade Golden Delicious apples.

Patulin is a metabolite of various *Penicillium, Aspergillus,* and *Byssochlamys* species. The toxicity of patulin to microorganisms, plants and animals, and its carcinogenicity to mice have been reviewed by Stott and Bullerman (*23*). Patulin has been found frequently in apples decayed by *Penicillium expansum* (*2, 7*). Results of Harwig et al. (*7*) indicate that where apples processed for juice include unsound fruit, patulin may be introduced into the end product. This has been confirmed by the demonstration of patulin in apple juice in Canada (*17*), the United States (*21, 25*) and Sweden (*8*). Patulin has also been detected in fruit other than apples (*1,5,17*). *P. patulum,* synonymous with *P. urticae* and *P. griseofulvum* (*16*), was frequently isolated by Graves and Hesseltine (*6*) from flour and refrigerated dough products and it could have been the dominant mold of spontaneously molded bread containing patulin (*13*). Bullerman and Olivigni (*3*) isolated molds from commercial Cheddar cheese. Some of these molds produced patulin in laboratory media; one of the isolates was identified as *P. patulum* (*22*). Another patulin producing fungal species is *Aspergillus clavatus.* This species was involved in intoxication of calves fed moldy barley (*11*). *P. crustosum,* which occurs only rarely on food products, is another patulin producer. *P. verrucosum var. cyclopium* is proposed as its correct name (*16*).

The most important factors determining growth and, therefore, production of patulin are temperature and moisture. The effect of temperature on growth and production of patulin has been determined by various investigators (*5,15,20*). The temperature range for production of patulin by *P. expansum* has been determined for tomatoes and bread (*5, 15*), but not for apples. The moisture requirement for germination of spores of *P. expansum* and *P. patulum* isolated from stored corn was determined by Mislivec and Tuite (*10*); however, the effect of moisture on growth and production of patulin received little attention.

The range of temperature over which microorganisms can grow is influenced by the water activity (a_w) (*19*). Therefore, in this investigation the effects of temperature on fungal growth and patulin production were studied at different levels of a_w. In addition, the temperature limits of patulin production in apples were determined.

MATERIALS AND METHODS

Organisms and spore suspensions

Fungal strains were maintained as lyophilized cultures. *P. expansum* strains RIV 50 and RIV 287, and *P. crustosum* strain RIV 58 had been isolated from a meat product, a naturally rotten apple, and a bakery product, respectively. *A. clavatus* strains RIV 612 and RIV 672 had been isolated from compost. Other strains of *P. expansum, P. patulum, P. crustosum,* and *A. clavatus* had been received from Dr. R. A. Samson, Centraal Bureau voor Schimmelcultures, Baarn, The Netherlands. Cultures grown for 1 week at 24 C on malt extract agar (Oxoid) were washed with an aqueous solution of 0.6% sodiumheptadecyl-sulfate (Tergitol-7,BDH) to prepare spore suspensions.

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Cultures on agar media

In a preliminary study patulin production by each of the strains was checked on two malt extract agar plates (Oxoid) of 1.00 a_w incubated at 24 C. Each plate was inoculated at three different spots with an inoculation needle dipped in a spore suspension of ca. 10^6 spores per ml. As soon as the colonies reached an average diameter of 3 cm, agar plates were stored at -18 C until extraction for patulin. A high patulin producing strain of each fungal species, i.e. *P. expansum* RIV 11, *P. patulum* RIV 56, and *A. clavatus* CBS 114.48, was used to determine the environmental conditions for patulin production. Various a_w conditions in malt extract agar were achieved by adding sucrose (MES-series) or glycerine (MEG-series). In a previous paper (*12*) preparation of agar plates, inoculation and a_w measurement have been described. The a_w measurement device consisted of a sample jar submerged in a temperature-controlled waterbath which facilitated equilibration of a vapor pressure around the sample, and connected with a closed circuit with a dewpoint meter. The accuracy of the device was 0.005 a_w unit. For each determination of rate of growth and patulin production, two inoculated agar plates with three colonies each and one non-inoculated agar plate, which served as control of the a_w after incubation, were used. They were enclosed in a 0.3-liter polyethylene bag (gauge 0.04 mm). Cultures were grown at combinations of 0, 4, 8, 12, 16, 24, 31, and 37 ± 0.3 C and six different a_w values on MES and MEG. The growth rate of mycelium was determined by daily measurement of two right-angled diameters of a colony. The regression lines of colony diameter on days after inoculation were calculated for each a_w-temperature combination. The germination time was obtained by extrapolating the regression line to the X-axis (*12*). Until extracted for patulin, cultures were stored at -18 C on the day the six colonies reached an average diameter of 3 cm or on the 35th day of incubation when they did not reach this size.

To assess whether or not the strains tested were representative of the mold species, the limiting a_w and temperature for growth and patulin production were determined for three other strains of *P. expansum* and *P. patulum*, which were grown on MES at the same time as the test strains.

Four replicate MES cultures of *P. expansum* RIV 11, grown at 0.99 a_w and 16 C, were analyzed for patulin to determine the repeatability of the method.

Cultures in apples

The pathogenicity to apple of the various strains was determined by stabbing Golden Delicious apples to a depth of ca. 1 mm with a needle covered with spores. Twenty apples were used for each strain. The apples were incubated at 20 ± 0.3 C in open polyethylene bags. Apples inoculated with strains of *P. expansum* were incubated for 11 days and apples inoculated with strains of the other fungal species for 15 days. On the last day of incubation, diameters of rotten areas were measured, and the rotten tissue was removed from the fruit and stored at -18 C until extracted for patulin. The effect of temperature on increase of rot and production of patulin was determined by inoculating Golden Delicious and Cox Orange apples with *P. expansum* RIV 11. Twelve apples were incubated at each of the following temperatures: 1, 4, 8, 12 16, 20, and 24 ± 0.3 C. Each day diameters of rot were measured. Incubation of the individual apples was continued until the diameter of rot reached 1.5 cm. To determine the influence of apple variety on increase of rot and patulin production, apples of the following varieties were inoculated with *P. expansum* RIV 287: Golden Delicious, Cox Orange, Ingrid Marie, Goudreinette, Notaris, and Jonathan. Twelve apples of each variety were incubated at 8 C. Incubation of individual apples was continued until the diameter of rot reached 4 cm. Apples were taken from the wholesale market shortly after harvest. Experiments were done with apples of equal maturity and size.

Extraction and analysis of patulin from the agar media

After thawing, the cultures were inactivated by adding 20 ml of chloroform. After evaporation of chloroform, the two agar plates with the cultures were blended in 75 ml of H_2O by means of a homogenizer (Ultra Turrax). After centrifugation, 5 ml of the supernatant fluid was extracted two times with 50 ml of chloroform. The chloroform extract was evaporated to dryness and the residue was dissolved in 1 ml of chloroform. After preliminary visual determination of patulin concentration by thin layer chromatography, the sample solution was diluted, depending on its concentration. Sample extract and patulin standard were spotted on a silica gel thin layer plate (Merck 60) with a thickness of 0.25 mm, and developed in toluene-ethyl acetate-formic acid (6:3:1 vol/vol/vol). The amounts of patulin from sample and standard were determined densitometrically by reflection measurement at 276 nm. After measurement, the identity of patulin was confirmed by spraying the plate with MBTH solution (0.5% 3-methyl-2-benzothiazolinone hydrazone hydrochloride in distilled water), patulin spots turned yellow (*14*). The limit of detection was ca. 0.1 mg of patulin per two agar plates.

Extraction and analysis of patulin from rotten tissue of apples

Rotten tissue was blended in ethyl acetate with an Ultra Turrax homogenizer. The ratio of ethyl acetate (in ml) to rotten tissue (in g) was 1:1. After homogenization, the ethyl acetate fraction was dried over anhydrous Na_2SO_4, evaporated to dryness and the residue taken up in 1 ml of chloroform. After preliminary visual determination of patulin concentration by thin layer chromatography the sample solution was diluted depending on its concentration. The extract was then analyzed by thin layer chromatography and densitometric measurement as described above for the quantitative analysis of agar plates. The limit of detection was 1-2 μg of patulin per gram of rotten tissue.

RESULTS

Cultures on malt extract agar

Results of the preliminary study showed that the strains of *P. expansum* and *P. patulum* produced patulin on malt extract agar plates. This was also true for *A. clavatus* strains RIV 672 and CBS 114.48. However, neither the strains of *P. crustosum* nor *A. clavatus* RIV 612 produced patulin on this agar medium.

Figure 1 shows an example of the data used for calculation of mold growth. The regression coefficients for all regression lines of colony diameter were at least 0.98. The average growth rate of colonies and patulin production on MES and MEG at each combination of temperature and initial a_w are shown in Fig. 2-8. The optimum temperatures for patulin production by *P. expansum* and *A. clavatus*, both 16 C, were lower than those for growth, 24 and 31 C, respectively. Optimum temperatures for patulin production at high a_w by *P. patulum* varied with the strain tested: strain RIV 56 has an optimum temperature at 8 C, whereas the optimum temperature of strain CBS 315.63 was 31 C. Temperature ranges for patulin production by *P. expansum*, *P.*

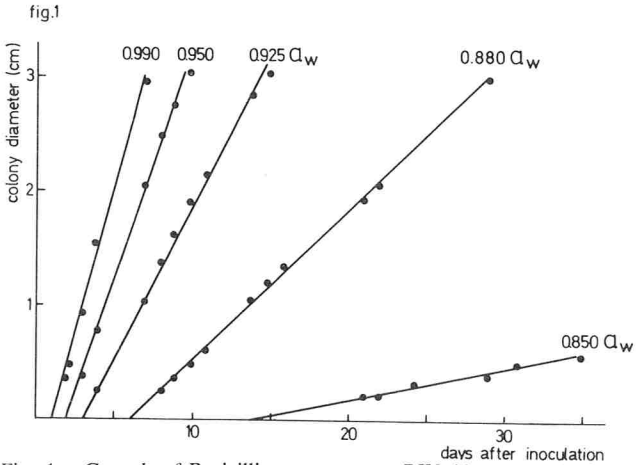
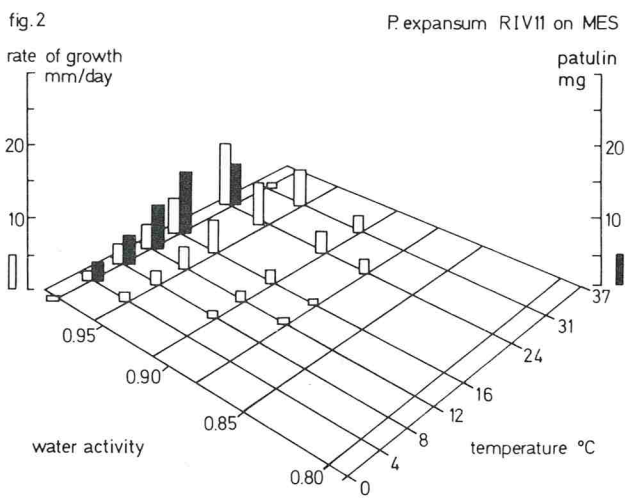
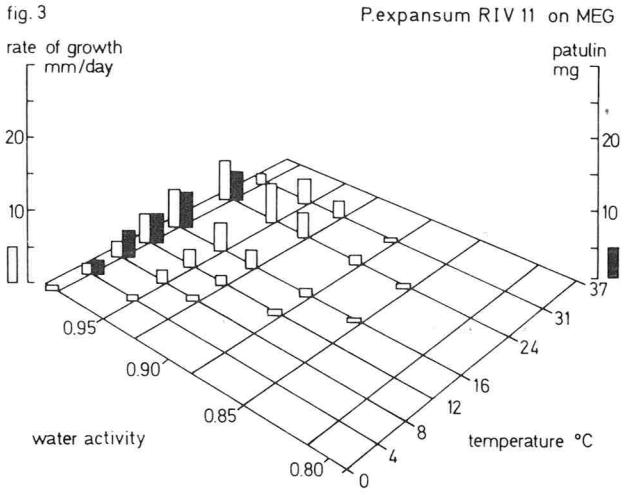
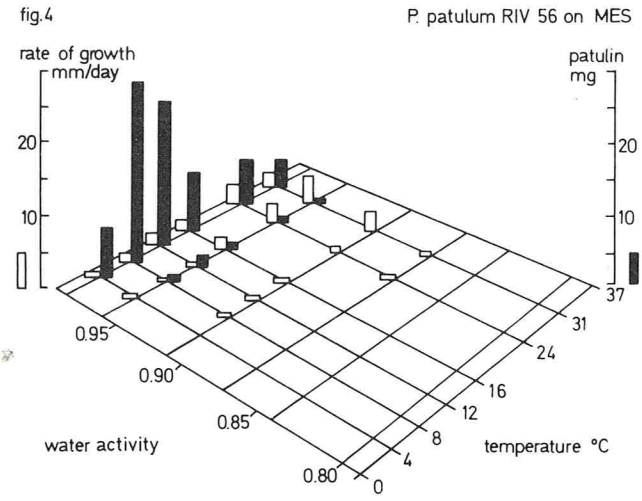
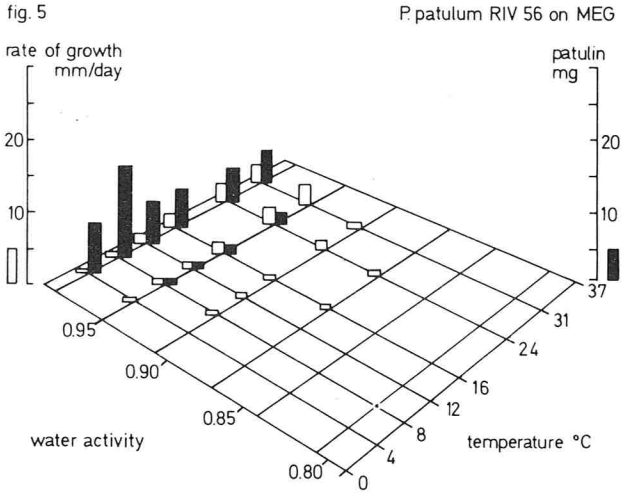


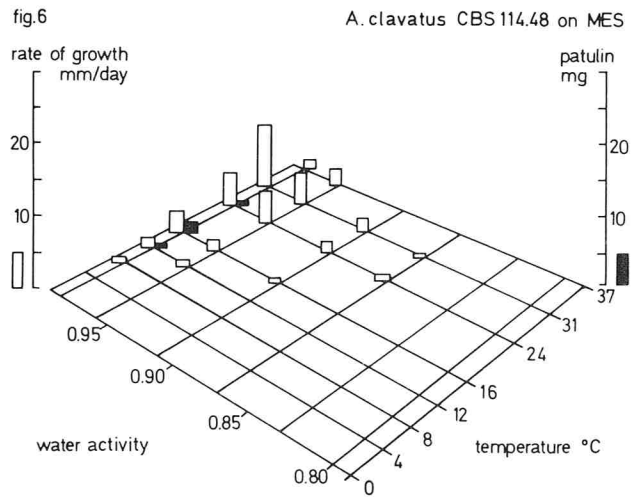
Fig. 1. *Growth of* Penicillium expansum *RIV 11 on malt extract glycerine agar at various a_w levels and 16 C.*











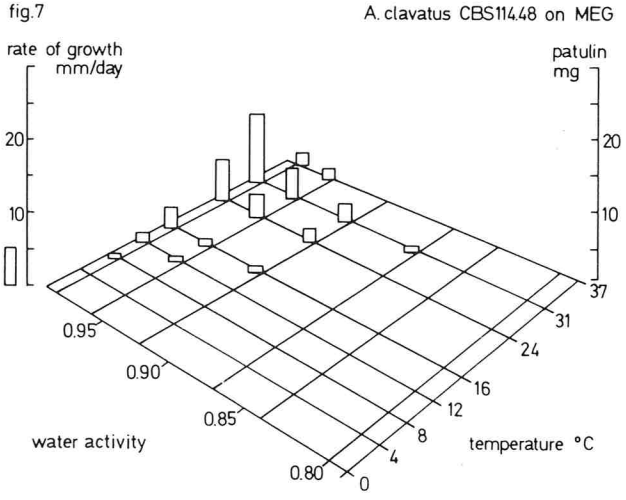


Fig. 2-7. *Growth of and patulin production by three fungal species on malt extract sucrose agar [MES] and malt extract glycerine agar (MEG) under various conditions of a_w and temperature (rate of growth - white column; patulin production - black column, the 1 mm black columns represent amounts of 0.1-1.5 mg patulin).*

patulum and *A. clavatus* were 0-24, 4-31, and 12-24 C, respectively.

Water activity had a profound effect on patulin production. *P. expansum* and *A. clavatus* showed patulin production at 0.99 a_w only, whereas *P. patulum* produced relatively little patulin at 0.95 a_w and large amounts at 0.99 a_w. No patulin could be determined in cultures of *P. crustosum* RIV 58 on MES and MEG. The optimum conditions for growth of this strain were 0.96 a_w and 24 C, whereas limiting conditions for growth were 0 and 31 C and 0.83 a_w. Germination times of strains of the four species were 5-10 h under favourable conditions

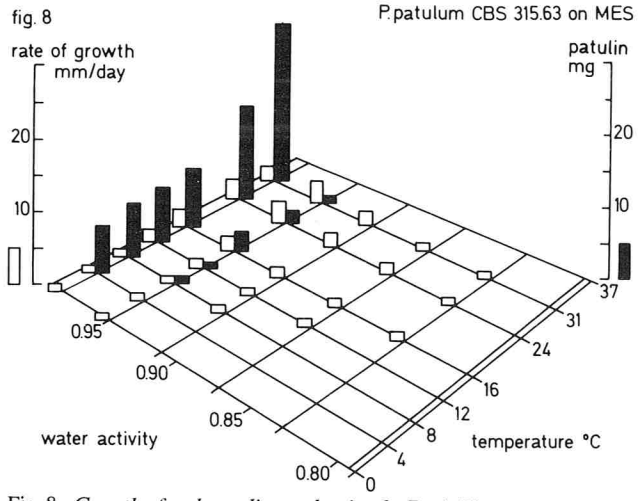


Fig. 8. *Growth of and patulin production by* Penicillium patulum *CBS 315.63 on malt extract sucrose agar [MES] under various conditions of a_w and temperature [rate of growth - white column; patulin production - black column, the 1 mm black columns represent amounts of 0.1 - 1.5 mg patulin].*

and they increased to 12-20 days under unfavourable conditions.

In Table 1 it is demonstrated that other strains of *P. expansum* and *P. patulum* had limiting conditions for growth and patulin production similar to strains of which the results are given in Fig. 2-5 and 8. A minor difference was found: at 0 C, *P. expansum* RIV 9 showed patulin production; its growth was faster than that of the other *P. expansum* strains and it therefore reached a greater colony diameter within 35 days.

The patulin contents of the four replicate cultures of *P. expansum* RIV 11 differed by not more than 8% from the average, when grown on MES at 0.99 a_w and 16 C.

Patulin production in apples

Pathogenicity of various strains of the four fungal species and patulin production are shown in Table 2. Fast rotting and patulin production were observed in Golden Delicious inoculated with *P. expansum* strains, *P.* crustosum RIV 58, and *A clavatus* RIV 612. Neither the *P. patulum* strains nor two strain of *A. clavatus* were able to produce rot. In Golden Delicious (0.984 a_w) the optimum temperature for patulin production of *P.*

Table 1. *Growth of patulin-producing penicillia and patulin production on malt extract sucrose agar at unfavorable conditions of a_w and temperature.*

Species and strain no	0.99 a_w			0.98 a_w	0.91 a_w
	0 C	31 C	37 C	16 C	12 C
P. expansum					
RIV 9	G +[1]	NG[3]	—[4]	G-	—
RIV 11	G-[2]	G-	—	G-	—
RIV 51	G-	NG	—	G-	—
RIV 52	G-	G-	—	G-	—
P. patulum					
RIV 14	G-	—	NG	—	G-
RIV 56	NG	—	NG	—	G-
CBS 315.63	G-	—	NG	—	G-
CBS 384.48	G-	—	NG	—	G-

[1]Growth and patulin detected.
[2]Growth and no patulin detected.
[3]No growth.
[4]Not tested.

TABLE 2. *Pathogenicity of four fungal species to and patulin production in Golden Delicious apples stored at 20 C.*

Species and strain no.	Incubation period (days)	Average diameter of rot spots (cm)	Patulin concentration in rotten tissue (μg/g)[1]
P. expansum			
RIV 9	11	5	1
RIV 11	11	5	18
RIV 12	11	5	4
RIV 50	11	4	15
RIV 287	11	3	ca. 16
P. patulum			
RIV 14	15	0	NT[2]
RIV 56	15	0	NT
CBS 315.63	15	0	NT
CBS 384.48	15	0	NT
CBS 746.70	15	0	NT
P. crustosum			
RIV 14	15	4	4
NRRL 1983	15	1	5
IMI 52736	15	2	3
IMI 91920	15	1	<1
IMI 143338	15	2	<1
A. clavatus			
RIV 612	15	4	4
RIV 672	15	0	NT
CBS 114.48	15	0	NT

[1]Lower detection limit ca. 1 μg/g rotten tissue.
[2]Not tested.

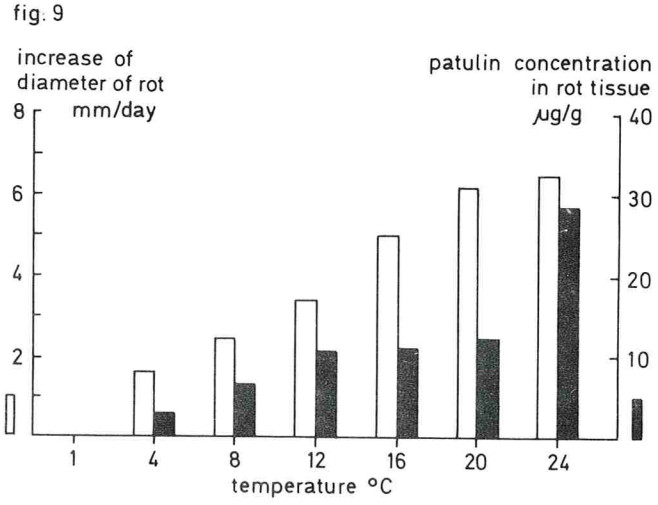


Fig. 9. *Increase of rot and patulin production by* Penicillium expansum *RIV 11 in Golden Delicious of 0.984 a_w in relation to incubation temperature (increase of rot - white column, patulin concentrations - black column).*

expansum RIV 11 was at least 24 C (Fig. 9), which is higher than that on MES or MEG. However, in Cox Orange apples incubated at different temperatures, the patulin concentrations produced in rotten tissue were about the same. Rot and patulin were detected in apples stored at 1 C.

Apples of various varieties inoculated with *P. expansum* and incubated at 8 C contained different concentrations of patulin in their rotten tissue. Compared with the patulin concentration in Golden Delicious, levels in Notaris and Ingrid Marie were at least two times higher, and those in Goudreinette and Jonathan at least five times higher. The patulin concentration in Cox Orange equaled that in Golden Delicious.

DISCUSSION

The results demonstrate that a_w is a very important factor for production of patulin as growth was observed over a relatively wide a_w range but patulin production only over a narrow range. The lowest a_w permitting production of patulin was 0.95, which was the a_w limit for production by *P. patulum*. On the other hand, the temperature range for production of patulin was wide and almost equalled that for growth. The narrow a_w range for production of patulin may explain the small amounts detected by Reiss (*15*) in wheat bread inoculated with *P. expansum*; our measurements of the a_w of wheat bread showed values of ca. 0.96. Therefore substantial amounts of patulin may only be encountered in foodstuffs of high a_w, such as fresh fruit. Decreasing the a_w of fruit by adding sugar to manufacture jams and marmalade is an effective means of preventing production of patulin on these products, as confirmed by Frank et al. (*5*). The small amounts of patulin detected in inoculated Cheddar cheese should not be explained only by the effect of the substrate (*24*), which is low in total carbohydrate, or by instability of patulin in this product (*22*) but also by the sub-optimal a_w for patulin production; Cheddar cheese has an a_w of 0.95 according to our measurements.

The limiting a_w values for growth of *P. patulum* and *P. expansum* lay at 0.83-0.85, a little higher than those determined by Mislivec and Tuite (*10*) for germination of spores. Further, our results with the *Penicillium* strains (Fig. 2-5, Table 1) suggest that, at a high a_w, patulin may be produced at the whole temperature range permitting growth. It is possible that even at the upper and lower temperature limits for growth, patulin had been formed, however in non-detectable quantities, due to the long germination time, leaving only a short period for growth.

Our results obtained with *P. expansum* RIV 11 confirm those of Sommer et al. (*20*). However, they contrast with those of Reiss (*15*), who found a rather low optimum temperature of 10 C for growth on wheat bread. This might be due to the use of different strains or substrates, although we found no difference in results obtained with apple and malt extract media. On the other hand we noticed a profound influence of strain as well as substrate on the optimum temperature for patulin production.

It has been known that *P. expansum* is a common storage rot organism and it is the most important *Penicillium* species causing rot of apple (*2, 7*). Also in this investigation *P expansum* caused rotting of apples, whereas the strains of the other fungal species tested caused slow rot or did not invade apples at all. However, other investigators observed low invasiveness of *P. patulum*, some strains of which produced patulin in the rotten tissue (*4, 9*). The relatively great invasiveness of *P. expansum* may explain the high frequency of this fungal species in apple rot. Our results indicate that in the manufacturing of apple juice, varieties such as Goudreinette and Jonathan should be sorted carefully as they favour greater production of patulin in rotten tissue than other varieties.

ACKNOWLEDGMENTS

The authors are grateful to Dr. J. Harwig for correcting the manuscript.

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Journal of Food Protection Vol. 41 No. 11, Pages 891-896 (November 1978)

Bisulfite Degrades Aflatoxin: Effect of Citric Acid and Methanol and Possible Mechanism of Degradation

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(Received for publication February 23, 1978)

ABSTRACT

Citric acid retarded degradation of aflatoxins B_1 and G_1 by bisulfite. Replacement of potassium acid phthalate-NaOH with citric acid-NaOH in the mixture of buffer (50 ml, 0.035 M)-methanol (0.65 ml)-0.8 g of K_2SO_3, pH 5.5, at 25 C resulted in a decrease from $9.76 \times 10^{-3}h^-$ to $2.47 \times 10^{-3}h^-$ and from $1.19 \times 10^{-2}h^-$ to $4.32 \times 10^{-3}h^-$ in rate of degradation of aflatoxin B_1 and G_1, respectively. Methanol also retarded degradation of aflatoxin by bisulfite. Increasing the methanol concentration from 1.3 to 10.0% (v/v) in 50 ml of 0.035 M KHP-NaOH buffer, pH 5.5, plus 0.40 g of K_2SO_3, resulted in a decrease in rate constants from $4.26 \times 10^{-3}h^-$ to $2.16 \times 10^{-3}h^-$ for aflatoxin B_1 and from $5.54 \times 10^{-3}h^-$ to $2.98 \times 10^{-3}h^-$ for aflatoxin G_1. Presence of citric acid and various concentrations of methanol also reduced rates at which free bisulfite concentrations changed. From these observations, known effects of methanol and probable effects of citric acid on bisulfite oxidation, we suggest that degradation of aflatoxin by bisulfite is dependent on bisulfite oxidation. ^{14}C-labelled aflatoxin B_1 was treated with K_2SO_3 at pH 5.5 and allowed to react for 96 h. Most of the degradation product(s) were in the water soluble phase, indicating that a structural modification of aflatoxin occurred.

Aflatoxin B_1 and G_1 can be degraded by bisulfite (*4*). This could be of practical importance since bisulfite may be added to various foods for several purposes (*7, 10*). Two types of foods commonly treated with bisulfite and which are potential sources of aflatoxin are fruits and wines. Many fruits contain citric acid and all wines contain alcohol; therefore it would be useful to see how these substances affect the bisulfite-aflatoxin reaction. Information has accumulated on the reactivity of bisulfite (*10*); hence, once effects of citric acid and methanol on the bisulfite-aflatoxin reaction have been determined, these data can be related to established reactions and a possible mechanism for this reaction can be suggested. An understanding of how different conditions affect the bisulfite-aflatoxin reaction and of the mechanism by which this reaction occurs may facilitate possible application of this treatment to a food system. This study was done to identify previously unreported (*4*) conditions that affect the bisulfite-aflatoxin reaction and also to explain mechanistically how aflatoxins are degraded by bisulfite.

MATERIALS AND METHODS

Preparation and sampling of reaction mixtures

Methods used to prepare and sample reaction mixtures were described previously (*4*) with the following exceptions. In experiments involving solutions buffered with citric acid, 35 ml of sterile 0.05 M citric acid (Mallinckrodt, St. Louis, MO, Analytical Reagent grade)-NaOH, pH 5.5, were used in place of the potassium acid phthalate-NaOH buffer. In experiments to determine effects of methanol, the alcohol was used at concentrations of 1.0 to 10% (v/v).

Quantitation of aflatoxin

Methods used to quantitate aflatoxin were described previously (*4*).

Determination of concentrations of free bisulfite

The amount of free bisulfite present in aqueous solution was determined using the A. O. A. C. procedure for analysis of free sulfur dioxide (*5*) followed by calculation using the Henderson-Hasselbach equation (*13*).

Preparation of ^{14}C-labelled aflatoxin B_1

^{14}C-labelled aflatoxin B_1 was prepared by the method of Schoenhard et al. (*9*) with several changes. Instead of using *Aspergillus parasiticus* ATCC 15517 and incubating mycelia at 30 C, *A. parasiticus* NRRL 2999 was used and incubation was at 28 C. In addition, 5 ml of 0.1 M phosphate buffer, pH 7.0, was added to each flask containing the resting culture so it could be incubated for 2 days instead of 1 day. The [^{14}C]aflatoxin B_1 was also given an additional purification step. The ^{14}C-labelled aflatoxin was spotted on silica gel (Adsorbosil-1, Applied Science Lab, Inc., State College, PA) on a thin layer plate, developed in chloroform:methanol:H_2O [98:1:1 (v/v/v)], and silica gel containing [^{14}C]aflatoxin B_1 was isolated, scraped into a vial, and aflatoxin was eluted with methanol.

Preparation of reaction mixtures used to incubate ^{14}C-labelled aflatoxin B_1

Fifty ml of a 0.035 M KHP-NaOH, pH 5.5, reaction mixture which contained 1.0 g of K_2SO_3 were prepared as described earlier (*4*) with one exception. One-half milliliter of a methanol solution containing ^{14}C-labelled aflatoxin B_1 (specific activity 0.791 m Ci/mmol) was added to the reaction mixture in lieu of unlabelled aflatoxin B_1. In addition, two control reaction mixtures were prepared which were identical to the radioactive reaction mixture except that 0.5 ml of methanol was added to each instead of ^{14}C-labelled aflatoxin B_1. These were used to monitor the change in pH caused by oxidation of bisulfite. Hence, these controls served to determine how much sodium hydroxide was needed to return the pH of the labelled reaction mixture to 5.5. The pH was maintained between 5.15 and 5.5. To monitor any degradation of [^{14}C]aflatoxin B_1 which might be caused by factors other than bisulfite, a reaction mixture was prepared which contained everything that the test reaction mixture contained except potassium sulfite. All four reaction mixtures were incubated quiescently in the dark at 28 C for 96 h.

Isolation of radioactive degradation products

After 96 h of incubation the radioactive samples were each extracted using three volumes of chloroform (100, 50, and 50 ml). The chloroform extract from each was concentrated and the entire volume of each extract was spotted on a silica gel (Adsorbosil-1, Applied Science Lab, Inc., State College, PA) thin layer chromatographic (TLC) plate. Standards of aflatoxin B_1, B_2, G_1, G_2, M_1, and B_{2a} were spotted next to the bisulfite-treated and the untreated sample. Following development of the TLC plate in chloroform:methanol:water [98:1:1 (v/v/v)], spots resulting from bisulfite-treated aflatoxin B_1 were compared with spots of known aflatoxin standards. Each spot resulting from extracts of treated samples which were co-chromatographed with a known standard was scraped off the plate and put into a scintillation vial. The remaining length of the thin layer plate which contained the bisulfite-treated aflatoxin B_1 extract was scraped at 1.5-cm intervals and material was added to separate scintillation vials. This procedure was followed for the chloroform extract from the uninoculated control reaction mixture which contained [^{14}C]aflatoxin B_1 but no potassium sulfite. Ten milliliters of Aquasol (New England Nuclear, Boston, MA) were added to each vial, the vial was shaken and contents were allowed to equilibrate overnight.

Water fractions which remained after chloroform extraction of treated and untreated reaction mixtures were concentrated by freeze drying. Each residue was resuspended in 1.5 ml of deionized, distilled water and treated with 8.5 ml of Aquasol. Radioactivity of all fractions was counted by a Packard Tri-carb Scintillation Spectrophotometer Model 3320 (Packard Instrument Co., Inc., Downers Grove, IL).

RESULTS

Effect of citric acid buffer on rates of aflatoxin degradation

It was previously shown that increasing concentrations of bisulfite degraded both aflatoxin B_1 and G_1 at increased rates when in the presence of 0.035 M potassium acid phthalate-NaOH buffer, pH 5.5, plus 1.3% (v/v) methanol (*4*). To observe the effect of citric acid, an experiment was designed with the same conditions as previously reported except that 0.035 M citric acid-NaOH, pH 5.5, buffer was substituted for the 0.035 M KHP-NaOH, pH 5.5, buffer.

Data in Fig. 1 and 2 illustrate the rates at which aflatoxin B_1 and G_1 were degraded by different concentrations of potassium sulfite in the presence of citric acid. In both instances straight line relationships were evident when results were plotted on a semi-logarithmic scale. Increasing the bisulfite concentration resulted in increased rates for degradation of aflatoxin B_1 and G_1. Reaction rate constants calculated from slopes of these plots are in Table 1. It is evident that bisulfite degraded aflatoxin G_1 more rapidly than B_1.

Effect of methanol plus potassium acid phthalate buffer on degradation of aflatoxin

Methanol serves as a carrier of aflatoxin and is very soluble in water. Hence it was used to add aflatoxin to reaction mixtures. Since substitution of citric acid for potassium acid phthalate markedly affected the rate at which aflatoxins B_1 and G_1 were degraded, it was necessary to obtain similar information for methanol.

A single concentration of bisulfite (0.40 g K_2SO_3/50 ml of 0.035 M KHP-NaOH, pH 5.5), a constant temperature (25 C) and five different concentrations of methanol (1.3 to 10.0% (v/v)] were tested. As the methanol concentration was increased, the rate at which bisulfite degraded aflatoxin B_1 (Fig. 3) or G_1 (Fig. 4) was decreased. Table 2 gives the rate constants obtained for degradation of aflatoxins B_1 and G_1 when different concentrations of methanol were tested. Increasing the

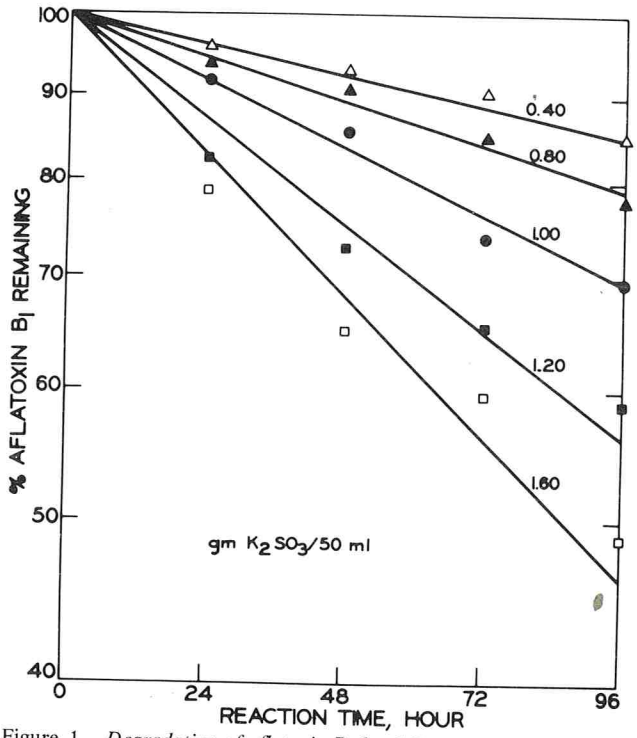

Figure 1. *Degradation of aflatoxin B_1 by different concentrations of potassium sulfite held at pH 5.5 and 25 C. Each reaction mixture contained 0.035 M citric acid-NaOH buffer plus 1.3% (v/v) methanol.*

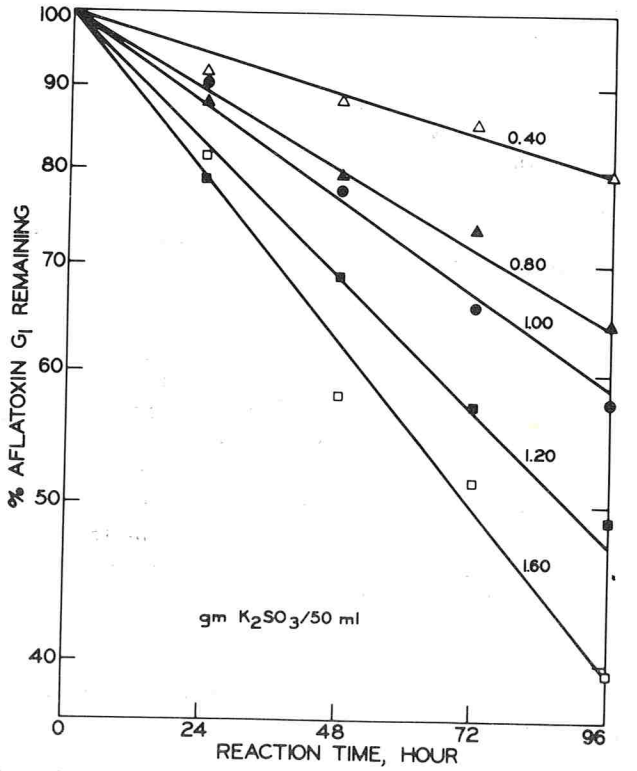

Figure 2. *Degradation of aflatoxin B_1 by different concentrations of potassium sulfite held at pH 5.5 and 25 C. Each reaction mixture contained 0.035 M citric acid-NaOH buffer plus 1.3% (v/v) methanol.*

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TABLE 1. *Reaction rate constants for degradation of aflatoxins B_1 and G_1 by different concentrations of potassium sulfite in the presence of 0.035 M citric acid-NaOH, pH 5.5, plus 1.3% (v/v) methanol and incubated at 25 C.*

g K_2SO_3 per 50 ml reaction mixture	Reaction rate constant, $k^{h^{-1}} \times 10^{-3}$	
	Aflatoxin B_1	Aflatoxin G_1
1.60	7.27	9.78
1.20	5.38	7.37
1.00	4.01	5.83
0.80	2.47	4.32
0.40	1.54	2.18

TABLE 2. *Reaction rate constants for the degradation of aflatoxins B_1 and G_1 by 0.40 g K_2SO_3/50 ml of 0.035 M KHP-NaOH, pH 5.5, at 25 C in the presence of different concentrations of methanol.*

Methanol concentration %, (v/v)	Reaction rate constant, $k^{h^{-1}} \times 10^{-3}$	
	Aflatoxin B_1	Aflatoxin G_1
1.3	4.26	5.54
2.0	3.89	5.13
4.0	3.54	4.42
8.0	2.77	3.70
10.0	2.16	2.98

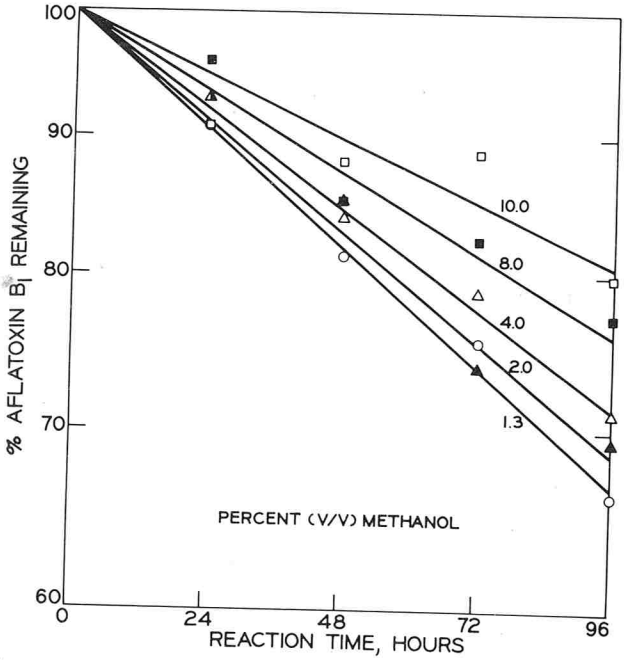

Figure 3. *Aflatoxin B_1 degradation by 0.40 g K_2SO_3/50 ml of 0.035 M KHP-NaOH, pH 5.5, at 25 C when five different methanol concentrations were present.*

methanol concentration from 1.3 to 10.0% (v/v), served to reduce by about one-half the rate at which equivalent amounts of bisulfite degraded aflatoxins B_1 and G_1.

Effect of methanol plus citric acid buffer on degradation of aflatoxin by bisulfite

Using bisulfite (0.40 g of K_2SO_3/50 ml of 0.035 M citric acid-NaOH, pH 5.5), four different concentrations of methanol [1.0 to 4.0% (v/v)] were tested to see if methanol further retarded the rate at which bisulfite degraded aflatoxins in the presence of citric acid. Increasing the methanol concentration from 1.0 to 4.0% (v/v) again decreased the rate of aflatoxin degradation by approximately one-half (Table 3).

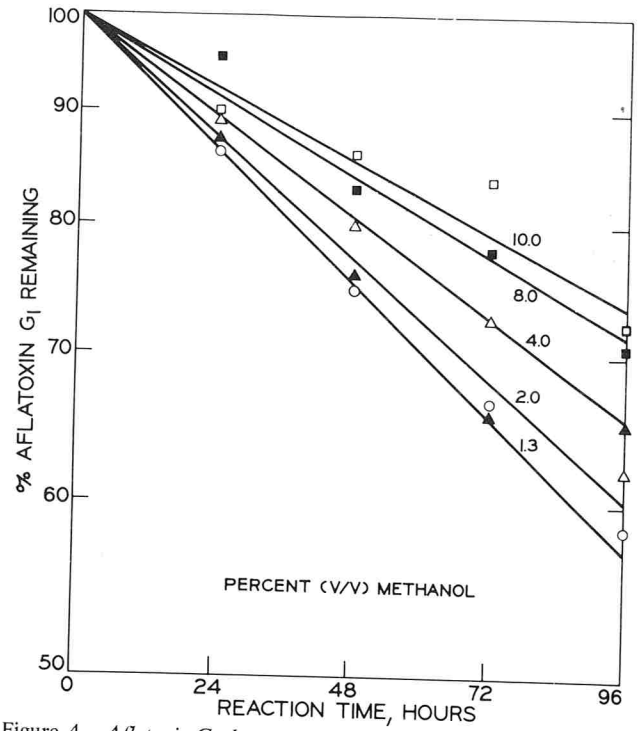

Figure 4. *Aflatoxin G_1 degradation by 0.40 g K_2SO_3/50 ml of 0.035 M KHP-NaOH, pH 5.5, at 25 C when five different methanol concentrations were present.*

TABLE 3. *Reaction rate constants for the degradation of aflatoxins B_1 and G_1 by 0.40 g K_2SO_3/50 ml of 0.035 M citric acid-NaOH, pH 5.5, at 25 C in the presence of different concentrations of methanol.*

Methanol concentration %, (v/v)	Reaction rate constant, $k^{h^{-1}} \times 10^{-3}$	
	Aflatoxin B_1	Aflatoxin G_1
1.0	2.08	2.39
1.3	1.70	2.23
2.0	1.68	1.93
4.0	1.00	1.42

Effects of methanol and buffer composition on "free" bisulfite concentration

Different concentrations of methanol were added to several series of reaction mixtures containing 0.035 M potassium acid phthalate-NaOH, pH 5.5, or 0.035 M citric acid-NaOH, pH 5.5. Each 50 ml of reaction mixture was fortified with 0.025 g of K_2SO_3 (0.0030 M HSO_3^-) and held quiescently in the dark at 25 C. Duplicate samples were tested by iodometric titration (5) at 24-h intervals for the amount of remaining free bisulfite.

The greater the methanol concentration, the slower was the decrease in free bisulfite concentration (Fig. 5). There appeared to be a direct correlation between the amount of methanol present and the rate at which the concentration of free bisulfite decreased.

Similar observations were made when citric acid instead of potassium acid phthalate was used in the buffer. Data in Fig. 6 illustrate the rates at which free bisulfite decreased when different concentrations of methanol were present in reaction mixtures buffered with citric acid-NaOH. Increasing the methanol concentration resulted in greater retention of free bisulfite.

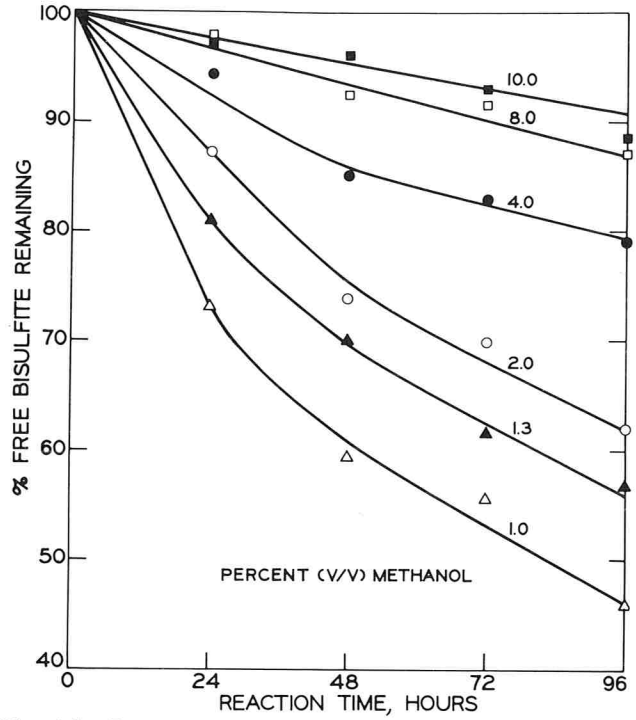

Figure 5. *Percent of free bisulfite remaining versus time when a constant potassium sulfite concentration [0.025 g K_2SO_3] was quiescently incubated in the dark at 25 C with different amounts of methanol in 50 ml of 0.035 M KHP-NaOH buffered at pH 5.5.*

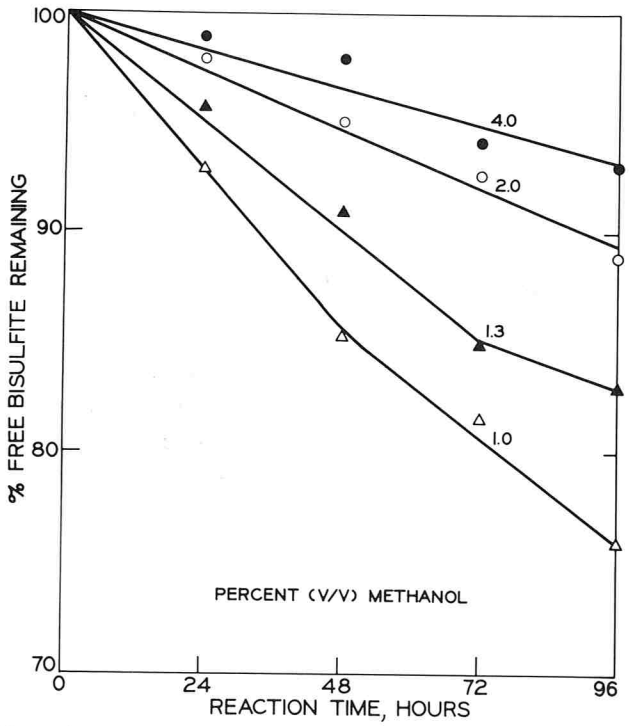

Figure 6. *Percent of free bisulfite remaining versus time when a constant potassium sulfite concentration (0.025 g K_2SO_3) was quiescently incubated in the dark at 25 C with different amounts of methanol in 50 ml of 0.035 M citric acid-NaOH buffered at pH 5.5.*

Degradation products formed from aflatoxin B_1 by bisulfite

[^{14}C]Aflatoxin B_1 was treated with 1.0 g of K_2So_3 in 0.035 M KHP-NaOH, pH 5.5, buffer and incubated quiescently in the dark for 96 h at 28 C. This sample and an untreated control sample of [^{14}C]aflatoxin B_1 were fractionated as previously described and each fraction was tested for radioactivity. The untreated control contained 45,703 dpm in the [^{14}C]aflatoxin B_1 fraction. The bisulfite-treated sample contained primarily four "radioactive" spots. Three of these spots co-chromatographed with aflatoxin B_1, B_2, and slightly below G_1 on a TLC plate; however, radioactivity present in these fractions was relatively small compared to that found in the fourth fraction. The fourth fraction was in the water soluble phase and contained over 90% of the radioactivity (Table 4). This indicates that most of the aflatoxin B_1 was significantly modified or degraded allowing for most of the radioactivity to end up in the water phase.

TABLE 4. *Degradation products formed from aflatoxin B_1 by bisulfite.*

Fraction	Amount of ^{14}C present in each fraction	
	DPM	Percent
B_1	3,750	8.2
Co-chromatographed with B_2	2,865	6.3
R_f=0.46 (Below AF G_1)	2,065	4.5
H_2O-Soluble extract	41,600	91.0

Furthermore, an end product was formed in small amounts and it co-chromatographed with and fluoresced blue like aflatoxin B_2. Present in an even smaller but detectable amount was a spot with a R_f value of 0.46; it co-chromatographed on a TLC plate slightly below aflatoxin G_1. No attempt was made to further identify the end product(s); however, the major end product(s) was (were) water soluble or at least more polar than compounds soluble in chloroform. This suggests that the major degradation product(s) is (are) more than simply hydroxylated forms of aflatoxin B_1 such as occurs when aflatoxins B_{2a}, M_1, P_1, Q_1, and aflatoxicol are formed from aflatoxin B_1 (*2*). These forms are soluble in chloroform.

DISCUSSION

Effect of citric acid

When comparing rates at which aflatoxin B_1 and G_1 were degraded by bisulfite in the presence or absence of citric acid, it is evident that citric acid effectively reduced the ability of bisulfite to degrade aflatoxin. In fact, when conditions were comparable, aflatoxin B_1 and G_1 were degraded approximately 2.5 to 3 times slower when 0.035 M citric acid-NaOH buffer rather than 0.035 M potassium acid phthalate-NaOH buffer was used. This is a potentially important observation because foods, such as fruits, which may be treated with bisulfite may contain an appreciable amount of citric acid which could retard the bisulfite-aflatoxin reaction.

Effect of methanol

Methanol also decreased the rate of the bisulfite-aflatoxin reaction. When either citric acid-NaOH or potassium acid phthalate-NaOH served as buffers, increasing the amount of methanol in the reaction

mixtures decreased rates of aflatoxin degradation. This observation may be of practical importance since ethanol, which is chemically analogous to methanol, is likely to have this same effect on degradation of aflatoxin by bisulfite. Supporting evidence for this statement will appear later in this paper. Since more than 10% ethanol may be present in some wines and wines sometimes contain aflatoxin (*12, 14*), it is important to know the effect of bisulfite on aflatoxin when an alcohol is present. Tests with ethanol should be done to verify our observations with methanol.

Free bisulfite concentration

Beside the relationship between increasing methanol concentration and rates at which free bisulfite concentrations decrease, there appears to be a relationship between rates at which free bisulfite concentrations decrease and rates at which aflatoxins are degraded under similar conditions. For example, when either citric acid-NaOH or potassium acid phthalate-NaOH were used as buffers, increasing the methanol concentration resulted in a decrease in rates at which aflatoxins were degraded as well as a decrease in the rates at which free bisulfite concentrations changed. When comparing rates at which free bisulfite concentrations decreased and rates at which aflatoxins B_1 and G_1 were degraded in the presence of citric acid to rates at which these rates changed in the presence of potassium acid phthalate at equivalent methanol concentrations, it is apparent that a similar relationship existed. These observations suggest that the mechanism which caused a decrease in the concentration of free, unreacted bisulfite is similar to or related to the mechanism by which bisulfite degraded aflatoxin.

Bisulfite oxidation

What might methanol and citric acid have in common so they could affect the ability of bisulfite to degrade aflatoxin? Also, how might the relationship between rates at which free bisulfite concentrations change and rates at which aflatoxins are degraded be explained? These questions may be answered more easily if one understands what happens to aqueous bisulfite when it is exposed to air. When an aqueous solution of bisulfite and/or sulfite is exposed to molecular oxygen, bisulfite, and/or sulfite undergoes oxidation by a free radical process (*10, 11*).

The first indication that bisulfite was being oxidized to the sulfate form was the observed decrease in pH of the reaction mixtures upon extended incubation. Increasing the initial bisulfite concentration resulted in increasing the rate at which the pH of the reaction mixture was lowered. As described by Schroeter (*10*), this would be expected to occur when bisulfite solutions are oxidized. The change in pH of the reaction mixtures results from the different strengths of the two acids, i.e., HSO_3^- which is the starting material and HSO_4^- which is the oxidized product. The difference in the strengths of these two acids can best be illustrated by comparing the dissociation constants of each as is illustrated (*15*) above:

$$\frac{K_{HSO_3^-}}{K_{HSO_4^-}} = \frac{1.02 \times 10^{-7}}{1.20 \times 10^{-2}} = 8.5 \times 10^{-6}$$

For this reason, the pH of reaction mixtures was closely monitored and in no instance was it allowed to drop below 5.15.

Methanol or ethanol can reduce the rate at which sulfite and/or bisulfite is/are oxidized (*1, 10*). This can explain why increasing the methanol concentration in bisulfite-treated reaction mixtures resulted in decreasing the rates at which free bisulfite disappeared or reacted. This being true, the decrease in free bisulfite concentration in reaction mixtures is at least partially, if not totally, the result of bisulfite oxidation. This is further supported by the fact that increasing the methanol concentration of the bisulfite-treated reaction mixtures decreased the rate at which the pH was lowered (unpublished data).

Potassium tartrate and sodium succinate also can retard sulfite oxidation when present in small amounts (*10*). Structures of these compounds are analogous to the structure of citric acid except that citric acid has one extra carbon atom and one extra carboxyl group. Hence, one might predict that like sodium succinate and potassium tartrate, citric acid can also retard bisulfite and sulfite oxidation. Furthermore, using 0.035 M citric acid-NaOH buffer instead of 0.035 M acid phthalate substantially decreased the rate at which the pH of the bisulfite-treated reaction mixture decreased (unpublished data).

When comparing rates at which free bisulfite concentrations decreased when equivalent amounts of methanol were present in 0.035 M citric acid-NaOH versus 0.035 M potassium acid phthalate-NaOH buffer solutions, it is evident that free bisulfite disappeared more rapidly when potassium acid phthalate rather than citric acid was used in the buffer. This suggests that citric acid may be acting to retard bisulfite oxidation while potassium acid phthalate may not retard or at least did not as effectively retard bisulfite oxidation.

These data support the hypothesis that bisulfite was oxidized to the sulfate form and this oxidation process was retarded by the presence of methanol and further reduced by the presence of citric acid.

Bisulfite oxidation and aflatoxin degradation

Since methanol and citric acid reduced both the rate of oxidation of bisulfite and of degradatin of aflatoxin by bisulfite, it is possible that degradation of aflatoxin is dependent on bisulfite oxidation. Bisulfite oxidation occurs by a free radical process (*10, 11*); hence aflatoxin would be degraded by the free radicals formed.

Aflatoxin is a conjugated, unsaturated lactone whose internal structure contains a coumarin moiety. Dey and Row (*3*) have previously demonstrated that coumarin readily reacts with bisulfite in aqueous solution resulting in cleavage of the lactone ring and addition of a sulfonic acid at the 4 position. Since the internal structure of

aflatoxins B_1 and G_1 contain this same coumarin moiety plus a methoxy group, it is conceivable that this same reaction occurs with aflatoxin. With the reaction initiated by formation of free radicals resulting from bisulfite oxidation, aflatoxins B_1 and G_1 may be degraded to a similar sulfonic acid addition product. However, this proposed reaction may be subject to steric hindrances. Should this be true, an alternative mechanism might be operative. An oxygen-induced, anti-Markownikoff addition of sodium bisulfite to alkenes has previously been documented (*8*). Since aflatoxin B_1 and G_1 have a vinylene group at the 15, 16 position of the dihydrofuran moiety, it is possible that the bisulfite radical reacts at this site to form a sulfonic acid addition product. Aflatoxins B_1 and G_1 can be converted to the hydroxylated forms, B_{2a} and G_{2a}, across this same double bond, i.e. at the 15, 16 position (*6*).

Additonal support for the alternative mechanism proposed for the bisulfite-aflatoxin reaction lies in the fact that relatively small, yet detectable amounts of aflatoxin B_2 were present among the degradation products of aflatoxin B_1. This suggests that the site of attack by the bisulfite radical is at positions 15, 16 of the C = C bond. Some of the sulfonic acid groups may be displaced from the aflatoxin to which they were previously added resulting in formation of aflatoxin B_2 which is saturated in the 15, 16 positions.

Whatever is true, the major end product or products which have been proposed as being formed by bisulfite-aflatoxin interaction would be expected to be relatively water soluble since a sulfonic acid group is added to the aflatoxin moiety. Approximately 91% of the ^{14}C-labelled degradation products from aflatoxin B_1 remained in the aqueous phase after chloroform extraction which supports the idea that a sulfonic acid group is added to the aflatoxin moiety.

ACKNOWLEDGMENTS

Research supported by the College of Agricultural and Life Sciences and the Graduate School, University of Wisconsin-Madison.

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Journal of Food Protection Vol. 41 No. 11, Pages 897-898 (November 1978)

A Research Note

Comparison of Bacterial Swab Samples Given Different Storage Treatments[1]

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ABSTRACT

Six paired sides of U.S. Good beef were swabbed to obtain microbial samples. Half of the beef sides were stored at an elevated temperature (25 C) for 8 h with subsequent storage for 12 h at 1 C before sampling, whereas the counterpart sides were stored the entire period at 1 C. Samples from adjacent areas were taken so that a comparison could be made of 0.03 M phosphate buffer and 0.1% peptone broth as diluents for swab samples. To evaluate the effect of storage time, swab samples were stored at 5 C for 1, 24, 48, 72, and 120 h before being transferred to Standard Plate Count Agar and subsequently incubated at 25 C. Results revealed that no differences (P>.05) existed between the effectiveness of a phosphate buffer solution and peptone broth as diluents for swab samples. Storage of swab samples at 1 C resulted in recovery of fewer microorganisms at 24, 48, and 72 h.

Bacterial contamination of food products is of concern to all segments of the food industry. The consumer wants to be assured of a wholesome product, therefore measurement of microbial load is considered essential to quantitate the amount of contamination. Level of contamination has been reported as being responsible for various degrees of color and flavor degradation of fresh meat and other foods with a resultant decrease in stability and economic value (*1, 3, 5, 8, 10*).

The plate count method is one of the most frequently used approaches to estimate microbial load. Establishment of an accurate estimate of the number of colonies on agar plates depends on successful recovery of each microorganism of the initial sample. Research has previously indicated (*2*) that certain microorganisms are inactivated more rapidly when samples are stored at 7 C as opposed to higher temperatures. Other results (*11*) have demonstrated that when microbial samples were collected from meat shipments under field conditions and stored at this temperature for up to 100 h, multiplication or death rate was not significantly affected when compared to 1 h of storage.

[1]*This research was supported by a grant from East Texas State University through Contract 1501-9511 and by the Sam Rayburn Research and Educational Center, Bonham, Texas.*
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Since information relative to the relationship of environment to stability of microbial samples is applicable to the swab technique for recovery of microorganisms, this study was conducted to evaluate the effect of storage time, temperature and diluent on the number of microorganisms sampled from fresh beef.

MATERIALS AND METHODS

Six paired sides of U.S. Good beef were swabbed (exposed muscle surface of the neck and round) with a 12.9-cm² template to obtain microbial samples. Half of the beef sides were chilled at 1 C for 4 h, stored at an elevated temperature (25 C) for 8 h with subsequent storage for 12 h at 1 C before sampling, whereas the counterpart sides were stored at 1 C from slaughter until sampling at 24 h postmortem. A swab sample from the neck and round (six replicates per location) was collected by use of the swab technique and placed in 10 ml of sterile 0.1% peptone broth. Subsequent swabs from the same anatomical locations were also taken for storage in 10 ml of 0.03 M phosphate buffer. Therefore, the number of samples were six sides × two locations per cut × two cuts × five storage periods = 120.

To evaluate the effect of storage time, swab samples were stored at 5 C for 1, 24 and 72 h and 120 h at 1 C before being further diluted to appropriate concentrations, plated on Plate Count Agar by the pour plate method, incubated at 25 C for 72 h and subsequently counted. Duplicate samples from adjacent areas were taken so that the effectiveness of sterile 0.1% peptone broth and 0.03 M phosphate buffer as diluents for storage of the swab samples could be compared.

Data were analyzed by factorial analysis of variance (*12*). Mean separation analysis by orthogonal decomposition was done on the levels of those factors that produced significant main effects. Statistical procedures available on the BMDP statistical package as implemented on an IBM 360/50 were used for all statistical evaluations (*4*).

RESULTS AND DISCUSSION

The diluent used (phosphate buffer and peptone broth) did not affect number of recovered microorganisms after storage from 1-120 h. This observation is in agreement with previous research (*9*), although other workers (*6*) have reported higher bacteria counts from phosphate buffered distilled water than from 0.1% peptone water. Swab samples from beef sides that were stored at 1 C for the entire 24 h had microbial counts that were numerically lower than those samples from beef which were chilled at 1 C for 12 h. However, the differences were insignificant (P>.05).

This study suggests that phosphate buffered distilled water and peptone broth have equal value as a diluent and storage medium for swab samples. Therefore, either diluent should yield the same results. Results suggest that the elevated storage temperature (25 C) for 8 h did not increase ($P>.05$) microbial proliferation. This observation can be attributed to insufficient time at an elevated temperature to permit significant multiplication of microorganisms. As previously reported (*7*), any increased microbial load obtained during storage at the higher temperature could be counteracted by greater death rate due to "cold shock" or "stress" when the product was transferred from ambient conditions to a 1 C storage environment.

Data (not shown) revealed that swab samples stored for 1 h had more ($P<.05$) viable microorganisms than did those samples which were stored for 24, 48, and 72 h. The lower number of microorganisms for the longer storage periods was attributed to stress from the storage temperature of swab samples and limited nutrients provided by a phosphate buffer and peptone broth. Microbial counts at 120 h suggested that enough multiplication occurred to give higher ($P<.05$) counts at 120 h than at 24, 48, or 72 h. The trend observed from extended storage indicates that a more accurate estimate of microbial load by use of the swab technique may be obtained if the swab samples are not stored more than 1 h.

CONCLUSIONS

Results from this study suggest that: (*a*) no difference ($P>.05$) existed in 0.03 M phosphate buffer and 0.1% peptone broth as a diluent for microbial swab samples; (*b*) holding beef sides at an elevated temperature (25 C) for 8 h after chilling for 4 h at 1 C did not affect ($P>.05$) microbial load at 24 h; and (*c*) a more accurate estimate of microbial load by use of the swab technique was accomplished when swab samples were not stored beyond 1 h, whereas additional storage (from 24-72 h) was associated with decreased ($P<.05$) recovery of microorganisms from swab samples.

ACKNOWLEDGMENTS

The authors extend acknowledgment to Deborah Carter and Mark Kurland for laboratory contribution to this work.

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Journal of Food Protection Vol. 41 No. 11, Pages 899-901 (November 1978)

Accuracy of Menus in Foodservice Establishments

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ABSTRACT

Safety, nutritional quality and honest representation are primary expectations of consumers with respect to their food supply. While food safety and nutrition have received much attention by public health agencies, the honest representation of food has not been among the priorities of food sanitation programs of local governments. This report summarizes findings of a survey of food representation in public eating establishments in the District of Columbia. It also outlines a three-phase program of education, consultation and enforcement to insure that the integrity of the food supply is as much a part of our food protection program as are safety and nutritional quality.

One of the major objectives of food protection programs conducted by all levels of government is to meet consumer expectations. These expectations are that the food be safe, that it be nutritious and that it be honestly represented. While food safety and nutrition have received much attention by municipal public health agencies, the honest representation of food has not been among the priorities of food sanitation programs of local governments. However, proper labeling and accurate representation of food on menus of public eating establishments are areas of broad public concern, especially since consumers are expressing interest in knowing exactly what they are being served, as well as knowing its nutritional quality. For example, consumers want to be assured that fresh orange juice is juice that has been squeezed from an orange, not a mixture of coloring, flavoring and water; or that the "meat" of hamburger is ground beef, not ground beef combined with soybean; or that cream is the product derived from whole fresh milk, containing not less than 18% milk fat, not a "half and half" mixture of milk and a milk substance with approximately 12% milkfat (*1*).

This increased consumer interest in the nutritional quality of food products has been precipitated by the White House Conference on Food, Nutrition and Health, held in Washington, D.C. in 1969; by the 10-State Nutrition Survey conducted by the U.S. Department of Health, Education and Welfare; by public statements of nutritionists, consumer advocates and others concerned about the nation's food supply; and by the need to expand food protection efforts beyond food sanitation. As a result of these interests, the District of Columbia Environmental Health Administration (EHA) expanded its food protection services to include a simple truth-in-menu survey. This report summarizes the results of that study.

METHODS

The study began September 6, 1977 and was concluded on October 20, 1977. It included a survey of the menus of 141 foodservice establishments in Washington, D.C. These establishments were chosen at random from a list of licensed foodservice facilities which provide waiter/waitress services and offer customers an individual menu from which to make their selections. Since most foodservice establishments operate during at least two meal periods, more than 350 individual menus were evaluated. The major concern of this investigation was the verification of the following information: (*a*) product freshness (previously frozen foods, timeliness or recency of production and use of preservatives); (*b*) United States Department of Agriculture (USDA) grades of meats, i.e., Prime and Choice; (*c*) aging of meats; (*d*) dietary intake of livestock, i.e., grain and milk-fed; (*e*) specific meat products (proper identification, substitution); (*f*) product identification, by species, type or with a specific standard identity, such as Black Angus, Kosher, Cream, etc.; (*g*) geographic origin of product, such as imported or with specific location; and (*h*) size and weight control, i.e., jumbo shrimp and 10-ounce filet mignon steak.

To insure consistency in interpretation and validation of the menu information, one environmental health specialist, with substantial training and experience in food technology and quality control, conducted the entire investigative field study.

RESULTS

The survey findings reveal that many food products are misrepresented on menus of public eating establishments. For example, approximately 19% of the foodservice establishments visited by the investigator implied that a bakery product was freshly made or prepared on the premises when, in fact, it came from a commercial bakery. Most of these establishments also implied that a standard brand name or commercially-

baked cheesecake was their own. Moreover, most of the facilities surveyed often used the words "fresh" or "freshly" in conjunction with a process or operation to describe a commercially-prepared product. Examples ranged from "Fresh Roasted Coffee" to "Freshly Ground Sirloin Steak." Fruit salads/cups and cocktails, also advertised as fresh, contained some commercially-packed fruit sections containing a preservative as an ingredient.

With frozen foods, the most significant findings involved seafood. All shrimp listed on the menus as fresh had been previously frozen. Various other seafood products described on the menus as fresh or "just caught" were also frozen. In a few instances, some of the vegetables and fruit juices, listed as fresh were also frozen (Table 1).

TABLE 1. *Comparison between menu description and actual food product found in restaurants surveyed in the District of Columbia.*

Description of product on menu[a]	Description of product served	Number of restaurants where disparity was identified
Fresh grapefruit juice	Frozen	1
Fresh orange juice	Frozen	4
Fresh hamburger	Frozen	1
Fresh beef liver	Frozen	1
Fresh calf liver	Frozen	3
Fresh sea catch	Frozen	2
Fresh lobster meat	Frozen	3
Fresh shrimp	Frozen	22
Fresh spinach	Frozen	1
Fresh fruit salad cups	Some components were not fresh	7

[a]Selected examples of the manner in which food products were represented on menus.

Foodservice establishments, which indicated a specific breed of animal or dietary intake, could not provide tangible evidence to substantiate these claims. Examples include Black Angus Beef that was not Black Angus and Maryland Milk-Fed Chicken. Neither could most foodservice establishments, whose menus stated particular geographic origins of food products, verify the origins of the products or the origin was different from that which was stated on the menu. Such disparities include the menu description of domestic Swiss cheese as "imported" or Maine lobster, whose origin could not be validated, as seen in Table 2.

TABLE 2. *Comparison between menu description of "origin" and actual "origin" of food products found in restaurants surveyed in the District of Columbia.*

Menu description of origin[a]	Origin of product served	Number of restaurants where disparity was identified
Imported Swiss cheese	Domestic Swiss	3
Imported prosciutto ham	Domestic prosciutto	5
Maryland crabmeat	Florida (2), Georgia (1), Virginia (1)	4
Maine lobster	Origin could not be substantiated	13
South African lobster tails	New Zealand (2), Belize (2), Nassau (1)	5

[a]Selected examples of the manner in which food products were represented on menus.

Further significant disparities, involving identification of specific meat cuts were noted in some restaurants. These included veal cutlets, roast sirloin of beef, club steak and slices of beef tenderloin. The more inexpensive products, labeled veal steak and veal patties, were used instead of veal cutlets. Roast cuts from the beef round were served instead of sirloin. Club steaks were sliced from top sirloin butts and flank steaks were used in lieu of beef tenderloin. In at least 90% of the establishments where Prime rib was listed on the menu, the actual USDA Grade of beef was Choice. Similarly, over 85% of the restaurants, which featured roasts and various steak cuts as Prime, could not substantiate this grade. New York sirloin strip and filet/tenderloin steaks were most widely misrepresented as Prime, as seen in Table 3.

TABLE 3. *Comparison between menu description and actual "grade" of meat products found in restaurants surveyed in the District of Columbia.*

Menu description of Grade[a]	Grade of product served	Number of restaurants where disparity was identified
Prime roast beef	Not USDA Prime	4
Prime London broil	Not USDA Prime	3
Chopped sirloin	Commercial "ground beef"	18
Prime filet tenderloin steak	Not USDA Prime	10
Prime New York sirloin/ strip steak	Not USDA Prime	11
Chopped sirloin steak	Commercial "ground beef"	15

[a]Selected examples of the manner in which food products were represented on menus.

In addition, many of the restaurants indicated that some of their meat products were aged, although less than half of them had facilities to capably age their meats in the traditional manner. In the remainder of these foodservice establishments, the manager on duty indicated that meats were either purchased aged or that the length of time the meats remain in air-tight plastic wrappings ("Cryovac") qualified them as aged. More than 95% of the restaurants surveyed purchased a commercial ground meat product from official USDA establishments which is labeled "ground beef." This product, in turn, was represented in 26 different manners on the various menus evaluated, ranging from chopped sirloin or chopped steak to chopped tenderloin steak. Some establishments had also indicated the grade of this product as Prime.

In more than 75% of the establishments, where portions were prepared or sliced on the premises to meet a stated portion on the menu, the minimum weight variance was 10 to 20%, favoring the restaurant. At one foodservice establishment, two different weight portions of a steak cut were listed on the menu. However, there were no scales available to weigh the portions. At another establishment, a 2-lb. lobster was featured on the menu; however, it actually weighed 1¼lb.

As shown in Table 4, many of the surveyed restaurants misrepresented the identity of the foods actually served.

TABLE 4. *Comparison between menu "identity" and actual food product found in restaurants surveyed in the District of Columbia.*

Menu identification[a]	Actual identity of food product served	Number of restaurants where disparity was identified
Chicken salad	Commercially-cooked turkey	21
Sliced breast of chicken	Commercially-cooked turkey	3
Breast of capon	No capon in stock	2
Sliced chicken	Commercially-cooked turkey	4
Baked ham	Canned boiled (6), smoked ham (3), "Cure 81" (not baked) (3)	12
Kosher corned beef	Not kosher	5
Maple syrup	Not maple syrup (table syrup)	10

[a]Selected examples of the manner in which food products were represented on menus.

For example, no establishment that listed capons on the menu had any in stock. In over 75% of the restaurants where chicken was identified as the basic ingredient, such as in sliced chicken and chicken salad, a commercially-cooked turkey product was used. Three out of four establishments, featuring baked ham on their menus, served a product that was not baked. Similarly, the country hams and the Virginia hams that were analyzed did not conform to conventional product descriptions.

Additional discrepancies include the substitution of domestic blue cheese for Roquefort by more than 75% of the restaurants surveyed, and use of dairy half-and-half instead of cream by 90% of the establishments which featured sliced fruits and cereal with cream.

DISCUSSION

The motivation for this survey of the accuracy of menus in public eating establishments was the desire of the District of Columbia government to work with consumer groups and the foodservice industry to resolve problems and issues of common concern. Increasingly, the honest representation of food has become an issue of major import to consumer groups, regulatory agencies, and the foodservice industry, not only in the District of Columbia but in other urban centers as well. Clearly revealed in this study are inconsistencies between the foods described on the menu and what is actually served the consumer. This may in part be due to the lack of knowledge and understanding of various food identities by the restaurant management, the long-standing use of terms that have been accepted in describing both a type of food and a specific food item, the desire to make the menu appealing, and the seasonal availability of some foods.

Regardless of the reasons for the disparities, the authors believe that corrective action is necessary. Therefore, the District of Columbia government is implementing a three-phase program involving education, consultation and enforcement to insure that consumers are protected against fraudulent advertisement and to help the Washington, D.C. foodservice industry meet consumer expectations. The educational phase of the program will consist of seminars and workshops designed to assist the restaurant managers in developing accurate menu language; the first seminar was held in December 1977. These workshops include the active participation of the U.S. Department of Agriculture, the National Marine Fisheries Service, the Washington Hotel Association and the Restaurant Association of Metropolitan Washington. In addition, consumer orientation sessions will be held and consumer bulletins will be issued by the District of Columbia government to help consumers define and understand appropriate terminology. This menu dictionary is already being printed.

In the consultation phase, foodservice managers will be given the opportunity to consult with technical personnel of EHA on an individual basis to assure the accuracy of their menus.

The final phase will consist of rigid enforcement of applicable sections of both the District of Columbia General Food Regulations and the Consumer Protection Act. These two statutes provide broad legal authority for the regulation and control of menu accuracy. An evaluation of the effectiveness of these three phases will be made in the latter part of 1978.

ACKNOWLEDGMENTS

The D.C. Environmental Health Administration thanks the Restaurant Association of Metropolitan Washington, the Hotel Association of Washington, D.C. and many individual managers of the food establishments surveyed for their cooperation and support. This paper was presented to the International Society of Restaurant Association Executives, Washington, D.C., November 17, 1977.

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Journal of Food Protection Vol. 41 No. 11, Pages 902-906 (November 1978)

Effect of Low-Temperature Cleaning on Microbiological Quality of Raw Milk and Cleanliness of Milking Equipment on the Farm

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ABSTRACT

Milking equipment on four farms each in the St. Paul, Minnesota area and the Ithaca, New York area was cleaned at wash solution starting temperatures of 120, 130, 140, 150, and 160 F. The effect of wash solution temperature on raw milk microbiological quality was determined by the Standard Plate Count (SPC), Psychrotrophic Bacteria Count (PBC), Coliform Count (CC) and Laboratory Pasteurized Count (LPC). Cleanliness of the farm milking equipment was determined by microbiological counts (SPC, PBC, CC) of circulated sterile water, visual examination and determination of residual calcium on the equipment. Statistical analysis of the data indicated that Klenzade farm detergents and Agway farm detergents can be used at temperatures such that the final wash solution temperature does not drop below 105 F and have no significant effect on cleaning performance, microbiological quality of raw milk or microbiological status of the milking equipment.

Proper cleaning and sanitizing of dairy farm equipment is vital for production of high quality milk. The cost of cleaning and sanitizing of milk-handling equipment on the farm (including energy costs) make up a considerable part of the production expense. The amount of energy used by farm milkhouse water heaters may be as high as 1888 kilowatts per 21 days (data from this report). Also, the amount of energy required to heat and re-cool bulk tank surfaces may be considerable.

This research was designed to determine the effect of low-temperature cleaning on microbiological quality of milk, and cleanliness of dairy farm milk handling equipment. Also, because of the apparent lack of published research on low-temperature cleaning of dairy equipment and with national concern for energy conservation, this study would appear very timely.

MATERIALS AND METHODS

Selection of farms

Eight farms were selected for this study; four from the St. Paul, Minnesota area and four from the Ithaca, New York area. "Farm Type" was used as a basis for selecting the farms in each area. Two parlor-system farms with pipelines and two stanchion systems farms, one with a pipeline and one with a transfer system were selected from each area (Table 1).

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Controlling cleaning solution temperature

The cleaning solution temperature on each farm was controlled by adjusting the thermostat setting on the farm water heater. Starting cleaning solution temperatures of 160, 150, 140, 130, and 120 F were used for 3-week periods to clean the farm bulk tank, pipeline, claws and all other milk handling equipment. A total of 10 tests (two at each temperature) were made on each farm starting in October 1975 and continuing until July 1976. The test order was randomized and an attempt was made to conduct each cleaning temperature test in the summer and in the winter season.

Cleaning chemicals and cleaning cycles

The equipment on all farms was treated in the following manner: (a) a 2-3-min pre-rinse at 110 F; (*b*) a 10-min recirculated chlorinated alkaline detergent wash (temperature of wash solution was varied); (*c*) an acid rinse (pH 5.0 - 6.0); and (*d*) a 2-min sanitize cycle before milking at 200 ppm available chlorine. All products were used according to label directions.

Klenzade liquid chlorinated alkaline detergent (Cir-Klenz) was used on two of the St. Paul farms and Klenzade powdered chlorinated alkaline detergent (Aim) was used on the other two St. Paul farms. The acid rinse of the St. Paul farms was done with Klenzade's acid product (Passiv-8). Sanitizing of the equipment was done with Klenzade chlorinated sanitizer (XY-12).

On the Ithaca farms, Agway, Inc. cleaning products were used in the same manner as Klenzade's products were used on the St. Paul farms. Agway's liquid chlorinated alkaline detergent (Agway Liquid Pipeline Cleanser) and Agway's chlorinated powdered alkaline detergent (Agway Pipeline Cleaner) were used as washing detergents. Agway's acid (Agway Acid Cleaner) was used for an acidified rinse and Agway's chlorinated sanitizer (Agway Sanitizer and Teat Dip) was used as the sanitizer. Table 1 indicates the type of detergent used on each farm.

On both the Ithaca and St. Paul farms, all cleaning parameters except temperature were kept as consistent as possible from period to period. Also, before conducting these tests the water hardness was determined on each farm (Table 1).

Sample collecting and transport

A milk sample was taken from the bulk tank after four milkings (2 days) had been collected. This sample represented milk that had been handled by equipment which was cleaned for 3 weeks by 160, 150, 140, 130, or 120 F wash solution. Milk from the St. Paul farms was collected using a sterile pipette and transported in a "Whirl-Pak" bag stored in ice water to the Microbiology Laboratories of Economics Laboratory, Inc., in St. Paul. Samples from the Ithaca area farms were collected by a sanitized dipper method (*3*) and transported in ice water to Agway, Inc. Research Laboratories (777 Warren Road, Ithaca, New York 14850).

TABLE 1. *Calcium (ppm) recovered by acid swabs from dairy farm milk handling equipment cleaned at wash solution temperatures of 160, 150, 140, 130, and 120 F.*

Farm type[a]	Detergent Type	Farm No. and location	Water hardness (Grains)	Season[b]	Wash solution temperatures (F) 160 WV[c]	160 P	150 WV	150 P	140 WV	140 P	130 WV	130 P	120 WV	120 P
P.P.	Liquid	1 MN	14	W	15	20	11	11	—	—	18	10	—	—
				S	10	18	16	19	21	19	16	9	15	14
S.P.	Liquid	2 MN	14	W	14	14	18	19	14	12	16	52	12	12
				S	14	13	13	15	11	18	14	16	—	—
S.P.	Powder	3 MN	12	W	—	—	—	—	—	—	13	22	21	17
				S	27	23	26	11	11	30	35	15	38	14
T.S.	Powder	4 MN	19	W	—	—	19	20	10	12	—	—	39	28
				S	—	—	13	12	16	11	19	10	13	29
S.P.	Powder	5 NY	14	W	—	—	20	19	19	17	15	20	22	22
				S	—	—	—	—	—	—	—	—	—	—
S.P.	Powder	6 NY	7	W	18	19	25	20	14	17	18	17	26	19
				S	—	—	—	—	—	—	—	—	—	—
P.P.	Liquid	7 NY	14	W	17	15	19	19	21	17	18	16	22	21
				S	—	—	—	—	—	—	—	—	—	—
T.S.	Powder	8 NY	10	W	19	24	20	20	18	17	13	19	30	17
					—	—	—	—	—	—	—	—	—	—
	AVERAGE				17	18	18	14	14	17	18	19	24	17

[a]P.P. -Pipeline, Parlor S.P. - Stanchion Pipeline T.S. - Transfer System.
[b]Seasons: W - Winter, S - Summer.
[c]WV - Wash Vat P - Pipeline.
When blank controls were determined, results were always <5.0 ppm.

Sterile water (distilled water autoclaved twice in a 5-gal plastic container, 250 F, 15 min) was poured into the wash vat and circulated through the farm pipeline or transfer system between the acid rinse and sanitize cycles. A representative sample was then collected in "Whirl-Pak" bags and transported to the laboratory for analysis. The water samples were handled and transported in the same manner as the milk samples and were analyzed on the same day as collected. The amount of sterile water circulated on each farm was the minimum amount required to circulate through the equipment. The volume of water circulated, the time of sampling, and all other parameters were kept as consistent as possible from period to period on each farm.

Acid swabbing for determination of calcium residuals was done with a cotton swab (tube type) on the pipeline or transfer tubing and wash vat. A few days before sampling 5.0 ml of 0.1 N HCl were placed in the tube and the swab was allowed to soak in the HCl. On each farm the pipeline was disassembled at a convenient union near the receiving bowl, the acid swab was rotated twice inside the pipe (approximately 2.0 in.^{2}), and placed back in the 0.1 N HCl. A 2 in.^{2} area in either the wash vat or the receiving bowl (in the case of transfer systems) was swabbed with an acid swab. The swab was placed back in the acid and the acid swabs and tubes were brought back to the laboratories for analysis.

Bacterial Analysis

Microbiological analyses done on the raw milk samples included: Standard Plate Count (SPC), Laboratory Pasteurized Count (LPC), Psychrotrophic Bacteria Count (PBC), and Coliform Count (CC) and were done according to *Standard Methods* (*4*). SPC, PBC, and CC were performed on the circulated water samples.

Calcium determination

Several studies (*1, 2, 5, 6,*) have indicated that calcium is a major constituent of milkstone and recovery of calcium may be an effective means of indicating cleanliness. A tube swab method (described earlier) was used to recover residual calcium from the equipment. The amount of calcium recovered was determined by atomic absorption spectrophotometry, as outlined in section 301A of *Standard Methods for the Examination of Water and Wastewater* (*3*).

Visual examination of equipment

After each 3-week cleaning period, visual examination of the pipeline, claws, vat, bulk tank, and other equipment was done and results were recorded. The equipment was examined for any type of protein film (blue or purple film), fat film (oily, dull appearance), mineral film (white or red film) or water hanging from the equipment. After each 3-week period the pipeline was disassembled and examined.

Energy saving determination

To determine energy usuage, watt-meters were installed on water heaters on test farms in the Ithaca area. Kilowatt hours were recorded after each 3-week period.

Statistical analysis

Correlation coefficients were determined on the data by Economics Laboratory, Inc., Corporate Statistical Services. Standard statistical procedures were used to determine the correlation coefficients and to determine their significance.

RESULTS

Visual examination of milking equipment, pipeline and bulk tank indicated that there were no differences in cleanliness of the equipment washed at the five washing solution temperatures.

Microbiological analyses were done on sterile water circulated through the milking equipment to further determine cleanliness of the milking equipment (see Table 4). SPC, CC and PBC were done on the circulated water and the correlation coefficients were determined on SPC versus cleaning temperature, CC versus cleaning temperature and PBC versus cleaning temperature. These correlation coefficients (critical absolute values of r <.283) were not statistically significant at the 95% confidence level. This indicated that cleaning temperature had no significant effect on the test used in this study to determine the microbiological status of the milking equipment.

Microbiological analyses (SPC, CC, LPC, and PBC) were done on the raw milk to determine the effect of cleaning temperature on both the microbiological quality of the raw milk and cleanliness of the equipment. Analysis of the data was done by means of correlation coefficients. Correlation coefficients on the SPC versus cleaning temperature, PBC versus cleaning temperature, LPC versus cleaning temperature and CC versus cleaning temperature were not statistically significant at the 95% confidence level. This again would indicate that cleaning

temperatures used in this study did not have a significant effect on the milk microbiological quality or the cleanliness of the milking equipment.

A third method used in this study to determine cleanliness of the milking equipment was a residual calcium determination. As pointed out by previous investigations (*1, 2, 5, 6*), calcium is a major constituent of milkstone and determination of residual calcium could be an effective means of determining cleanliness (Table 1). Again, correlation coefficients were used to analyze the data. Correlation coefficients determined between the parts per million calcium recovered on the cleaned equipment versus the cleaning temperature were not significant at the 95% confidence level. This would further support the speculation that cleaning temperature has no significant effect on cleanliness of the equipment if all other cleaning parameters are done properly.

Microbiological counts from the standard test used for determining raw milk microbiological quality (SPC) are shown in Table 2. On three occasions the SPC exceeded the 100,000 level (the level for acceptable Grade A milk). Two occurred on a St. Paul farm (Farm #3) with a starting cleaning temperature of 160 and 140 F and the remainder occurred on an Ithaca farm (Farm #8) at a starting cleaning temperature of 120 F. However, it does not appear that these high counts occurred as a result of inadequate cleaning. On these two farms the counts were usually higher at all cleaning temperatures than on the other farms. Psychrotrophic bacteria counts are also in Table 2. The average counts from the 160 and 150-F cleaning periods were 3,300 and 1,200 while the average counts at 130 and 120-F cleaning periods were 800 and 1,200. This indicates that there was not an increase in psychrotrophic bacteria with a decrease in cleaning temperature. Test results for thermoduric bacteria are in Table 3. During this experiment, the LPC on all farms did not exceed 10,000, and the average counts from this test did not indicate an increase in thermoduric bacteria at the lower cleaning temperatures. The coliform group of bacteria did not show an increase in numbers at the lower cleaning temperatures. The data on the CC are in Table 3.

Microbiological counts from the circulated sterile water are in Table 4. Since the method of circulating the water varied from farm to farm, the data can only be compared from cleaning period to cleaning period and not from farm to farm. However, there does not appear to be an increase in the SPC, PBC, or CC of the circulated water with a decrease in cleaning temperature. This is further proven by the lack of significant correlation coefficients between the counts and the cleaning solution temperature.

The amount of energy saved by reducing the temperature of the washing solution was determined by installing a watt-meter on the farm milkhouse water heaters. Energy consumption data at the five cleaning temperatures (on the Ithaca farms) are in Table 5. As data in Table 5 point out, a considerable saving was realized at the lower cleaning temperatures.

DISCUSSION

There are several sources of bacterial contamination of raw milk, including udder infections, soiled milking equipment, feed, soil and other sources that cause variance in raw milk counts. Also, factors such as season of the year, type of milking equipment, milk storage temperature, rate of milk cooling, and other considerations cause variance in raw milk counts. The author recognizes that this introduced variance could have a tendency to mask any significant correlations tested for in this study. However, elimination of the introduced

TABLE 2. *Standard plate count (SPC) and psychrotrophic bacteria (PBC) of milk handled by equipment cleaned at 160, 150, 140, 130, and 120 F.*

Farm	Season	160 F		150 F		140 F		130 F		120 F	
		SPC	PBC	SPC	PBC	SPC	PBC	SPC	PBC	SPC	PBC
1	W	2,300	150	2,400	<1	300	<1	2,600	2,280	5,600	7,200
	S	570	120	2,800	12	1,400	<1	2,100	<1	3,000	11
2	W	3,000	400	5,300	2,800	2,900	23	3,800	<1	900	660
	S	2,600	830	14,000	<1	1,300	370	2,400	10	1,600	950
3	W	150,000	11,000	12,000	230	140,000	4	2,400	5	49,000	350
	S	48,000	23,000	5,000	4,000	* *	* *	2,800	<1	11,000	100
4	W	*	*	9,900	1,000	400	20	830	310	5,200	<1
	S			2,400	<1	710	10	5,000	<1	1,000	410
5	W	*	*	5,200	2,100	3,950	10	4,400	200	2,600	<1
	S			2,700	260	3,450	10	4,500	15	* * *	* * *
6	W	14,000	1,900	11,000	15	1,400	350	28,000	280	12,000	85
	S	15,000	250	36,000	3,000	15,000	75	56,000	110	33,000	7,400
7	W	1,700	120	1,300	10	5,300	130	4,100	190	2,700	250
	S	950	130	1,300	10	800	110	4,400	7,800	1,200	8
8	W	54,000	2,100	26,000	5,700	27,000	15	42,000	2,000	31,000	790
	S	16,000	45	2,400	160	70,000	12,000	45,000	35	100,000	70
Average of Winter & Summer		26,000	3,300	8,700	1,200	18,000	880	13,000	800	17,000	1,200

*150 F was maximum output of water heater.
**Lower unit of water heater failed.
***Powdered detergent solubility problems occurred and the period was dropped and temperature increased.

TABLE 3. *Coliform count (CC) and laboratory pasteurized count (LPC) of milk handled by equipment cleaned at 160, 150, 140, 130, 120 F wash solution temperatures for three weeks.*

		160 F		150 F		140 F		130 F		120 F	
Farm	Season	CC	LPC	CC	LPC	CC	LPC	CC	LPC	CC	LPC
1	W	<1	<1	<1	310	<1	58	25	150	3	3
	S	2	<1	<1	10	6	4	380	4	4	440
2	W	37	<1	3	17	40	<1	220	7	50	3
	S	35	66	40	11	250	20	<1	120	33	<1
3	W	30	6	12	26	7	19	40	210	530	1,400
	S	260	100	60	130	* *	* *	110	160	90	420
4	W	*	*	3	<1	2	5	11	9	<1	17
	S			7	<1	<1	12	40	12	280	<1
5	W	*	*	<10	5,800	12	15	15	10	30	<10
	S			13	20	10	80	70	20	* * *	* * *
6	W	100	20	128	700	70	15	36	15	35	35
	S	35	90	1,200	90	420	7	720	50	2,300	10
7	W	<10	10	17	120	100	20	130	30	10	65
	S	39	35	11	150	53	53	110	<10	8	22
8	W	<10	5,800	45	8,600	15	240	70	750	21	130
	S	12	130	10	530	62	70	150	140	39	570
AVERAGE		47	520	97	1,000	70	41	130	100	220	210

*150 F was maximum output of water heater.
**Lower unit of water heater failed.
***Powdered detergent solubility problems at low temperature.

TABLE 4. *Standard plate count (SPC), psychrotrophic bacteria count (PBC) and coliform count (CC) of sterile water after circulating through milking equipment cleaned at 160, 150, 140, 130, and 120 F wash solution temperatures for 3 weeks.*

		160 F			150 F			140 F			130 F			120 F		
Farm	Season	SPC	PBC	CC	SPC	PBC	CC	SPC	PBC	CC	SPC	PBC	CC	SPC	PBC	CC
1	W	2	<1	<1	57	<1	<1	3	<1	<1	49	<1	<1	1	<1	<1
	S	<1	<1	<1	1	<1	<1	2	<1	<1	4	<1	<1	2	<1	<1
2	W	<1	<1	<1	570	<1	<1	12	<1	<1	60	<1	<1	50	30	<1
	S	2	<1	<1	<1	<1	<1	6	<1	<1	<1	<1	<1	1	<1	<1
3	W	75	<1	<1	25	<1	<1	270	<1	<1	950	<1	<1	880	<1	<1
	S	39	<1	<1	16	1	<1	* *	* *	* *	4	<1	<1	30	<1	<1
4	W	*	*	*	1	1	4	1	<1	<1	<1	<1	<1	140	<1	<1
	S				110	<1	<1	12	<1	<1	20	<1	<1	<1	<1	<1
5	W	*	*	*	300	5	<1	6	<1	5	4	<1	<1	<1	<1	<1
	S				10	10	<1	109	<1	<1	7,600	<1	<1	* * *	* * *	* * *
6	W	30	15	<1	140	<1	10	10	30	<1	80	<1	10	45	10	<1
	S	<1	<1	<1	160	<1	2	8	<1	<1	1	2	1	1,800	10	<1
7	W	65	5	10	41	<1	<1	1,500	10	4	<1	<1	<1	10	20	10
	S	93	<1	<1	66	<1	<1	2	<1	21	<1	<1	<1	1,200	<1	5
8	W	3,500	10	<1	10	1	<1	1	<1	<1	35	10	1	10	10	5
	S	600	<1	<1	300	230	10	29	<1	<1	27	<1	<1	3	<1	<1
AVERAGE		370	3	2	110	16	2	120	3	2	550	1	1	280	6	2

*150 F was maximum output of water heater.
**Lower unit of water heater failed.
***Powdered detergent solubility problems at low temperatures.

TABLE 5. *KWH consumed per 21 days by dairy farm milk house water heaters at wash solution temperatures of 160, 150, 140, 130, and 120 F.*

				Winter season			
Farm	160 F	150 F	140 F	130 F	120 F	KWH saved* * *	Dollars saved* * * *
5	*	1676	1830	1888	1496	180	$ 7.20
6	776	706	663	548	498	278	11.12
7	809	1161	879	876	621	188	7.75
8	460	439	406	379	335	125	5.00
				Summer season			
5	*	1680	1350	1245	* *	435	$17.40
6	773	637	579	503	454	319	12.76
7	1220	902	853	706	634	586	23.44
8	470	414	349	380	292	178	7.12
AVERAGE	751	952	863	816	619	286	$11.47

*Farm has an undersized water heater and could not reach 160 F.
**Run not completed because of detergent solubility problems.
***Difference between highest cleaning temperature and lowest cleaning temperature.
****Assuming KWH at $0.04/KWH.

variance is not possible or practical in this type of investigation.

In trials conducted before collecting the data in this report, equipment on the St. Paul farms was washed at starting temperatures below 120 F. Soiled equipment resulted from cleaning at these temperatures (i.e. appearance of a dull, oily film). During these washing trials the final wash solution temperature dropped below 105 F. Also, in one of the cleaning periods, the water heater failed and the wash solution temperature dropped below 105 F, resulting in soiled equipment. One might speculate that as the temperature dropped below 105 F fat in the soil solidified and redeposited on the equipment. The starting temperature and the end temperature were periodically recorded during each trial; no final temperature less that 105 F was recorded.

Figure 1 shows a temperature recording conducted on a farm with a parlor system with approximately 200 ft of 3-inch pipeline. This farm uses six milking machine units and washes with 30 gal of water. It should be noted that temperature drop is a function of several factors: amount of water used, starting temperature, length and diameter of pipeline, length of wash cycle, ambient temperature, equipment temperature, and design of equipment. These factors will vary with season and time when equipment is washed. Therefore, if one is going to recommend lower cleaning temperatures, precautions should be taken to make sure that at no time should the wash solution temperature drop below 105 F.

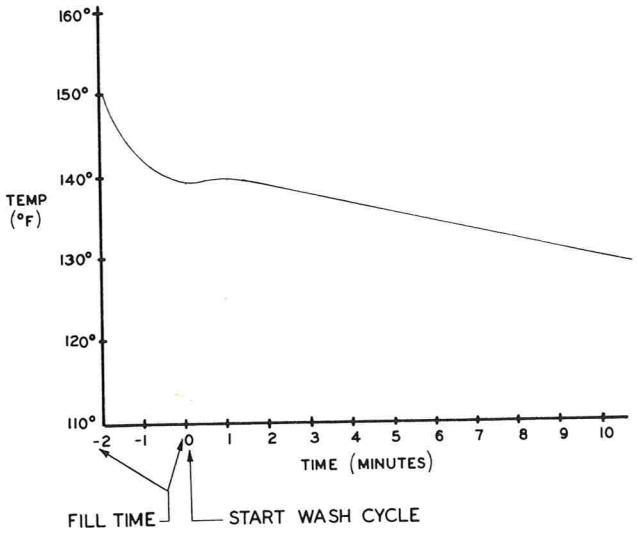

Figure 1. *Temperature decrease during the wash cycle of milking equipment on a parlor-system dairy farm.*

On all farms in this study label recommendations (except wash solution temperature) were followed for cleaning and sanitizing of the milking equipment. Therefore, if one is going to make cleaning solution temperature recommendations of less than 160 F, one should be assured that concentrations, cleaning cycle length, mechanical action of the wash solution, and other parameters that influence cleaning are adequate. Also, based on design of the equipment, care should be taken that product solubility problems do not occur.

Energy savings amounting to $6.66 to $31.25 per month would make it attractive to producers to wash equipment at lower temperatures. Also, additional energy could be saved by reducing the amount of energy needed to re-cool the bulk tank walls. With the advent of farm equipment designed to obtain energy from other sources, cleaning at lower temperatures may be quite valuable. For example, some manufacturers have designed equipment that will utilize heat from the bulk tank compressor. Hot water obtained by this means may reach 145 F which would be adequate for dairy equipment washing using Klenzade's and Agway's products. Also, if further use of solar energy becomes popular or necessary, washing at lower temperatures may be necessary.

CONCLUSIONS

1. This study indicated that milk handling equipment can be effectively cleaned at lower temperatures, providing the final wash solution temperature does not drop below 105 F and that all other cleaning functions are done properly.
2. There is a significant saving of energy realized by cleaning dairy farm equipment at lower temperatures.
3. The lower cleaning solution temperatures used in this study had no significant effect on milk microbiological quality or the microbiological status of the milk handling equipment.

ACKNOWLEDGMENTS

The author expresses appreciation to D. Sprague, F. Szematdinicz, R. Martin and R. Eckberg of Agway, Inc. for their collaboration and assistance with this study. The author also expresses appreciation to the personnel from the Corporate Statistical Services and Microbiological Departments of Economics Laboratory, Inc., for their assistance in conducting this research.

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Journal of Food Protection Vol. 41 No. 11, Pages 907-909 (November 1978)

Problems and Opportunities for the Foodservice Industry in the 1980's

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(Received for publication April 3, 1978)

The foodservice industry is a many-faceted giant. Based on dollars spent, one of three meals were consumed away from the home in 1977; in that year the sales of food and drink amounted to $85.9 billion dollars. The growing number of singles and working women as well as higher incomes are the major factors which will sustain growth of the industry, and by 1981 it will reach the volume of about 118 billion dollars. The foodservice industry is the largest U.S. retail employer. In recent years labor costs have escalated significantly. Part of this is attributable to the higher minimum wage as well as the increased social security tax. Another factor causing pressure on profits is the high cost of energy. To reduce these costs, labor saving devices and more efficient scheduling have been used. Solar energy, conservation of power, and central preparation of food have also been used to achieve better economies. The problems with higher labor turnover plus the lack of fully or even partially trained food handlers are presented. The impact of consumerism on the industry and the menus of today and the future are revealed.

DEFINITION AND MAGNITUDE

The foodservice industry may be defined in terms of sales of food and drink away from home. Commercial feeding establishments were responsible for approximately 84.5% of these sales in 1977. These include restaurants, limited menu restaurants, bars and taverns, food contractors, hotels, cafeterias, motels, and the vending machine industry. There are also other smaller classifications. The non-commercial segment consists of hospitals, schools, employee feeding, clubs and transportation.

According to National Restaurant Association figures, sales of food and drink amounted to 85.9 billion dollars in 1977. The projected rate of growth is shown in Fig. 1. There are now 500,000 foodservice establishments including 365,000 restaurants; this number will grow to 410,000 by 1985. The most rapidly growing segment is the fast food or limited menu restaurants. Based on the amount of money spent for food in 1977, one of three meals was consumed away from the home. By 1980, one of two meals will be eaten out.

Distributors and manufacturers of institutional products as well as many other service and supply industries must be included as part of the foodservice industry. To gain an idea of the magnitude of just one of these associated industries, distributors' sales in 1977 amounted to approximately 37 billion dollars and it is projected that this will grow to 54 billion dollars by 1980.

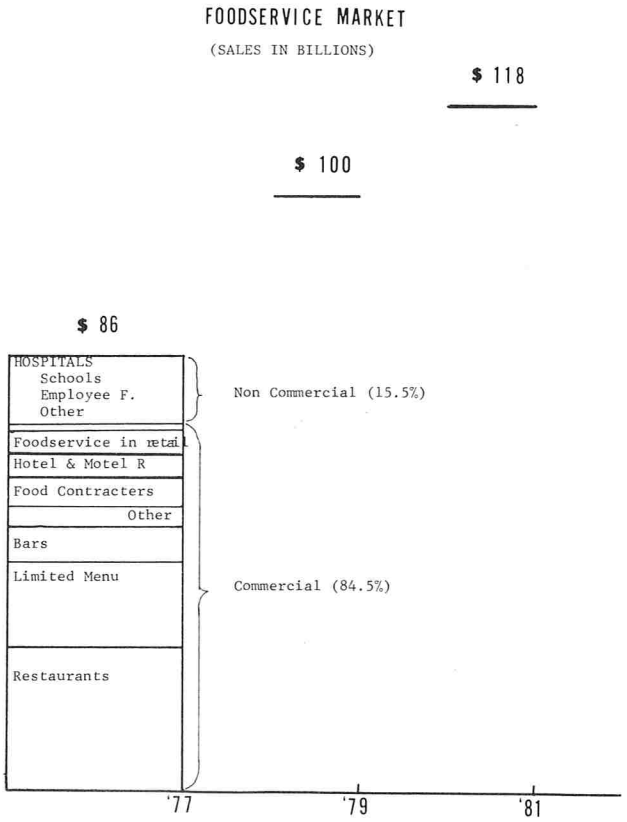

Figure 1. *Projected growth of the foodservice industry.*

FACTORS CONTRIBUTING TO GROWTH

The most significant factors which substantiate further expansion of the foodservice industry include the following: by 1985 one-half of the work force, age 35 to 44 will be women, whereas the figure now stands at one-third. The number of people living alone will continue to increase. The number of persons under age

25 doubled between 1970 and 1975. There has been a surge in number of persons with higher incomes. Singles and small families are the heaviest users of restaurants. Young adults are accustomed to eating out, expecially in fast food service establishments; this explains their rapid growth rate.

The fast food chains will intensify their efforts to diversify their menu to reach a broader market. For example, a major hamburger chain has moved to salads, fish, poultry, and steaks; one of the donut chains has already moved to soups and may continue to move away from pastry. The fish shops are now including chicken; the chicken shops are now including fish; and the hamburger shops are now including fish and chicken.

New products may take 3 years for completion of consumer and market research before a full roll-out takes place. This presents a major challenge to foodservice manufacturers to capitalize on their technological expertise to shorten the critical path.

LABOR AND COSTS

The restaurant industry is extremely labor-intensive. As such, it is the largest retail employer with 8 million full- or part-time workers. This is 8.3% of the American labor force; 53% of the workers are dependents.

As the average age of the U.S. population increases, more difficulty will be experienced in hiring personnel at the minimum wage. The minimum wage has gone up to $2.65 this year and will increase to $3.35 in 1981. The tip credit went down to only 40%; now an employer has to pay a wage equivalent to 60% of the minimum. As the minimum increases, the tipped employee will tend to get the same wage as the kitchen employee.

Under the new social security bill, restauranteurs with tipped employees will have to pay social security tax on their employees' tips up to the point where the salary plus tips equal a minimum wage. Under the old law, they were required only to pay the employers' half of the social security bill on the employees' actual salary. These factors will result in higher menu prices and possibly a fixed service charge by some restauranteurs.

ENERGY

Energy costs have increased from 1 to 5% of sales and the end is not yet visible. Efforts have already been made to hold this cost down. A recently introduced measure is the low-temperature dish machine. In my opinion this will take 4 to 5 years before it has much impact. There are significant conflicts with FDA, EPA and various local regulations on use of such equipment which relies on chemical rather than thermal sanitization.

Solar energy will be used in heating process water and for the environment. Efforts will have to be made to enable use of this approach for cooking. Energy conservation by means of new exhaust systems that utilize 80% untempered air will continue to grow. These hoods use high-velocity outside air to create a low pressure over the cooking surface thereby picking up fumes and pulling them up the stack. Restaurants may be redesigned to lower ceilings and to bring back the old ceiling fans. Recovery systems for heat still need to be improved in efficiency and reduced in cost for fryers, ovens, refrigerators, condensers and dish washers.

Freezers, because of their constant need for power, may be reduced in size. The appearance of new products, such as retorted trays and pouches, may further the trend toward smaller freezer requirements. A shortage of water in certain areas will prompt a further disappearance of the traditional glass from the restaurant table. This will conserve the energy needed to make ice, purify water, and wash glasses and pitchers. It will also reduce consumption of cleaning chemicals and save the labor involved.

COST CONTROL

The central receipt, preparation, processing, packaging, storing and distribution of selected entrees and menu items, such as desserts, with subsequent delivery to dining facilities for final preparation in serving will intensify. It has already been used quite successfully by the Department of Defense and by some School Lunch Programs. Such facilities have high capacity and can operate at reduced costs. They use specialized capital-intensive manufacturing and packaging equipment and highly skilled labor. This results in better economies and improved product quality.

Use of central food preparation facilities may lead to an increased standardization of package sizes and food portions. However, in restaurants the number of optional sizes for entrees will increase to control cost as well as to satisfy customers needs and desires.

Quality control efforts will be more formal and will intensify especially by the larger chains in an effort to control costs and improve quality; for example, McDonald's presently uses 190 "field" consultants.

SANITATION AND TRAINING

Efforts by the FDA on a Model Foodservice Sanitation Ordinance resulted in its issuance late in 1977. It was designed to be a voluntary approach and an effort to sort out some 4,000 to 5,000 separate jurisdictions scattered among the 50 states. Ten states have already accepted the model ordinance. The states of Illinois and Florida, and the cities of Chicago, New York and Washington presently have mandatory programs.

People entering the industry generally have had no formal, or merely very superficial training in food handling and sanitation. In addition, there is a huge turnover in personnel. The U.S. Army has estimated that there is approximately a 50% annual turnover in its foodservice personnel. The balance of the foodservice industry on the average does not fare as badly, with an annual turnover rate of one out of three employees. There will be no moderation in this trend.

Part of the Illinois ordinance is the requirement to have a Manager or Supervisor receive training based upon the minimum standards proposed by the FDA. Certification of this group of Managers is exceedingly

difficult, primarily because of the large numbers involved; it is estimated that approximately 10% of the labor is Management or Supervisory in nature. There are approximately 800,000 individuals involved and there is also a high turnover in this area. Further complexities in training are presented by language problems. There are a large number of ethnic restaurants where the English language is poorly understood. However, the National Institute for the Foodservice Industry (NIFI) has already successfully presented courses in instruction based upon the HEW Certification Program. This was done not only in English, but in several other languages as well.

Sanitation regulations may ultimately trigger the total disappearance of open foods and condiments. The salad bar as such may disappear or be equipped with a positive pressure air curtain and specialized guards. Other affected items include the bread basket, the cream pitcher, sugar bowl, salt shaker and even perhaps pitchers of beer. Obviously, the slack will have to be filled by single-service packaging. This may create a struggle with energy conservation, because of the energy and resources required in packaging.

MENUS OF THE FUTURE

The issue of consumerism has arrived in restaurants. The Los Angeles County "Truth In Menu Law" is designed to protect consumers from false advertising. It subjects restaurants to immediate referrals to criminal prosecution or initiation of civil and injunctive action no matter how inconsequential the infraction. Other cities such as Washington, D.C. and Chicago also have similar ordinances. Table 1 lists some of the more common controversial points on today's menu.

To keep ahead of the consumerists, food manufacturers should place greater emphasis on the quality, reliability, and better sanitation of their manufactured product. This should include the identity of the actual source of the product, as well as the specific weight.

With the rise of consumerism, menus may become huge. For example, the old product formerly known as *french fries* will be called "oil cooked potato strips.":

> Frozen peeled 3/8 × 1/4 × 4 in. potato strips, held at ±0 F — for _____ days before use. _____variety potatoes grown in _____in soil treated with _____fertilizer; while growing they are sprayed with _____to control insects, hasten ripening, increase yield, etc. Upon harvesting the potatoes are washed with recycled water containing _____, _____, _____. Before storage the potatoes are treated with ionizing radiation +/or _____to inhibit sprouting. In processing the potatoes are peeled with lye _____, _____, _____or steam, etc; automatically sliced in a machine which has been sanitized with _____ppm chlorine and coated with mineral oil or a silicone compound to inhibit rusting; after dicing they have been dipped into dextrose, sodium sulfite and / or ascorbic/citric acid mixtures with EDTA to inhibit, control, or regulate browning. The frozen potatoes are placed in packages treated with such and such, or containing such and such, which may migrate from the film at a rate of _____ppt.
>
> The frozen potatoes have been placed in a fryer containing a compound consisting of tallow, cottonseed oil, sodium dimethysiloxane as an antifoaming agent, and BHA antioxidant. The frying process permits a migration of _____ppt metal from the fryer, and perhaps peroxides and other by-products from the degraded fats. After frying, the potatoes have been treated with 0.5% to 0.75% sodium chloride containing _____as an anti-caking agent and iodine as a prophylactic against thyroid conditions.
>
> Caution — This product 1 serving, _____grams, contains _____ milligrams % of cholesterol; this factor has been under controversial investigation for the last 20 years as an atherosclerotic compound. The product if consumed immediately contains _____% protein, _____% fat, _____% carbohydrates, _____calories, _____% Vitamin A, _____, etc. And all this excludes the little box or bag usually used by the fast food service units.

Table 1. *Truth in menu.*

Advertised	Used	Legal
Geographic		
Florida red snapper	Pacific	No
Iceland herring	Finland	No
Russian dressing	Local	Yes
New England style clam chowder	Local	Yes
Wisconsin cheese	Local	No
Size		
12 oz. Steak	Lower weights	No
Foot-long frankfurter	Shorter length	No
Mile-high sandwich	About 6 inches	Yes
Condition		
Fresh	Frozen	No
Frozen	Dehydrofrozen	No
Fresh daily	Day old	No
Grade		
Prime	Other	No
USDA graded	Not graded	No
U.S. inspected	Not inspected	No
Manufacturer		
Homemade	Commercial	No
ABC Co.	XYZ. Co.	No
"Coke" ®	"Pepsi"®	No
Substitutes		
Scallops	Cubed fish	No
Veal cutlets	Ground veal	No
Calf liver	Beef liver	No
Butter	Margarine	No
Chicken salad	Turkey salad	No
Fresh baked	Frozen baked	Yes

COMPETITION BY SUPERMARKETS

Finally, the supermarkets will compete more vigorously. Sales figures from the National Association of Retail Grocers of the U.S. for 1977 showed only a 9.1% increase as compared to 7.8% for 1976. However, profits decreased from 2.4 to 1.8%. The food chains will increase their competition through increased sales and marketing promotion. They may well become fast food operators, either in fact, or by acquisition; either within their stores, or as free-standing operations.

The food chains have several of the key prerequisites: (*a*) high traffic locations, (*b*) distributional systems and (*c*) lower food costs because of the buying power of supermarkets. Produce and baking items and some meat are bought from the store and result in 1-2% savings. In some markets, the kitchen labor can cook for both the delicatessen and the restaurant.

Journal of Food Protection Vol. 41 No. 11, Pages 910-918 (November 1978)

Foodborne Disease in Canada - 1975 Annual Summary

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(Received for publication May 12, 1978)

ABSTRACT

Data on foodborne disease in Canada in 1975 were compared with data for 1974. A total of 838 incidents, comprising 710 outbreaks and 128 single cases, and involving 7106 ill persons, was recorded for 1975. The number of outbreaks increased by 89% and single cases by 129% over those reported for 1974. As in 1974, *Staphylococcus aureus* was responsible for more incidents (37) than any other agent. Other incidents were caused by *Salmonella* (25), *Clostridium perfringens* (12), *Clostridium botulinum* (6), suspect mold and yeast (13) and suspect *Streptococcus* sp. (8). In both years, non-microbiological agents, mainly chemical, accounted for less than a quarter of the incidents of known etiology. Two persons were reported to have died through foodborne disease. About 41% of incidents and 50% of cases were associated with meat and poultry. Vegetables, fruits, bakery products, sandwiches and Chinese food also played a prominent role. Mishandling of food took place mainly in foodservice establishments (25% of incidents) or homes (20%). More than 60% of reported foodborne disease incidents occurred in Ontario. The number of incidents per 100,000 population was highest in the Northwest Territories (10.6), Ontario (6.4) and British Columbia (4.7). Narrative reports of five foodborne outbreaks are presented.

The rationale for establishing a national system for collecting and disseminating data on foodborne disease in Canada was presented previously (*1, 2*). Detailed summary reports for 1973 (*3*) and 1974 (*4*) have been published in English and French and distributed to health agencies and interested persons in Canada and other countries; copies are available from the author on request. A similar detailed summary is also planned for the 1975 data.

The following definitions, used in this summary, are identical to those previously published (*1*), except that definitions of the main classes of etiological agents, and suspect agents are added. Paralytic shellfish poison (*Gonyaulax* sp.) is placed in the animal category; in the 1974 Annual Summary (*1*) it was classified under the plant category.

Microbiological: Pertaining to cells or products of cells of bacteria, yeasts, or microscopic fungi.

Parasitic: Pertaining to round worms, tapeworms, protozoa or flukes which invade human tissue through the alimentary tract.

Plant: Pertaining to whole or part of vegetable material, including flowers, trees, mushrooms, and toxic substances produced by these.

Animal: Pertaining to whole or part of an animal, including toxic livers of mammals, toxic fish and shellfish caused by bacterial or algal action, and birds which have eaten seeds poisonous to man.

Chemical: Pertaining to substances produced by a chemical process, including metals, cleaning solutions, pesticides, rancid compounds and extraneous matter.

Suspect agent: An agent for which proof of foodborne disease transmission is inconclusive, but which is suspected of causing illness.

Food: Any substance for human consumption, excluding drinking water.

Outbreak: An incident in which two or more persons experience a similar illness after ingestion of a common vehicle (food), and epidemiological evidence implicates the vehicle as the source of the illness.

Case: A person who has been ill as a result of consuming food shown to be contaminated on the basis of epidemiological evidence or laboratory analysis.

Single case: One case, as far as can be ascertained, unrelated to other cases in respect to vehicle consumed.

Incident: An outbreak or single case.

Laboratory-confirmed incident: Where the specific etiological agent is determined by laboratory analysis.

Outbreak of unknown etiology: An outbreak where epidemiological evidence implicates a common food, but where laboratory analysis fails to identify the etiological agent.

Single case of unknown etiology: A case where clinical data are consistent with foodborne illness, and either epidemiological or sufficient laboratory evidence implies a foodborne incident, although there is not enough information to implicate a specific agent.

THE DATA

The present report is a summary of foodborne illnesses occurring during 1975 reported by the Health Protection Branch, provincial epidemiologists, provincial laboratories, and municipal and regional health authorities. Data were collated, tabulated, and returned to the originators for verification. From the information listed under each incident the following tables were prepared.

Table 1 shows that 838 foodborne incidents, comprising 710 outbreaks and 128 single cases, occurred in 1975, and involved 7,106 cases of illness. Compared with figures for 1974, outbreaks increased by about 84%, single cases by 129%, and total cases by 64%. The percentage of laboratory-confirmed incidents and cases, however, dropped in 1975, except for those involving plant and animal agents. The reason for this was the recording of many more incidents of unknown etiology in 1975 (707, 84.4%, for 1975 and 341, 77.0%, for 1974).

Table 2 lists the incidents caused by specific agents, including the range and median numbers of cases per outbreak. The agent responsible for most outbreaks (24) and single cases (13) was *Staphylococcus aureus* with a median of six cases per outbreak. Although *Salmonella* ranked second in the number of outbreaks (23) and third in number of single cases (2), more persons suffered from salmonellosis (1294) than from staphylococcal enterotoxemias (320). This represents an increase in *Salmonella* cases and a decrease in staphylococcal cases in 1975 as compared with 1974. Twelve outbreaks and 556 cases of illness from *Clostridium perfringens* occurred in 1975, an increase over the previous year, although the median number of cases per outbreak decreased from 90 to 30.5. *Clostridium botulinum* was responsible for six incidents and 13 cases in 1975, as compared with five incidents and 11 cases in 1974. There were fewer incidents (one outbreak and one single case) of illness from *Bacillus* sp. than for the previous year. Three organisms were placed in the suspect category; these were mold and yeast (13 incidents), *Streptococcus* sp., mainly enterococci, (eight incidents) and *Pseudomonas aeruginosa* (one incident). Four microbiological agents, which had not been reported as causing illness in 1973 or 1974, were recorded for 1975 — *Arizona hinshawii, Pseudomonas aeruginosa, Shigella sonnei* and *Yersinia enterocolitica*. Only two incidents (six cases) of trichinosis occurred compared with the six incidents (50 cases) the previous year. Three single cases were caused by plant agents (mushrooms and pokeweed) and another three by animal agents (paralytic shellfish poison, scombroid poisoning and suspect insect infestation). The last involved consumption of dry cereal heavily contaminated with larval and adult grain beetles; illness from this agent has not previously been reported in the literature. Leaching of tin in canned acid products, presence of caustic wash (sodium hydroxide) in bottled beer and french fries, pesticide (lindane) in cole slaw, rancid oil in licorice and corn chips, and extraneous matter (including grease and glass, Varsol and citric acid) in canned and bottled soft drinks, were reported to have caused illness. These chemical poisonings were generally of a mild nature, and involved relatively few people. The exception was lindane poisoning from cole slaw served to United States tourists in Montreal; 40 of the 45 consuming the food were seriously ill with vomiting, diarrhea, convulsions and paresthesia.

Two deaths were associated with foodborne disease in 1975, considerably less than the nine reported for the previous year. One elderly person succumbed to a *Salmonella paratyphi* B infection after eating contaminated shepherd's pie served in a rest home; and one patient in a hospital died shortly after being admitted, because of the staphylococcal enterotoxemia incurred through consumption of fried liver.

Foods associated with illness are shown in Table 3. This table lists all incidents, whether associated with a specific agent or not; therefore, etiological information pertaining to many of these incidents is incomplete. Thirty-two percent of incidents and 24.7% of cases were associated with meat, 8.6% of incidents, and 26.6% of cases with poultry and 6.0% of incidents and 2.8% of cases with marine foods. These percentages are generally similar to those for 1974, except that incidents involving meat increased slightly (26.4 to 32.1%) and cases involving turkey increased greatly (4.9 to 24.7%). The latter increase was due to large numbers of persons involved in some outbreaks; four outbreaks each had more than 100 persons ill, one with 900 cases. Vegetables and fruits (down in percentage in both incidents and cases from the previous year) bakery products, sandwiches, and Chinese foods also played a significant role.

Table 4 shows that mishandling in foodservice establishments was responsible for 25.2% of all incidents and 40.3% of all cases. Improper care in the home (20.0% of incidents and 20.3% of cases) was also important. Mishandling in food-processing establishments (5.4% of incidents) and retail food establishments (4.4%) were less significant. Mishandling in foodservice establishments contributed a greater number of incidents than in the previous year, otherwise the percentages for the two years were similar.

The incidents caused by mishandling of foods in food-processing establishments (45 incidents and 79 cases) are summarized in Table 5. Microbiological and chemical agents were most frequently involved in those incidents for which etiological information was available. Eleven (24.4%) of the incidents responsible for 21 (26.6%) cases resulted from microbial contamination, and 13 (28.9%) of the incidents responsible for illness in 19 (24.1%) cases were caused by chemical contamination. Wild plants (mushrooms and pokeweed) sold commercially caused intoxication, and histamine-like substances affected one person (scombroid poisoning) after eating canned tuna fish. No widespread outbreaks involving commercial products occurred in 1975, unlike 1973 (*1*) and 1974 (*2*), although small incidents were caused by some of the same agents - *Salmonella, Staphylococcus,* yeast, molds, tin and caustic wash.

TABLE 1. *Number of foodborne incidents and cases in 1975 and 1974.*

Etiology	Outbreaks		Single cases		Total incidents		Percentage incidents		Total cases		Percentage cases	
	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974
Microbiological	75	67	32	17	107	84	12.7	19.0	2443	1569	34.4	36.2
Parasitic	1	4	1	2	2	6	0.2	1.3	6	50	0.1	1.1
Plant	—	—	3	1	3	1	0.4	0.2	3	1	0.0	0.0
Animal	—	1	3	—	3	1	0.4	0.2	3	43	0.0	1.0
Chemical	6	9	10	1	16	10	1.9	2.3	63	64	0.9	1.5
Total known	82	81	49	21	131	102	15.6	23.0	2518	1727	35.4	39.8
Unknown	628	306	79	35	707	341	84.4	77.0	4588	2612	64.6	60.2
Total	710	387	128	56	838	443	100.0	100.0	7106	4339	100.0	100.0

TABLE 2. *Number of persons ill in foodborne incidents by specific cause in 1975 and 1974.*

Etiology	Number of outbreaks		Number of cases in outbreaks		Number of cases/outbreaks					
					Range		Median		Single cases	
	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974
MICROBIOLOGICAL										
Staphylococcus aureus	24	29	320	606	2-69	2-110	6	6	13	5
Salmonella sp.	23	22	1294	620	2-600	2-126	16	10	2	2
Clostridium perfringens	12	3	556	200	3-250	10-100	30.5	90	—	—
Clostridium botulinum	2	4	9	10	4-5	2-3	4.5	2.5	4	1
Bacillus sp.	1	4	2	86	NA[a]	2-40	NA	18	1	—
Yersinia enterocolitica	1	—	138	—	NA	NA	NA	—	—	—
Arizona hinshawii	—	—	—	—	—	—	—	—	1	—
Shigella sonnei	1	—	69	—	NA	NA	NA	—	—	—
Shigella flexneri	—	1	—	12	—	NA	—	NA	—	—
Suspect *Pseudomonas aeruginosa*	1	—	2	—	NA	NA	NA	—	—	—
Suspect *Streptococcus* sp.	6	1	13	2	2-3	NA	2	NA	2	—
Escherichia coli	—	1	—	12	—	NA	—	NA	—	—
Vibrio parahaemolyticus	—	1	—	2	—	NA	—	NA	—	—
Brucella abortus	—	—	—	—	—	NA	—	—	—	1
Suspect mold and yeast	4	1	8	2	2	NA	2	NA	9	8
Total microbiological	75	67	2411	1552	2-600	2-126	7	10	32	17
PARASITIC										
Trichinella spiralis	1	4	5	48	NA	3-29	NA	8	1	2
PLANT										
Mushroom (*Lactarius/Russula* sp. and *Amanita pantherina*) toxin	—	—	—	—	—	—	—	—	2	—
Pokeweed (*Phytolacca americana*) poison	—	—	—	—	—	—	—	—	1	—
Alcaloid - solanine	—	—	—	—	—	—	—	—	—	1
ANIMAL										
Paralytic shellfish poison	—	1	—	43	—	NA	—	—	2	—
Scombroid	—	—	—	—	—	—	—	—	1	—
Suspect insect	—	—	—	—	—	—	—	—	1	—
CHEMICAL										
Metal	1	2	4	4	NA	2	NA	2	1	—
Caustic wash	1	1	3	7	NA	NA	NA	NA	2	—
Pesticide	1	—	40	—	NA	—	NA	—	—	—
Extraneous matter	1	1	2	2	NA	NA	NA	NA	4	—
Rancidity	1	2	2	23	NA	3-20	NA	11.5	1	—
Other chemicals	1	3	2	27	NA	3-19	NA	5	2	1
Total chemical	6	9	53	63	2-40	2-20	2.5	3	10	1
Total known	82	81	2469	1706	2-600	2-325	6	7	49	21
Total unknown	628	306	4509	2577	2-900	2-175	3	3	79	35
TOTAL	710	387	6978	4283	2-900	2-350	3	3	128	56

[a]NA = not applicable.

TABLE 3. *Foods associated with foodborne incidents and cases.*

Food	Incidents[a]				Cases			
	Number		Percentage		Number		Percentage	
	1975	1974	1975	1974	1975	1974	1975	1974
Meat	269	117	32.1	26.4	1753	1020	24.7	23.5
beef	58	17	6.9	3.8	304	389	4.3	9.0
ham and pork	36	25	4.3	5.7	101	296	1.4	6.8
hamburger	66	20	7.9	4.5	207	64	2.9	1.5
sausages	55	31	6.6	7.0	192	108	2.7	2.5
other or unspecified	54	24	6.4	5.4	949	163	13.4	3.7
Fish	34	18	4.0	4.1	98	57	1.4	1.3
Shellfish	17	8	2.0	1.8	101	68	1.4	1.6
Poultry	72	42	8.6	9.5	1894	321	26.6	7.4
chicken	43	23	5.1	5.2	139	103	1.9	2.4
turkey	29	18	3.5	4.1	1755	214	24.7	4.9
other or unspecified	—	1	—	0.2	—	4	—	0.1
Eggs	1	2	0.1	0.5	20	4	0.3	0.1
Dairy foods	19	17	2.3	3.8	226	95	3.2	2.2
ice cream	5	6	0.6	1.4	62	12	0.9	0.3
cheese	2	5	0.3	1.1	4	12	0.1	0.3
milk and other products	12	6	1.4	1.4	160	71	2.2	1.6
Bakery products	60	24	7.2	5.4	196	92	2.8	2.1
cakes and bread	17	9	2.1	2.0	90	39	1.3	0.9
pizzas	26	7	3.1	1.6	73	21	1.0	0.5
pies, puddings, and pasta products	12	5	1.4	1.1	21	26	0.3	0.6
other baked products	5	3	0.6	0.7	12	6	0.2	0.1
Confectionery	11	11	1.3	2.5	22	121	0.3	2.8
Vegetables and fruits	60	51	7.2	11.5	215	281	3.0	6.5
raw vegetables and fruits	5	5	0.6	1.1	7	24	0.1	0.6
processed low acid vegetables	14	18	1.7	4.1	57	56	0.8	1.3
processed acid vegetables and fruits	19	11	2.3	2.5	56	67	0.8	1.5
other vegetables and fruits	22	17	2.6	3.8	95	134	1.3	3.1
Chinese foods	38	19	4.5	4.3	125	62	1.8	1.4
Salads	26	13	3.1	2.9	140	111	2.0	2.6
Sandwiches	31	25	3.7	5.6	269	370	3.8	8.5
Beverages	25	9	3.0	2.0	53	25	0.7	0.6
Multiple vehicles	11	11	1.3	2.5	338	196	4.7	4.5
Other foods	23	11	2.8	2.5	147	210	2.1	4.8
Unknown	141	65	16.8	14.7	1509	1306	21.2	30.1
TOTAL	838	443	100.0	100.0	7106	4339	100.0	100.0

[a]All incidents, whether associated with a specific agent or not.

TABLE 4. *Places where food was mishandled in foodborne incidents in 1975 and 1974.*

Establishment	Number of incidents		Percentage of incidents		Number of cases		Percentage of cases	
	1975	1974	1975	1974	1975	1974	1975	1974
Foodservice establishments	211	128	25.2	28.8	2860	2741	40.3	63.1
hotels, restaurants	122	64	14.6	14.4	1111	625	15.6	14.4
fast food facilities	38	10	4.5	2.2	102	29	1.4	0.7
catering companies	22	21	2.6	4.7	1192	1243	16.8	28.6
others	29	33	3.5	7.5	455	844	6.5	19.4
Homes	168	62	20.0	14.0	1442	338	20.3	7.8
Food-processing establishments	45	38	5.4	8.6	79	194	1.1	4.5
Retail food establishments	37	15	4.4	3.4	271	61	3.8	1.4
Other	5	9	0.5	2.1	152	137	2.1	3.2
Unknown	372	191	44.4	43.1	2302	868	32.4	20.0
TOTAL	838	443	100.0	100.0	7106	4339	100.0	100.0

Although there was some similarity in the monthly occurrence of incidents of 1974 (*4*) and 1975, the actual peak in the former year was in October whereas in the latter year it was in June and July. The regional distribution of the incidents is somewhat similar for the two years (Table 6). Most occurred in Ontario and British Columbia with the former accounting for 62.3% of all incidents, an increase of nearly 20% over the previous year. Although total numbers of incidents were up in most other provinces, the percentages were down slightly from 1974. Northwest Territories, Ontario and British Columbia ranked first, second, and third in the number of incidents per 100,000 population. The most noticeable difference between 1975 and 1974 was the dramatic increase in the number of incidents from Ontario. This probably reflects a greater interest in reporting rather than an actual rise in the number of foodborne illnesses occurring in that province.

TABLE 5. *Incidents of foodborne illness caused by mishandling of food in food-processing establishments in 1975.*

Etiology	Vehicle	Number of Incidents	Cases
Salmonella infantis	salami	1	3
Staphylococcus aureus	dehydrated soups	1	6
Staphylococcus aureus	frankfurters	1	1
Penicillium sp	candy	1	1
Geotrichum sp	yoghurt	1	1
Mold	bottled soft drink	2	2
Mold	apricot baby food	1	1
Yeast	chocolate cake	1	2
Yeast	bottled beer	1	2
Mold and yeast	bottled soft drink	1	2
Phytolacca americana	poke-root tea	1	1
Lactarius or *Russula* sp	dried mushrooms	1	1
Scombroid poisoning	canned tuna	1	1
Tin	canned tomato products	2	5
Caustic wash	bottled beer	2	2
Grease and oil	canned soft drink	3	4
Glass fragments and other extraneous matter	bottled soft drink	2	2
Rancidity	corn chips	1	2
Rancidity	licorice	1	1
Varsol	milk	1	1
Citric acid	bottled soft drink	1	2
Probably bacterial	meat products	3	4
Probably bacterial	baby food	2	2
Probably bacterial	canned mushrooms	1	1
Probably bacterial	canned apple juice	1	7
Probably bacterial	soft drink	1	3
Probably bacterial	potatoes	1	1
Probably mold	canned grapefruit juice	1	1
Probably yeast	bottled soft drink	2	3
Probably tin	canned grapefruit juice	1	1
Probably chemical	bakery products	2	4
Probably extraneous matter	bottled soft drink	1	2
Unknown	canned corn	1	2
Unknown	veal and pork loaf	1	5
TOTAL		45	79

EXAMPLES OF OUTBREAKS

The following are examples of unpublished foodborne disease incidents which occurred in 1975 in Canada. Not all of the examples chosen were necessarily the best documented. Some were chosen because they represent typical recurring problems, others because they represent less common situations with which investigators may be less familiar. Some illustrate the problems of incomplete epidemiological or laboratory analyses and why so few incidents reported are of known etiology.

Clostridium perfringens poisoning in school children

In April, 30 grade six students and four adults went on an overnight field trip in British Columbia. The day before the trip six of the mothers individually prepared batches of hamburger stew and refrigerated these overnight. The next day these were transported unrefrigerated in two large pots to the camp site. The stew was brought to a boil at 12:30 pm and allowed to "simmer" until served at 5:30 pm. Seven to 12 h later 28 students and two adults suffered from diarrhea and abdominal cramps. Most of the ill persons had recovered by the next afternoon. Food-specific attack rates indicated that the vehicle was the hamburger stew. Although remnants of the stew looked and smelled normal they contained 3.0×10^7 *C. perfringens*/g. Probably the "simmering" was sufficiently cool to allow the growth of the pathogen. The organism was isolated from stool specimens of two children and one adult. This outbreak is typical of those involving *C. perfringens* — cooking of large volumes of meat in a stew, which allows slow heating and cooling to take place plus development of anaerobic conditions, and subsequent serving after keeping warm for a long period of time.

Shigellosis after a New Year's party

About 100 persons attended a New Year's party held in a community hall in rural British Columbia. A local caterer prepared the food which was served as a cold buffet at 12:10 am, January 1. The food, consisting of turkey, stuffing, ham, beef, potato salad and various other salad items, and french pastries, was prepared the day before. Alcoholic beverages were also available. It

TABLE 6. *Regional distribution of foodborne incidents in 1975 and 1974.*

Province or Territory	Number of incidents		Percentage of incidents		Number per 100,000 population[a]	
	1975	1974	1975	1974	1975	1974
British Columbia	125	116	14.9	26.2	4.7	4.8
Alberta	29	18	3.4	4.7	1.6	1.1
Saskatchewan	20	19	2.4	4.3	2.2	2.1
Manitoba	26	16	3.1	3.6	2.6	1.6
Ontario	522	188	62.3	42.4	6.6	2.3
Quebec	73	49	8.7	11.1	1.2	0.8
New Brunswick	5	10	0.6	2.3	0.7	1.5
Nova Scotia	20	11	2.4	2.5	2.4	1.4
Prince Edward Island	4	5	0.5	1.1	3.4	4.3
Newfoundland	10	6	1.2	1.4	1.8	1.1
Northwest Territories	4	2	0.5	0.4	10.6	5.3
Yukon	—	—	—	—	—	—
More than one province or territory or other[c]	—	3	—	0.6	—	NA[b]
CANADA	838	443	100.0	100.0	3.1	2.0

[a]Based on 1975 and 1974 estimates by the Census Division, Statistics Canada.
[b]NA: Not applicable.
[c]Other: Canadian Forces plane abroad.

was not until January 6 that reports of illness and hospitalization were received, and several days later that all the available information was collected. Of 92 persons who ate the food, 69 reported some illness. Incubation periods varied between 15 and 144 h, with a mean of 49.5 h. Diarrhea (sometimes bloody), cramps, fever, nausea and vomiting were the main symptoms. *S. sonnei* was isolated from 27 of 30 stool specimens submitted for analysis. Each strain showed the same antibiotic sensitivity and colicin patterns. Food-specific attack rates showed that potato salad was the food most likely to have caused the illness, but only turkey and meat samples were available for laboratory analysis; these were negative. Several of the food handlers excreted the *Shigella* after the party and two lived in an area where there had been five *Shigella* cases just before the party. In fact, the daughter of one of these two handlers had suffered from similar symptoms during the 8 days immediately preceeding the event; unfortunately, no stool examination was made. Both food handlers had prepared the potato salad at 4 pm on December 31 and then left it at room temperature until eaten, over 8 h later. The delay in the investigation made collecting facts difficult, but there is no doubt that a *S. sonnei* outbreak occurred with potato salad as its probable vehicle. This food has been previously implicated in *Shigella* outbreaks. This incident, not only illustrates the dangers of leaving potentially hazardous food at room temperature for long periods, but also points out that celebrations are frequently occasions for abuse of foods. Public health personnel have to be particularly alert during times of such celebrations.

Staphylococcal intoxication from freeze-dried soups

In February, several medical and para-medical personnel were participating in a survival course in northern Ontario. A part of this course was to spend two days and a night on snow at temperatures well below 0 C. Apart from warm clothing the only facilities available to them were a plastic bag as shelter, a metal container, knife, matches, candle, etc., and food in the form of small packages of dehydrated soups, tea and honey. Three varieties of soups were available in 5-g packages — beef, vegetable and chicken. To use the soup or tea a fire had to be made, snow melted in the container and boiled with the ingredients. At varying times from a few hours until the end of the period outdoors a total of six persons out of 16 complained of illness. The main symptoms were nausea, vomiting and headache occurring ¼- 15 h after eating (median incubation period 3½ h). Six of the 16 ate other foods, either smuggled-in sandwiches, chocolate bars or soups, or prepared from the surrounding vegetation, e.g., Labrador tea; only one of these was ill. From food-specific attack rate analysis no single food seemed to be associated with the illness. Yet when vegetable and/or chicken soups were grouped together the association was significant. This may be partly explained by the fact that some people did not remember exactly what soups they had eaten and when. All the foods in samples of the survival packs, and the remainder of the packs actually used were analyzed microbiologically; no significant numbers of viable microorganisms were found. Samples of the soups were then analyzed for staphylococcal enterotoxin; 130-137 ng/g of enterotoxin A was found in chicken soup, and 232 ng/g enterotoxin C in the vegetable soup, 123 ng/g in the chicken soup and 47 ng/g in the beef soup. Although these amounts are slightly less than those normally recognized as causing illness, it is possible that under the conditions of exposure experienced these low levels of toxin can produce symptoms in some people. Since the soups were imported it was not possible to find out how they became contaminated although very likely this occurred before dehydration. The manufacture of these soups had ceased before the outbreak.

Scombroid poisoning from canned tuna

Early one morning in December an Ontario woman prepared a sandwich consisting of canned Cuban tuna fish, butter, mayonnaise, salt, pepper and bread. She took the sandwich to work and placed it on a cold and shaded window ledge. It was cold when eaten at 11:30 am. Only a quarter of the sandwich was consumed. The taste was obnoxious — it was metallic in nature and burned the mouth. Someone else in the office had a bite and described the taste as vinegar-like. The woman felt a strange sensation while eating, and she developed nausea, gas and a full stomach feeling. An hour afterwards she was a little better. However, later on that day she was still nauseated and had a severe headache all evening. She vomited about 10:00 p.m. and went to bed. The next morning, her condition was improved but still not back to normal. The remainder of the tuna fish was kept refrigerated until examined in the laboratory. The fish was found to be sterile; a direct smear revealed no organisms. A sample of the tuna was extracted for possible future histamine analysis and kept frozen. This sample was analyzed in April 1976, when a procedure for detection of histamine was available. Approximately 124 mg of histamine/100 g was detected. When the same sample was analyzed 18 days later the level had dropped to 80 mg/100 g. Because of the ease with which histamine denatures (for instance during freezing and thawing) it is probable that if the extract had been analyzed soon after preparation the level would have been greater than 124 mg/100 g. Scombroid poisoning occurs after consumption of scombroid fish (tuna, mackerel, skipjack, etc.) which contain histamine or histamine-like substances. It seems probable that, during storage at warm temperatures, certain bacteria (probably mainly *Proteus* sp.) break down the histidine in the flesh to histamine and other related compounds, considered to be the agents in scombroid poisoning. Since these are heat stable they could be present in canned tuna. The level of histamine associated with illness is >60 mg/100 g of fish, and therefore the level found in the imported can was sufficient to cause the illness. Not all of the symptoms typical of scombroid

poisoning occurred, however; missing were burning throat, flushing, itchiness of the skin and epigastric pain. Based on the symptoms given the condition could have been misdiagnosed, say, as a staphylococcal enterotoxemia. The fact that not all typical symptoms may be apparent and the facilities for histamine analysis are not routinely available may mean that scombroid poisoning is under-reported.

Foodborne illness at a church bazaar

A bazaar had been held annually in late summer on a small coastal community in New Brunswick for a number of years. However, in 1975 it was no longer possible for food to be prepared in the kitchen of the local hospital. For that year meals were prepared in advance in different homes and in the basement of the parish church. Considerable quantities of food were involved as 1,200 meals were served in one day. Beef, ham, turkey, dressing, potato salad, cole slaw, milk and a variety of sweet baked goods were consumed. One person felt sick 1 ½ h after eating and was hospitalized that evening. Others also reported gastrointestinal symptoms, and in all 58 persons complained of acute illness with nausea, vomiting, cramps and diarrhea, mainly between 3½ and 5 h after eating. Twelve were hospitalized from one to five days and 21 were treated as outpatients in the local hospital. The 58 victims were discovered through a telephone survey of 133 persons attending the bazaar; the actual number suffering food poisoning was probably much greater, since 1,200 meals were served. It seemed that a number of patients complained about the taste of the turkey. The beef and turkey were prepared in different homes and stored in a cold room in the church basement, along with the potato salad. There seemed much opportunity for bacterial growth, as time/temperature abuse of the food occurred. The turkey had the most opportunity for contamination and growth. Fourteen turkeys were cooked in different homes on a Thursday afternoon, kept at room temperature until Friday afternoon, when they were sliced, and then stored in the church cold room (15 C) until Sunday. Meals were served from 3:00 to 9:00 pm with food lying on the tables outside. Even though the onset of the disease was rapid, by the time the provincial Department of Health had been notified all the food had been eaten or discarded. In addition, stool and vomitus specimens from the victims were accidentally discarded at the laboratory before analysis was carried out. Also, unfortunately, the food handlers were not interviewed properly or specimens taken. One food handler, however, indicated that about half the turkeys had "gone bad", and parts that appeared good were served and the obviously-spoiled portions thrown away. As a result, the cause of the illness was not determined, although it appeared to be bacterial (possibly staphylococcal) in nature.

The regional District Medical Health Officer recommended that, in the future, all church groups should be asked to cooperate with local health authorities when catered events are planned. An intensive educational program for prevention of foodborne diseases was given priority by the provincial Health Department, and, hopefully, the chance of a similar outbreak occurring again will be reduced.

ACKNOWLEDGMENTS

Federal Agencies: (*a*) Laboratory Centre for Disease Control and Field Operations Directorate, Health Protection Branch, Health and Welfare Canada, (*b*) Medical Services Branch, Health and Welfare Canada.

Provincial Agencies: (*a*) British Columbia Department of Health Services and Hospital Insurance, (*b*) Alberta Department of Health and Social Development, (*c*) Saskatchewan Department of Public Health, (*d*) Manitoba Department of Health and Social Development, (*e*) Ontario Ministry of Health, (*f*) Ministère des Affaires Sociales du Québec, (*g*) New Brunswick Department of Health, (*h*) Prince Edward Island Department of Health, (*i*) Nova Scotia Department of Public Health, and (*j*) Newfoundland Department of Health.

Local Health Agencies: (*a*) *Alberta*: Alberta East Central Health Unit; Athabasca Health Unit; Banff National Park Health Unit; Barons-Eureka Health Unit; Big Country Health Unit; Chief Mountain Health Unit; Chinook Health Unit; City of Calgary Health District; City of Edmonton Health Department; Drumheller Health Unit; Edson Health Unit; Foothills Health Unit; Fort McMurray and District Health Unit; Grande Prairie Health Unit; High Level-Fort Vermilion Health Unit; Jasper National Park Health Unit; Leduc-Strathcona Health Unit; City of Lethbridge Health Unit; Medicine Hat Health Unit; Minburn-Vermilion Health Unit; Mount View Health Unit; North Eastern Alberta Health Unit; Peace River Health Unit; Red Deer Health Unit; Stony Plain-Lac Ste. Anne Health Unit; Sturgeon Health Unit; Vegreville Health Unit; County of Warner Health Unit; Wetoka Health Unit. (*b*) *Ontario*: Algoma Health Unit, Brant County Health Unit; Bruce County Health Unit; Durham Region Health Unit; East York Borough Health Unit; Elgin-St. Thomas Health Unit; Etobicoke Borough Health Department, Grey-Owen Sound County Health Unit; Haldimand-Norfolk Health Unit; Haliburton-Kawartha-Pine Ridge District Health Unit; Halton County Health Unit; Hamilton Wentworth Health Unit; Hastings and Prince Edward Counties Health Unit; Huron County Health Unit; Kent-Chatham Health Unit; Kingston-Frontenac and Lennox and Addington Health Unit; Lambton Health Unit; Leeds, Grenville, and Lanark District Health Unit; Middlesex-London District Health Unit; Muskoka-Parry Sound Health Unit; Niagara Regional Area Health Unit; North Bay and District Health Unit; Northwestern Health Unit; North York Borough Health Department; Ottawa-Carleton Regional Area Health Unit; Oxford Health Unit; Peel County Health Unit; Perth District Health Unit; Peterborough County-City Health Unit; Porcupine Health Unit, Renfrew County and District Health Unit; St. Lawrence and Ottawa Valley Health Unit; Scarborough Borough Health Department; Simcoe County District Health Unit; Sudbury and District Health Unit; Thunder Bay District Health Unit; Timiskaming Health Unit; Toronto City Health Department; Waterloo Regional Health Unit; Wellington-Dufferin-Guelph Health Unit; Metro Windsor-Essex County Health Unit; York Borough Health Department; and York Regional Health Unit. (*c*) Québec: Montréal Urban Community.

I acknowledge the following agencies for allowing me to summarize unpublished data as examples of outbreaks: (*a*) British Columbia - South Central Health Unit and Provincial Laboratories; (*b*) British Columbia - East Kootenay Health Unit (Mr. W. E. Rogers and Mrs. J. McLaughlin) and Provincial Laboratories; (*c*) Federal - Food Directorate; (*d*) Federal - Food Directorate and Field Operations Directorate, Ontario Region; (*e*) New Brunswick - Health Region 5 and Communicable Disease Control.

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Journal of Food Protection Vol. 41 No. 11, Pages 919-925 (November 1978)

Egg Washing - A Review

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(Received for publication May 15, 1978)

ABSTRACT

Cleaning eggs by washing was in the past widely condemned but is now a common practice and required in plants operating under Federal Grading Service. Washing commonly resulted in increased spoilage losses during long term storage. Washing practices that promoted spoilage included using: (*a*) wash water colder than the eggs, (*b*) wash water with high bacterial counts, (*c*) wash water containing appreciable soluble iron, and (*d*) washing machines with surfaces contaminated by bacteria. Occasionally spoilage losses were substantial during long term storage even though apparently satisfactory washing practices were followed. Treatment with sanitizing chemicals did not destroy bacteria embedded in shells. Long term storage life is of little concern with present day marketing practices since few eggs are stored for extended periods. However, iron in washwater may accelerate spoilage. Washing, besides improving appearance of eggs, was effective in removing surface dirt and bacteria which would otherwise have contaminated egg meats when eggs were broken out.

Cleaning eggs by washing was at one time widely condemned. At the present time almost all market eggs are washed before distribution in this country, and washing is required in egg processing plants operating under Federal Grading Service (*85*). Washing obviously improves the appearance of eggs and thereby improves consumer acceptability. Dirty eggs have historically been downgraded and appropriately so, since it is well established that bacteria and dirt on shell surfaces are major sources for contamination of egg meats when eggs are broken out (*51,65,78,91,92*). Thorough egg washing is therefore particularly important in commercial egg-breaking operations. Even visibly clean eggs may harbor considerable numbers of bacteria on shell surfaces (*7, 51*).

Objections to washing as a means of cleaning eggs have been based on observations that washing greatly increased spoilage. Thus Jenkins and Pennington (*47*) concluded that a large proportion of eggs which went bad during cold storage had had wet shells at some time either from washing or some other cause and stated "Attempts, therefore, to improve the appearance of dirty eggs by washing is a practice which cannot be too strongly condemned." Jenkins et al. (*48*) found large increases in spoilage of experimentally washed eggs wiped with a damp cloth, washed in water, or washed in water and rinsed in dilute sulfuric acid. Grzimek (*39*) reported that both dry-cleaned and uncleaned dirty control eggs kept well and concluded that storage losses resulted from washing. Zurek (*93*) found considerable spoilage in washed, dry-cleaned, and uncleaned dirty eggs but not in clean eggs held as control. Haines (*41*) found that eggs washed under sanitary conditions did not show an increase in spoilage but were more susceptible to penetration by bacteria when placed in a bacterial suspension after washing. Fromm (*25*) found that washing increased the permeability of egg shells.

A report by the Egg Producers Council and the Council for Scientific Research of New South Wales (*17*) concluded that bacterial rotting of eggs was almost entirely due to washing. They also observed that machine-washing resulted in heavier losses than washing by hand. Sayers (*74*) and Gillespie et al. (*34*) also found that machine-washing resulted in heavy losses from rots and emphasized the need for efficient decontamination of machine surfaces which contact the eggs. Australian regulations at that time (1950) banned export of washed eggs because of excessive spoilage losses (*34*). Cotterill and Hartman (*14*) also found a higher incidence of rots in machine-washed than in hand-washed eggs.

Gillespie et al. (*32*) found mean losses from rots in unwashed eggs of 1.06% with a variation of 0 - 15.8% for different lots of eggs. Little difference between clean and dirty eggs was noted. Losses of eggs washed by hand ranged from 0.0 - 28.4% with a mean of 2.71%. Reasons for heavy losses in a few lots washed by identical procedures were not evident but may have been related to the types of bacteria in the washing fluid. Kahlenberg et al. (*49*) found that spoilage losses after 6 months of commercial storage ranged from 1.35% (unwashed clean) and 3.85% (unwashed dirty) to as high as 49% for machine-washed eggs in one commercial plant using cold tap water. Davidson et al. (*15*) observed a higher incidence of sours in farm-washed than in unwashed eggs

after 6-7 months of commercial storage. Sours showed up in only one lot of seven tested after 3 months of commercial storage. Sours were not readily detected by candling.

Lorenz and Starr (*53*) and Starr et al. (*80*) found that washing usually increased spoilage of both clean and dirty eggs. Lorenz et al. (*54*) observed large differences in the keeping quality of ranch-washed eggs where some ranches consistently had no spoilage in washed eggs and others had up to 33% rots.

Trussell et al. (*83*) also found large differences in spoilage among eggs from 94 farms examined. Rates of spoilage were higher for washed (0 - 25.8% with a mean of 4.6%) than for dry-cleaned (0 - 4.6% with a mean of 1.34%) eggs. Spoilage was higher for mechanically-washed than for hand-washed eggs. It again was not clear why some farms had a lower incidence of spoilage than others using the same type of cleaning. In a further study of mechanical washing by Trussell et al. (*84*), washed eggs from 15 farms showed average spoilage of 7.44%, with a range of 0.0-19.8%. After special instructions as to cleanup of machines and use of washwater at 130-135 F, spoilage averaged 6.06%, with a range of 0.0 to 22.6%, not significantly different from before. The operation reporting no spoilage used "bleach", presumably sodium hypochlorite, as the cleaning agent.

Pino (*66*) washed lots of 100 clean and soiled eggs by the "Rutgers method" in anionic detergent sanitizer, Nacconal NR, and found no spoilage in washed eggs after 4 weeks at 60 F. Winter et al. (*90*) found the keeping quality of eggs washed in water or detergent was poorer than that of unwashed clean or dirty controls. Keeping quality of eggs washed in detergent-sanitizer [quaternary ammonium (QAC) sanitizers] was better than that of eggs washed in water or plain detergents but no better than that of unwashed dirty eggs.

Miller (*58*) found that the percentage of eggs containing spoilage bacteria was higher in washed dirty eggs than in unwashed, regardless of the washing and sanitizing treatment used. He also found a considerable number of eggs containing cocci. About one-fourth of eggs containing cocci contained *Streptococcus faecalis* at 5,000,000-60,000,000/ml. Remaining cocci were mostly micrococci at levels of less than 1,000,000/ml.

Conner et al. (*13*) found only two cases of molds and one of rot in 7000 eggs stored 9 months at 30 ± 1 F after various washing treatments. The low storage temperature apparently prevented multiplication of bacteria in the eggs. Bigbee et al. (*3*) washed eggs in a detergent sanitizer and oil-in-water emulsions containing sanitizers. They noted no increase in percentage of eggs containing bacteria over that in the controls (9.09%) and also no spoilage after 6 weeks at 35 F.

Brant et al. (*11*) described an experimental cleaner which was reported to clean eggs more effectively with less damage than commercial washers. Spoilage losses after 8 weeks at 50 F were 0.1% for unwashed controls and 0.4% for eggs washed with the experimental cleaner. For commercially washed eggs after 8 weeks at 50 F, average spoilage was 1.8% for unwashed controls, 5.9% for washed dirties and 2.7% for washed clean eggs. The experimental cleaner used an acid cleaning formulation, and wash water was not recirculated.

EFFECT OF WASHWATER TEMPERATURE

Haines and Moran (*24*) appear to have been the first to observe that when eggs are placed in a bacterial suspension cooler than the eggs, a pressure gradient is set up which draws bacteria through the shell into the interior. These findings have been confirmed by numerous other investigators including Pritsker (*67*), Stuart and McNally (*82*), Funk (*27*), Lorenz and Starr (*53*), Starr et al. (*80*), Forsythe et al. (*23*), and Brant and Starr (*10*).

Brant and Starr (*10*) investigated the effect of temperature, time of exposure and bacterial concentration on infection of eggs dipped in suspensions of *Pseudomonas polycolor*. The rate of infection was higher when the bacterial suspension was cooler than the eggs and fell off rapidly as the temperature of the bacterial suspension was increased above that of the eggs. However, at high bacterial concentrations, appreciable infection occurred even when the bacterial suspension was warmer than the eggs. The time of exposure only slightly affected the incidence of infection.

EFFECT OF SANITIZERS

Sayers (*74*) found that disinfectant dips after machine-cleaning of eggs were ineffective in reducing spoilage. He found, however, that any method of disinfecting the machines themselves reduced spoilage associated with machine cleaning. Data reported by Funk (*27*) in 1948 covering experiments carried out over 10 years are quite variable but frequently show heavy spoilage losses of eggs washed in water at a temperature lower than the eggs. Washing soiled eggs in sanitizing solutions (Roccal, Kleeneg, Klenzade or 1% lye) seemed to give spoilage rates comparative to those of unwashed dirty controls but higher than those of naturally clean eggs.

Penniston and Hedrick (*65*), working with artificially dirtied eggs, found that counts in the broken-out egg meat were substantially lower in eggs washed with sanitizers (chlorine or Emulsept) than with plain water. Gillespie et al. (*36*) found that sodium hypochlorite at levels up to 5,000 ppm in egg washing machines reduced surface counts on eggs and was, at high levels, effective in reducing spoilage below that when a water wash was used. Spoilage was still higher than in unwashed controls. A QAC sanitizer (Fixanol) was similarly effective but its effectiveness fell off with continued use, suggesting that bacteria may become adapted to it.

Miller et al. (*57*) found that rinsing eggs in sanitizers following washing in water containing black rot organisms was ineffective in preventing spoilage. Adding Roccal to washwater containing black rot largely

destroyed bacteria present and prevented occurrence of black-rots in washed eggs.

Miller (*58*) found that rinsing eggs in a Roccal solution or 1% sodium hydroxide did not reduce the incidence of spoilage of washed eggs as compared to a water rinse alone. Forsythe et al. (*23*) found that washing either in a household detergent (Vel) or a quaternary ammonium sanitizer (Roccal) was effective in reducing surface counts (rinse method) to low levels.

Miller (*60*) found that the percentage of eggs containing gram-negative spoilage organisms after long-term storage was higher when eggs were washed in water or a household detergent than when washed in a detergent-sanitizer or an industrial-type detergent containing sodium silicate and alkyl aryl sulfonate.

Bierer et al. (*1*) evaluated the efficiency of a number of commercial egg cleaning formulations in removing *Salmonella typhimurium* from artificially contaminated eggs. Commercial egg-cleaning formulations containing QAC sanitizers were 52 - 92% efficient, which was comparable to commercial bleaches at 200 ppm chlorine. In further studies (*2*) with egg-cleaning formulations and individual chemicals, QAC formulations were judged to be relatively ineffective and zinc sulfate and sodium hydroxide were the most effective.

Rizk et al. (*68*) working with eggs artifically contaminated with *Salmonella* found that a number of QAC and chlorine sanitizers were effective in removing *Salmonella* from the surface (swab method) but that none were effective against *Salmonella* which had penetrated deeply into the shell (blending). In contrast to the results of Bierer et al. (*2*), zinc sulfate did not prove as effective as either QAC or chlorine sanitizers against surface bacteria.

Sauter et al. (*71*) found that keeping quality of nest-run eggs washed in a non-sanitizing detergent (Tide) was improved if they were dipped in an iodine (Heliogen) solution after washing. When a detergent containing QAC sanitizer was used, results were less clear cut. When eggs artificially inoculated with pseudomonads were washed with various sanitizing agents, spoilage was reduced but was still substantial. In a further study (*72*), washing 3 min in dilute (0.65%) sodium hydroxide eliminated spoilage from eggs artificially inoculated with pseudomonads.

Frank and Wright (*24*), Gordon et al. (*38*), Lancaster et al. (*52*) and Williams and Dillard (*89*) also found that salmonellae already embedded in the shells were not destroyed by dips in various sanitizing chemicals.

Dipping eggs in antibiotics after washing was also found to be ineffective in reducing rots (*14, 59, 75*). Elliott and Romoser (*19*) concluded that antibiotics are bound by proteins in the shell, masking their activity.

In contrast to results with sanitizing chemicals, dipping in hot water (60 C or above) for a few minutes [the "thermostabilization" procedure of Funk (*27*)] has proven consistently effective in controlling rots (*20, 37, 50, 70, 72, 75, 76*). Schmidt and Stadelman (*75*) found that this procedure stabilized the albumen during storage. The heat treatment procedure does not seem to have been applied commercially, however.

Mountney and Day (*63*) found that chlorine or QAC sanitizers controlled buildup of microbial contamination in washwater under commercial conditions. They found, however, that microorganisms isolated from the wash-water containing the QAC cleaning compounds were predominately gram-negative rods of types known to cause spoilage. Soprey and Maxcy (*79*) demonstrated that *Pseudomonas fluorescens* and *Escherichia coli* can adapt to QAC sanitizers. Gillespie et al. (*36*) also observed that a QAC lost its effectiveness with continued use. Chlorine sanitizers were found to rapidly lose their effectiveness as successive batches of eggs were washed (*65*). QAC sanitizers were less rapidly inactivated (*9, 65*), and were recommended by Rizk et al. (*68*) for this reason.

In summary, eggs washed with some type of sanitizing chemical in the washwater invariably kept better than eggs washed in water. Sanitizing rinses after washing or washing in sanitizers after contamination of eggs with bacteria was undependable in reducing spoilage or contamination by *Salmonella*. Apparently bacteria which have penetrated deeply into the pores of shells are protected from the action of sanitizing chemicals. Reports on the effectiveness of various sanitizers are conflicting.

EFFECT OF WASHING ON NUMBERS OF BACTERIA ON SHELLS

Bacteria numbers on egg shells have been determined by methods involving surface rinses (*23, 34, 69*), shaking the crushed evacuated shell with glass beads (*41*), blending the shell after removing the contents (*7, 11, 55, 90*), both swabbing the surface and blending (*68*), washing the surface in water (*13*), both rinse and blending (*65*), and rubbing the egg in a plastic bag containing buffered saline (*32*). Gunaratne and Spencer (*40*) found substantially higher counts by blending than by surface rinse from eggs artificially contaminated with pseudomonads. Penniston and Hedrick (*65*) found bacteria counts by rinse and blending methods were comparable when they analyzed artificially dirtied eggs washed in water, but after washing in Emulsept or chlorine, counts were 3-6 times higher by blending than the rinse method. Relative numbers found by rinsing or swabbing the surface versus blending the entire shell thus depend on whether bacteria are on the surface or embedded in the shell. Surface bacteria which are removed by rinse procedures are likely to contaminate the egg meat when the egg is broken out. Bacteria embedded in the pores are unlikely to contaminate the product during breaking but may penetrate to the interior and cause spoilage.

Penniston and Hedrick (*65*) found that, although washing eggs with plain water removed visible dirt, from three to six million organisms per egg were still present on the shell surfaces. In a further study using artificially

dirtied eggs, they found that bacterial counts in broken out egg meats averaged 1,500,000/egg for eggs washed in water and less than 3000/egg for eggs washed in chlorine or Emulsept. Forsythe et al. (*23*) reduced surface bacterial counts more than 90% (rinse method) by washing in either a detergent (Vel) or a QAC (Roccal).

Gillespie et al. (*34*) found that surface counts (rinse) were usually lower after eggs had been washed in water although large increases in spoilage were noted. Washing in hypochlorite or a QAC (Fixanol) effectively reduced surface counts (*36*). Reduction in surface counts was not necessarily related to a reduction in rots.

Conner et al. (*13*) found surface counts (rinse with brushing) of dirty eggs were reduced from 3,500,000/shell to 83,000/shell by machine washing and 16,000/shell by washing in cold water. Winter et al. (*90*) found higher bacterial counts (blending) on shells of dirty eggs washed in either cold or warm water than on the shells of unwashed eggs. They also found that shell counts were markedly reduced when eggs were washed in a detergent-sanitizer (AFCO 2626) containing a QAC sanitizer (Hyamine 2839). However, spoilage of eggs washed in a variety of detergent-sanitizers was as high as or higher than that of the unwashed controls.

Kraft et al. (*51*) found that 14% of dirty eggs had bacterial counts of greater than 10 billion/shell before washing while none had counts greater than 10 billion per shell after washing although 50% had counts in the range 100 million - 10 billion. The method of washing and of determining shell counts was not given.

Brant et al. (*11*) and March (*55*) found higher bacterial counts (blending) on the shells of commercially washed eggs after washing that before.

EFFECT OF IRON

Garibaldi (*28*) concluded that conalbumin, an iron-binding protein, was the principle barrier to growth of gram-negative organisms in eggs. Garibaldi and Bayne (*29*) found that ferrous sulfate greatly accelerated *Pseudomonas* spoilage of artificially inoculated eggs. Similar results were found with other gram-negative organisms (*30*) and some types of potential spoilage organisms did not cause rots in the absence of iron. Increased spoilage was also found in farm-washed eggs where appreciable levels of iron were present in the washwaters and rapid development of spoilage occurred in some eggs washed in water containing iron (*31*). Hartung and Stadelman (*46*) found that the presence of iron facilitated penetration of shell membranes by *Pseudomonas*. Brant and Starr (*10*) found higher rates of spoilage of eggs dipped in bacterial suspensions when ferrous sulfate was present in the suspensions. Brant et al. (*11*) noted that spoilage of washed eggs was accelerated following dipping in dilute ferrous sulfate. Brooks (*12*) and Board et al. (*8*) observed that there was a lag in multiplication of organisms in contact with the shell membrane unless ferrous iron was present in the inoculum. Other workers have reported that in eggs contaminated under commercial conditions and held at 15 - 30 C, infection remains confined to the cell membranes for up to 14 days or longer (*4, 18, 26, 35, 61, 64, 81, 92*). More detailed discussions of the mechanisms of bacterial penetration and rotting of eggs are given by Board (*5, 6*).

CLEANING EFFICIENCY, INTERNAL QUALITY, AND BREAKAGE

Most reported studies of egg-washing deal with microbiological aspects. However, effective removal of visible dirt is also important. Botwright (*9*) found that many detergent-sanitizers marketed for egg-cleaning were ineffective and found that best results were obtained when a QAC sanitizer was combined with an alkaline detergent. Druckery (*16*) also obtained best results with alkaline detergent-sanitizers. Winter et al. (*90*) compared hand washing with washing using three types of machines. Hand washing and a brush machine washer cleaned eggs better than bubbler or spray washers. Presoaking and addition of a detergent to washwater also improved cleaning. Brant et al. (*11*) found that many commercial washers were ineffective in cleaning eggs and they and Walters et al. (*87*) described a new experimental machine which was reported to clean eggs more efficiently with less breakage than commercial machines then available.

Brant et al. (*11*) reported losses during commercial washing (cracked and broken) of 1.37 - 7.8%. Shupe et al. (*77*) reported that losses in the washing operations in five egg-grading plants ranged from 0.34 - 2.55% and found that 13% of the total breakage losses occurred in handling from the nest to the egg carton. Morris et al. (*62*) and Miller and Mellor (*56*) found, respectively, 2.13% and 6.7% of shell eggs entering egg-grading plants were damaged during washing. Much of the contents of broken eggs ends up in the washwater, creating a serious waste disposal problem (*43, 45*). Judging from the amount of egg solids in washwater, breakage losses are usually greater in egg-breaking than in egg-grading operations, perhaps reflecting the lower quality of eggs used for breaking.

Aside from bacteriological considerations, washing generally has been found to have little effect on the interior quality of eggs (*15, 87, 90*), although Forsythe et al. (*22*) found that slight off-flavors could sometimes be detected by a trained taste panel for a few days after washing. Kahlenberg et al. (*49*) found that loss of interior quality of washed eggs varied with the type of machine.

DISCUSSION

Most egg washers now use highly alkaline cleaning compounds based on sodium metasilicate, sodium carbonate, and/or trisodium phosphate, together with small amounts of other additives. Some also contain active chlorine or QAC sanitizers. The washwater is recirculated and becomes contaminated with egg solids, dirt and bacteria from the eggs (*45*). Some fresh water is added so that the cleaning compound is continually

diluted unless more is added at intervals. Most machines use a sanitizing rinse following washing. The sanitizer flows back into the washer. In many of the reported studies, egg washing was done by hand or in older type machines. In some instances, household detergents (Tide, Vel) were used and they are quite different from the alkaline cleaners now used commercially. Laboratory studies have generally not attempted to duplicate the buildup of organic material which occurs in commercial washers.

Much of the work reported on egg-washing has been in relation to keeping quality during long term storage. Factors which favor increases in rots have been clearly identified as: (*a*) washing in water colder than the eggs, (*b*) washing in water with high bacterial counts, (*c*) washing in water containing appreciable soluble iron, and (*d*) washing in machines with surfaces contaminated by bacteria.

The importance of washing eggs in water warmer than the eggs to reduce bacterial contamination is well established. Too great a temperature differential may, however, stress the eggs and cause an increase in cracks or checks (*88*). High bacterial loads in the washwater can lead to infection even if proper temperature differentials are maintained (*10*). The types of bacteria present are also important as most bacteria will not cause rots even if they penetrate the shell (*5,6,21,30*). In all experiments, some eggs did not develop rots or show evidence of internal contamination even when exposed to bacteria under conditions favoring penetration of the shell. The reasons for differences in resistance to penetration by bacteria are not clear although there is some evidence that eggs with thicker shells are more resistant (*55,73*).

Content of iron in the washwater appears to be of critical importance. The role of iron in accelerating development of rots has been clearly established. Garibaldi and Bayne (*31*) noted that some eggs washed in water containing iron developed sours in 2 to 3 weeks which is within the usual marketing period for fresh eggs. In the absence of iron, development of rots is likely to be so slow as to not be a problem if eggs are marketed promptly, particularly if eggs are kept refrigerated.

Available chlorine in the washwater will rapidly and quantitatively oxidize any ferrous iron present to ferric iron. This reaction is the basis of an analytical method for available chlorine. The ferric iron will precipitate as insoluble ferric hydroxide. The precipitated ferric hydroxide presumably is less available to bacteria than soluble ferrous iron. The possibility has not been investigated, however. Garibaldi and Bayne (*31*) did their experiments on the effect of iron in washwater in a machine using a chlorine-based washing compound. As the experimental eggs were not washed until after several cases were put through the washer, it is not known if any residual chlorine was present at that time.

A sanitizing rinse following washing is required in egg processing plants operating under Federal Grading Service (*85*). There is little documentation as to the value of such a rinse. It has been repeatedly found that washing or rinsing eggs in a sanitizing agent is relatively ineffective in improving storage life of eggs or removing *Salmonella* when the bacteria are deeply embedded in the shells before washing or rinsing. Washing eggs in a sanitizing agent (chlorine or quaternary ammonium) was found better than a water wash in reducing surface bacteria on eggs and in the egg meat when the eggs are broken out (*65*). However, Forsythe et al. (*23*) found that washing in a household detergent (Vel) was as effective as a QAC (Roccal) in reducing surface bacteria.

At the present time, few eggs are held in long term storage. Most which are not promptly marketed as fresh eggs are diverted to breaking operations. With these marketing practices, long-term storage life is of no concern.

However, if it is necessary for some reason to store shell eggs for extended periods, consideration should be given to the fact that substantial spoilage losses have been observed in some lots of commercially washed eggs held in long-term storage, even when apparently satisfactory washing practices were followed (*11, 84*). Keeping quality of nest-clean eggs, on the other hand, has been found to be consistently high with spoilage losses usually 1% or less. Keeping quality of unwashed dirty eggs was usually poorer than that of nest-clean eggs. Therefore, on the basis of presently available information, only nest-clean unwashed eggs can be recommended for long-term storage. Washing, if desired, should be deferred until shortly before ultimate use.

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Errata

Difference in Injury of Cells of *Vibrio parahaemolyticus* Produced by Heat and Cold Stresses in Liquid and Solid Menstrua [1]

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This paper appeared on pages 764-767 of Volume 41, number 10 (October, 1978) of the *Journal of Food Protection.* The title was incorrectly printed on the article. The correct title appears above.

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Journal of Food Protection Vol. 41 No. 11, Pages 926-927 (November 1978)

Presidential Address

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(Received for publication September 25, 1978)

Presidential Addresses traditionally speak in glowing terms of accomplishments made during an individual's term in office. I believe that "time" is the best measure of the individual's accomplishments. This organization has had many resourceful and imaginative presidents, but we remember more often the paving stones they've laid down, than we do the individual's personality. For example, H.L. Thomasson was an outstanding president, but even he will be remembered most for the things he accomplished: the setting up of an operating office, the creating of the position of Executive Secretary and developing of the Journal, to name a few. Thomasson put us on addressograph plates, quite an advance, but today we are on computer. The organization has had three name changes in the 24 years I've been a member. The Journal has changed format several times, printers several times and even had two or three name changes of its own.

We've seen the National Mastitis Council, the 3-A Standards and other committees being born; we've also seen some die. We witnessed creation of a "Procedures to Investigate Foodborne Illnesses." We now operate on a budget, have sustaining members and have set up a foundation. We've survived and grown in a move from Shelbyville, Indiana to Ames, Iowa. We've met in San Diego, Miami, Seattle, Sioux City, Toronto and a dozen cities in between. We will survive jointures, dual meetings, mergers and all the rest.

None of this has happened under a single president, but by a succession of presidents and executive boards, each standing on the shoulders of its predecessors.

It is your organization; it's what you make it; what you want it to be. You elect presidents because every successful organization must have a leader, someone in a position of responsibility and authority, but still it is you who determines policy. Don't neglect your responsibilities. Support your elected officers and keep your Affiliate Representatives informed.

AFFILIATES AND MEMBERSHIP

We now have 28 affiliates and are close to adding a 29th. I believe that every affiliate annual meeting this year had a representative of IAMFES present. I only wish I could have personally attended each and every one myself. Our membership is just under 2300, a level we reached last year. We need to work for a substantial increase in this coming year. Each of us represent a membership committee of one and if we only obtained one additional member each, you can see what it would do.

COOPERATION WITH NEHA

We have had committees working with NEHA since 1968 or earlier. These committees continue to investigate the possibilities of some form of jointure. Progress has been made in the past year and the two organizations will meet in Milwaukee in July of 1980. They will use separate hotels and meeting facilities but encourage a free exchange of participants between the various educational sessions. Some social activities or a dinner will be held jointly. The member response from this meeting will in a large sense, dictate any further actions. It is difficult to find geographic locations where both groups are strong enough to support and conduct an annual meeting.

Henry Atherton, Earl Wright and I have attended NEHA Annual Meetings in the past three years. NEHA officers have attended our meetings as often and we are pleased to have NEHA President Paul Taloff and Executive Secretary Larry Krone with us this year.

JOURNAL

The *Journal of Food Protection* continues to grow both in size and stature under the very capable direction of our Editor, Elmer Marth, the Editorial Board and the Journal Management Committee. We now have a new Associate Editor, Mrs. Janice Richards who began work in the Ames office July first of this year.

The Journal is recognized worldwide as one of the outstanding publications in its field and has done much to enhance the position of IAMFES. The effort to expand the variety of articles and papers published continues.

FINANCES

The organization is still in good financial condition. In the past 3 years we have been able to absorb increasing costs by using reserves. However, anticipated increases in costs of paper, printing and postage will necessitate some additional increase in income in the coming year.

COMMITTEES

Committee work continues to be the very heart and soul of our organization. Our committees have excellent leadership, clearly defined goals and active members. The annual reports and printed publications of these committees are an important part of the continuing education program of our organization and are used by many people throughout the dairy and food world.

OTHER ASSOCIATION AFFAIRS

As you know this 65th Annual Meeting of the International Association of Milk, Food and Environmental Sanitarians is dedicated to H. L. Thomasson who was welcomed home by our Lord at the beginning of this year. David Rogers left us also, but to return to his native California. As mentioned earlier, Jan Richards is now Assistant Editor of the Journal and assisting Earl Wright. Jan comes to us from the Dairy Council in Kansas City. We have also replaced one of the secretaries in the Ames office.

I want to welcome Harry Haverland, Head of the Training Division of UPHS-FDA in Cincinnati as the newly elected Secretary-Treasurer and a member of the Executive Board. Our Senior Vice President, H. E. Thompson is not with us here in Kansas City due to an unscheduled eye operation, but has been checking on us all from his hospital bed by phone.

FUTURE

Our future seems bright with promise, but we must all work to claim those promises. We need to insure the future of our organization by increasing our student memberships and encouraging young people in dairy, food and environmental fields to unite with us. We need to strengthen out affiliates and keep communication lines to the membership open. We will continue our fine relationship with the National Mastitis Council. We are discussing plans for a one-time joint meeting with the American Dairy Science Association, possibly in 1983. The food industry continues its rapid growth with ever increasing needs for just the services IAMFES can provide. Let us meet this challenge.

CONCLUSION

I want to thank you again for allowing me to serve as President of this great organization, but more than that, for the privilege of getting to know many of you. It has truly been a "once in a lifetime" experience for me. May God continue to bless IAMFES and each one of you.

IAMFES Executive Board: front row, left to right, H. Atherton, J. Richards, E. O. Wright, H. Haverland. Back row, left to right, R. March, H. Hutchings, D. Fry, W. Arledge, W. Kempa.

65th Annual Meeting of IAMFES

The 65th Annual Meeting of IAMFES was dedicated to the memory of "Red" H. L. Thomasson, former Executive Secretary and President of the Association.

It was widely agreed that the 1978 Annual Meeting of the International Association of Milk, Food and Environmental Sanitarians, Inc., was a success.

The meeting, held at the Hilton Airport Inn, Kansas City, Missouri, Aug. 13-17, had a registration of over 400 persons, making it one of the largest annual meetings in IAMFES history.

A wide variety of events, ranging from the meeting's educational aspects— committee meetings, technical sessions, and evening discussion groups— to the social occasions of a wine-and-cheese "early bird reception," "Fun on the Farm" (a barbeque feast, hayrides, square dancing and — oh, yes — an egg toss), and the Annual Awards Banquet made for a full and satisfying convention.

Throughout it all, the Executive Board met to conduct Association business.

Executive Board Meetings

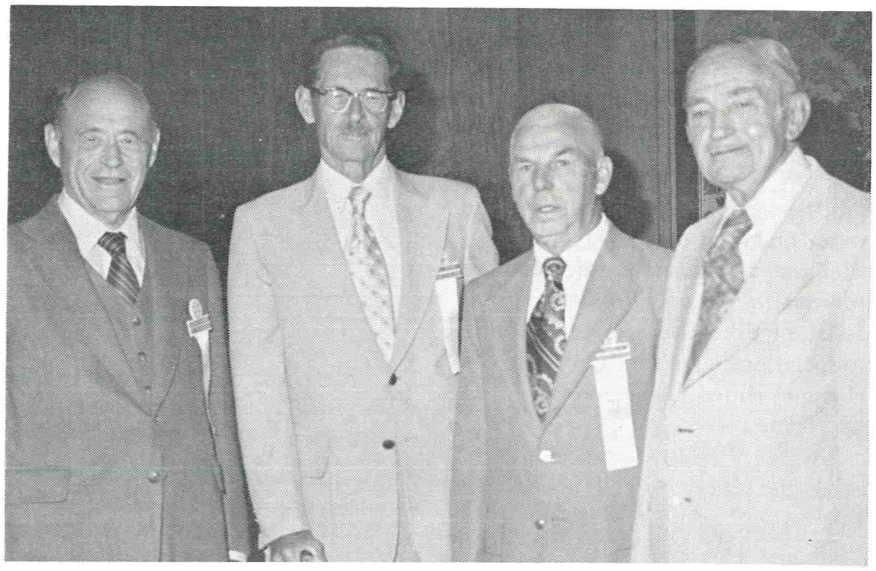
The following reports were given and business was conducted during the meetings of the Executive Board:

Auditor's Report. E. O. Wright presented the results of the auditor's report which showed total Association and Journal income from July 1, 1977 to July 1, 1978 to be $137,000.00 and total Association expenditures for the same period of $134,000.00. The *Journal of Food Protection* generated an income of $76,000.00 for the year, balanced against *Journal* expenditures of $80,000.00, resulting in a loss of $4,000.00. IAMFES income (excluding *Journal* income and operations) for the year was $61,000.00 and expenditures were $54,000.00, resulting in a profit of $7,000.00 producing a net income for IAMFES of $3,000.00. E. O. Wright explained that *Journal* losses were due to production and distribution increases, 15% for printing and paper, and 12% for postage.

Budget Committee. E. O. Wright presented the proposed budget for 1978-79. Following Board review, discussion, and revision, the projected income for the Association (excluding *Journal* operations) for the year is $65,675.00. Projected expenses for the Association are $64,400.00, providing an expected profit of $1,275.00. Projected income from the *Journal of Food Protection* is $80,000.00 while projected expenses for the *Journal* are $86,450.00, resulting in a net loss of $6,450.00. Total net loss for the Association is projected to be about $5,175.00.

The dues structure of the Association and ways of meeting the expected deficit were discussed following the Budget Committee's report. An increase in Association dues to a $21.00 base was proposed and passed. This would amount to a $4.00 increase in affiliate members' dues and a $5.00 increase for direct members.

E. O. Wright and David Fry reported on the joint meeting with the NEHA Board of Directors at their annual meeting held in June at



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Several past presidents of IAMFES gathered at the Annual Awards Banquet. From left, Harold Barnum, an IAMFES member for 46 years, C. K. Johns, a member for 48 years, I.E. Parkin, 42 years, and Fred Uetz, a member for 42 years.

Kansas and Missouri Sanitarians, hosts for the 65th Annual Meeting, meet for a buffet luncheon.
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Dr. Nan Unklesbay, Univ. of Missouri-Columbia, presents the keynote address, "A Justifiable Food-Energy-Legislative Triangle?"

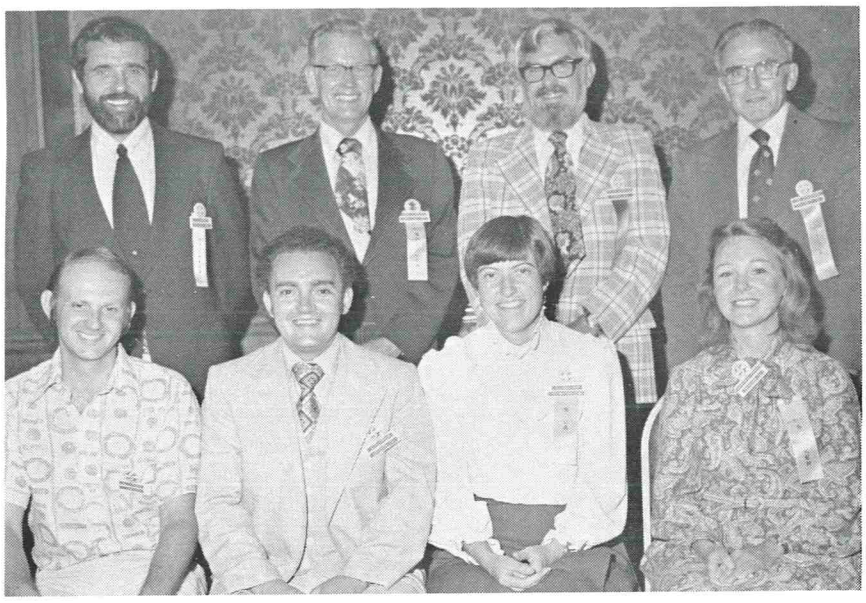
Snowmass, CO. NEHA President-Elect Harry Steigman indicated at that time that NEHA's 1981 sites of preference for the annual meeting did not coincide with those best for IAMFES. Two NEHA representatives, Paul Taloff, President, and Larry Krone, Executive Secretary, were present at the IAMFES meeting to explain NEHA's decision for a 1981 location.

Sanitarians' Joint Council. Ray Belknap presented the report which indicated that 30 states have registration in some form and noted that the Model Registration Act needs revision. A "code of ethics" is being developed by the Council and several ideas for distribution of the code were proposed. Ray requested that he be relieved of his position with the Sanitarians' Joint Council. Later during the Annual Meeting, Robert Sanders was appointed to fill the position.

Membership Committee. Ray Belknap presented the report and said Tennessee has agreed to develop an affiliate organization. Louisiana has potential for an affiliate group. Both locations need encouragement from the Board and Association, he noted, and an Affiliate Council representative is needed on the Membership Committee.

Executive Secretary's Report. The mailing list for the *Journal of Food Protection* has been changed from addressograph to computer. Per-

Some of the Food Sanitation Speakers: front row, left to right, E. Todd, C. D. Clingman, G. Holland, P. Franks. Back row, left to right, F. F. Busta, R. Winslow, H. Hutchings, J. Edmondson.



Food Sanitation Speakers: front row, left to right, Allen Katsuyama, Mary Pohlmeier, Robert Marshall. Back row, left to right, Bob Gregory, H. A. Hollender, Michael Robach.

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sonnel changes occurred during the year, including the hiring of Jan Richards as associate editor of the *Journal of Food Protection* and assistant executive secretary of the Association. The contract with the current printer has been retained, E. O. Wright reported.

Journal Report. E. O. Wright made the report for E. H. Marth. A large volume of manuscripts has been received and published this year and some changes in responsibilities may be necessary to accomodate the changed load, the report noted.

3-A Sanitary Standards—Committee on Sanitary Practices. Several standards have been developed this year. according to the report submitted by Dick Whitehead, Chairman. A conflict may exist between the work being done by the CSP and the Farm Methods Subcommittee on installation of pipelines, the report noted, and it should be looked into in order to avoid a duplication of effort.

Baking Industry Sanitation Standards Committee. The report submitted by Martyn Ronge, Chairman and presented by Harold Wainess, indicated BISSC held two meetings this year, formulated seven new standards, and is reviewing all 33 standards developed to date. Seventy companies have received BISSC authorization certificates. The report noted that a cooperative effort exists between 3-A and BISSC to eliminate duplication of standards.

Food Equipment Sanitary Standards Committee. Karl Jones submitted the Committee's written report, which appeared in the October issue of the *Journal* and outlined much of the group's work the past year.

Committee on Applied Laboratory Methods. Richard Brazis presented the Committee's written report to the Board and requested that Committee reports through the last few years be published in the *Journal.*

National Mastitis Council Representative's Report. Carl Webster reported that the NMC is working with the FDA regarding the efficacy and safety of teat dips. The NMC's current recommendation is for the FDA to delay further action until monographs for voluntary adoption of standards by the industry are reviewed.

International Dairy Federation Representative's Report. The International Dairy Federation operates structurally much as IAMFES operates, reported Harold Wainess, IDF Representative. Committees and panels of experts work together to develop monographs and papers, and hold symposiums and seminars. The U.S. is the only major country in the world that is not an IDF member and the IDF is interested in IAMFES as a member, he noted.

(Far Left)
Howard Hutchings presents the Past President's Award to David Fry.

(Left)
David Fry accepts the Shogren Award for the Florida Affiliate from P. J. Skulborstad.

Some the the Milk Sanitation Speakers: front row, left to right; K. Vantassell, M. Cousin, K. G. Savage. Back row, left to right, C. Sen Gelda, C. Neighbors, D. H. Williams.

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Jounal Management Committee. R. B. Read presented this committee's report which suggested, among other things, using a two-column format for the table of contents of the *Journal.* Instructions to authors need to be expanded in order to accomodate first-time authors as well as those who are familiar with publishing in a technical journal. The report also suggested that such publications as the Federal Register, the CDC's Morbidity and Mortality Review and surveillance publications should be reviewed and reported on in the *Journal.*

Committee on Communicable Diseases in Man. Frank Bryan indicated another draft of the manual on waterborne illnesses was sent out to committee members for review and their suggestions are now being incorporated into the manual. It should be ready for publication about the first of the year.

Discussion about attempts to develop an Egg 3-A Council and Symbol was part of the general business the Executive Board addressed during their meetings. Concern centered on possible infringement on the 3-A Council and symbol. The Board's final recommendation was that it will assist any other food processing equipment manufacturers to standardize their equipment design and construction so that it would be consistent with the principles of 3-A.

Reviewing possible sites for the 1981 Annual Meeting will be the Site Selection Committee's task, the Board noted. In action later during the Annual Meeting, Washington was selected by the Board as the first choice for the 1981 meeting site with Kentucky as an alternate. (Note: Following visits in Sept. to Washington, Seattle was chosen as the site of the 1981 meeting.)

Dues Payment Structure Committee. In one of his first official duties as President of IAMFES, Howard Hutchings named Dave Fry, Clair Gothard, and Harry Haverland to a new committee, the Dues Payment Structure Committee and gave them the charge of exploring the possibility of a uniform dues program for all affiliates.

Florida Affiliate Report. Dick Jolley presented the report for the Florida affiliate, hosts for the next annual meeting in Orlando. Proposed events will include a separate entertainment banquet for children to permit parents to attend the Annual Awards Banquet. Plans also include leaving some free time for persons attending the meeting to be able to visit Disney world.

Bridge Committee. The Board discussed the possibility of forming a "Bridging Committee" between IAMFES and NEHA to work on common problems and goals of the organizations. As discussed during the Board's final meeting, the committee would have continuity through the use of staggered terms with four or five members representing each organization. Alternating chairmen would provide leadership from each organization. The proposed committee would replace the Ad Hoc Jointure Committee, Howard Hutchings suggested.

Affiliate Council

The main order of business conducted at the meeting of the Affiliate Council Aug. 14 was to approve an increase in dues to $21.00 for direct members and $18.00 plus local dues for affiliate members. Student membership will continue to be $5.00. Much discussion surrounded the date the increases would become effective and the result was that new direct dues take effect Jan. 1, 1979, and affiliate members' dues increases take effect July 1, 1979.

Progress toward jointure with NEHA was also an item of much discussion. E. O. Wright noted that several good meetings had been held with NEHA representatives and out of these came the decision that committees composed of IAMFES and NEHA members could begin working on common problems within the two organizations. Common operation of the two executive offices has also been explored. Each organization will pursue separate locations for their 1981 Annual Meetings. A motion was passed that IAMFES officers appoint members to serve on joint committees for the purpose of pursuing jointure further.

E. O. Wright reported for the Executive Secretary's office. He noted that the *Journal* has expanded to its largest ever and now receives papers from top European scientists. The *Journal* mailing list and IAMFES membership list is now on computer.

P. Read represented E. H. Marth in reporting on the progress of the Journal. He noted that there is little copy coming in from affiliates and there is a need to get more general interest articles into print. A way suggested to provide more general articles through the *Journal* was to get copies of presentations and talks made at affiliate meetings.

E. O. Wright spoke for the Awards Committee and said a full slate of candidates for awards was received this year.

Clair Gothard, President of the Affiliate Council, suggested other means of recognition in addition to the current awards and approval was shown for a Certificate of Merit Award.

The affiliate with the largest membership increase last year was Virginia, with an increase of 39 members over the previous year.

The affiliates went on record as requesting additional time for meetings during the IAMFES Annual Meeting and suggested two separate meeting times or starting during a lunch hour to provide the additional time necessary.

E. O. Wright conducted the election of officers. Clair Gothard was elected President and Archie Holliday was elected Secretary.

Technical Sessions

A strong offering of papers and presentations provided an excellent educational program for IAMFES members who attended the Annual Meeting. Abstracts of the presentations appeared in the October issue of the *Journal.*

Keynote addresses were by Dr. Nan Unklesbay, University of Missouri-Columbia, speaking on "A Justifiable Food-Energy-Legislative Triangle?" and Arthur W. Nesbitt, Nasco International, "Communications—Key to Public Relations."

Technical session presentations included stability of polyvinylchloride tubing in dairy processing operations, goat milk production and problems, inhibition of *Clostridium botulinum* type A and B spores by phenolic antioxidants, ultra filtration and reverse osmosis, toxicity of chlorinated compounds found in drinking water assessed by a fertile egg injection technique, "kids, cartons, and quality," cost of quality in a food plant, 3-A sanitation criteria and their development, International Dairy Federation, the inhibition of *Salmonella typhimurium* and *Staphylococcus aureus* by butylated hydroxyanisole and the propyl ester of P-hydroxybenzoic acid, psychrotrophic bacteria in relation to keeping quality of milk products, bacterial numbers in milk, opportunities to improve milk quality, refrigeration-energy converter, brucellosis, functions of cleaners, the environmental health professional — can he communicate and motivate?, designing tomorrow's foods, food protection for the 80's, foodborne disease—data from six countries, development of a reciprocity system for foodservice management training and certification programs, quality standards for retail meats, sanitary processing of egg products, effects of foam-reducing methods on recovery of indicator organisms from foods, innovative water saving in canneries, sanitation problem of soft drink mixing machines, the extract-release volume method as a test of microbial quality of chicken, retortable food pouches, and inhibition of *Vibrio parahaemolyticus* by sorbic acid in crab meat and flounder homogenates.

Business Meeting

President Dave Fry called the meeting to order August 16, 1978, at 10:07 a.m. with approximately 150 persons in attendance.

The following reports were given (and have been highlighted in the "Executive Board" section, hence little detail here):

Report of the Executive Secretary (E. O. Wright), 3-A Symbol Council Report (E. O. Wright), Baking Industry Sanitation Standards Committee (Harold Wainess for Martyn Ronge), National Mastitis Council (Carl Webster), Farm Methods Committee (Dale Termunde), Food Equipment Sanitary Standards Committee (Karl Jones), Committee on Communicable Diseases (Frank Bryan), Applied Laboratory Methods Committee (Richard Brazis), Foodservice Food Protection Committee (C. Dee Clingman).

Following the report by Harold Wainess on the International Dairy Federation, Robert Zoll made a motion to instruct the Executive Board to investigate appropriate

channels for assisting the International Dairy Federation. The motion passed.

Howard Hutchings reported on activities with the National Environmental Health Association (NEHA).

The following resolution, which was accepted, was presented by Charles Felix.

RESOLUTION

WHEREAS:

The Sixty-fifth Annual Meeting of the International Association of Milk, Food and Environmental Sanitarians held in Kansas City, Missouri, August 13-17, 1978, provided the membership with an educational program of exceptional merit and an atmosphere of professional exchange and fellowship as cordial as any in memory,

THEREFORE BE IT RESOLVED:

That IAMFES extend its heartfelt appreciation to the many individuals of the host affiliates, the Missouri Association of Milk and Food Sanitarians and the Kansas Association of Sanitarians, for their selfless dedication to the myriad tasks that made this annual meeting an outstanding opportunity for professional improvement and personal growth;

BE IT FURTHER RESOLVED:

That a copy of this resolution be forwarded to the executive secretary of the Association to be maintained in the permanent files of IAMFES and that a copy be transmitted to each of the host affiliates for their records.

Richard Whitehead submitted the following resolution, which was accepted, on Voluntary Sanitary Standards.

RESOLUTION

WHEREAS:

The development of sanitation criteria for dairy processing equipment is signally in the public interest, and

WHEREAS:

The publication of such sanitation criteria as 3A Sanitary Standards has been the greatest single factor in achieving uniformity of equipment requirements, and

WHEREAS:

The sponsoring voluntary collaborative groups broadly represent industry and the regulatory community, and

WHEREAS:

The "spin-off" educational effect of standards development upgrades the sanitary design of all types of food equipment, and

"Fun on the Farm"

WHEREAS:

The spirit of voluntarism inherent in 3A Sanitary Standards is a priceless human commodity resulting in the integrity of voluntary standards, and

WHEREAS:

The 34 year successful history of 3A Standards has firmly established unquestioned credibility of substance,

THEREFORE BE IT RESOLVED:

That the IAMFES, here in body assembled, reaffirm complete support of its role in the 3A Sanitary Standards Committees under the terms of reference for cooperation as outlined by the Surgeon General, USPHS, in November, 1944, for the development of standards or practices "on a uniform national scale;"

AND THAT:

The IAMFES seize upon every opportunity to espouse the integrity of voluntary standards, as a preferred route for achieving common goals;

AND THAT:

Every sanitarian should extend the applicable lessons learned in the sanitary evaluation of dairy processing equipment under 3A criteria to any and all types of food processing equipment under his jurisdiction;

AND THAT:

Other food industries be encouraged to adopt applicable 3A criteria in any future voluntary standards program that may arise in such industries.

BE IT FURTHER RESOLVED:

That a copy of this resolution be forwarded to the executive secretary of the Association to be maintained in the permanent files of IAMFES and that a copy be transmitted to the 3A Symbol Council for its record.

Orlowe Osten accepts the Sanitarian's Distinguished Service Award from James Welch, Klenzade Products, Maynard David, Diversey Chemicals, and Robert Velez, Pennwalt Co. Klenzade, Diversey, and Pennwalt are sponsors of the $1000 Sanitarian's Award.

(Top right) James Smathers receives the Industry Award plaque from Phil Bautz, representing the Farm & Industry Institute, sponsor of the $1000 award. (Right) Ray Belknap receives the Citation Award from P. J. Skulborstad, an IAMFES Past President.

1978 Awards

Osten Receives Sanitarian's Award

Orlowe M. Osten, Director of the Dairy Industries Division of the Minnesota Department of Agriculture, received the 1978 IAMFES Sanitarian's Award at the Annual Meeting in Kansas City.

Osten was presented the award, which includes $1000 and a plaque, for outstanding contributions to the health and welfare of his community. Osten was instrumental in developing a Grade A milk inspection program in Minnesota through which communities can reduce the costs of inspection. Under the plan, local officials assume some of the inspection responsibilities while the state supervises the program. Osten also helped neighboring states of Wisconsin, Iowa, North Dakota, and South Dakota set up similar arrangements for milk inspection.

At different times during his professional life, Osten has served the field of milk and food sanitation as a food inspector, interstate milk certification officer, supervisor of the Grade A milk program in Minnesota, assistant director of the food inspection division of the Minnesota Department of Agriculture, as well as in his present position.

Osten is also a Lieutenant Commander in the U.S. Public Health Reserve Corps.

Those nominating Osten for the Sanitarian's Award cited particularly, his "ability to bring both local health and agriculture department personnel together in applying the fundamental principles of public health. It has affected the consuming public in a dimension which is difficult to measure," they noted.

Industry Award to Smathers

James B. Smathers was named winner of the 1978 IAMFES Industry Award. He was cited for accomplishments in industry on behalf of milk and food sanitation. The award includes $1000 and a plaque.

Recently retired Director of Quality Control and Field Services of the Maryland and Virginia Milk Producers' Association, Inc., Smathers was progressive in the development of bulk tanks, pipeline milkers, milk parlors, and feedlot handling.

He helped organize the National Mastitis Council (NMC), and aided in the development of the Interstate Milk Shippers' Conference. He was also instrumental in the work of the Virginia Fieldmen's Conference.

Smathers has served in a leadership role for other organizations and

committees, including the Federal 3A Sanitary Standards Subcommittee on Milking Machines and the International Farm Methods Committee of IAMFES.

In addition to leadership positions in industry and professional organizations, Smathers has promoted the field of milk and food sanitation through work with professional publications. He served as editor of the Maryland and Virginia Milk Producers' Association *News* magazine, as associate editor of *Pennmarva,* the publication of the Pennmarva Dairymen's Federation, Inc. He was also editor of the NMC Newsletter, and helped compile and edit "Methods for Production of High Quality Raw Milk," an IAMFES publication.

Smathers, along with other editors of *Pennmarva*, won a first place award in the Dairy Cooperatives Communication Sweepstakes of the National Milk Producers' Federation. He has also received the Distinguished Service Award of the National Mastitis Council.

Belknap Receives Citation Award

The 1978 IAMFES Citation Award was presented to Raymond A. Belknap for outstanding service to the Association in helping achieve its objectives. The award was presented at the IAMFES Annual Meeting in Kansas City in August.

Belknap, retired from his position as Deputy Chief of the Milk Sanitation Branch for the Food and Drug Administration in Cincinnati, Ohio, has served IAMFES in many ways. An Executive Board Member from 1959-1965, he was IAMFES president from 1962-63. He served the Iowa affiliate organization as secretary-treasurer from 1954-1958. Belknap has represented IAMFES at the Sanitarians' Joint Council for almost ten years. He is a member of the Commissioned Officers' Association of the U.S. Public Health Service.

Special services which Belknap has performed to promote the goals of IAMFES include developing and participating in teaching and training programs, administering state and local sanitation programs, promoting health programs, performing public health inspections and control activities, and making epidemiological investigations. Belknap has also promoted milk and food sanitation by proposing legislation and other regulations, developing professional and technical guidelines, and participating in meetings and conferences.

Among the publications Belknap has developed are manuals and training guides for inservice training for Public Health Service personnel and state regulatory milk officials. He also revised model milk and food service ordinances.

During his professional life, Belknap has served as a milk inspector, senior milk sanitarian for the Iowa Department of Health, a milk consultant for the Public Health Service and staff officer at the Public Health Service headquarters, in addition to his work for the FDA in Cincinnati.

Karl Jones receives the Honorary Life Membership plaque from P. J. Skulborstad.

Honorary Life Membership Award to Jones

Karl K. Jones, Environmental Health Officer at Purdue University, received IAMFES' Honorary Life Membership, awarded at the Annual Meeting.

The Honorary Life Membership Award is given to an IAMFES member who has given long and outstanding service to the Association. Jones served as the Indiana affiliate representative to IAMFES during the 1950's and was secretary-treasurer of IAMFES for eight years. He has served since 1959 and continues to serve on the IAMFES Committee on Food Equipment Sanitary Standards and was chairman of that committee for several years.

Jones is active in other professional organizations, also. He is chairman of the American Public Health Association's Committee on Food Protection, the Indiana State Board for Registration for Professional Sanitarians, and Purdue University's Student Hospitals Infection Control Committee. He also serves as chairman of the APHA Subcommittee on Microbiological Standards for Foods. Jones is a member of the ASME Food, Drug, and Beverage Equipment Committee, the Automatic Merchandising Health- Industry Council of the National Automatic Merchandising Association, and the National Sanitation Foundation's Joint Committee on Food Equipment Standards.

Jones has worked as an Indiana district sanitarian and in several positions for the Indiana State Board of Health, including state survey officer of the Retail Food Section, as chairman of the Subcommittee on Training State and Local Sanitation Personnel, and as chief of the Retail Food Section.

Jones has also made contributions to many food sanitation and health-related publications.

Certificate of Recognition to Dolan

Pat J. Dolan was awarded a Certificate of Recognition from IAMFES at the Annual Meeting in Kansas City.

Dolan, now a dairy foods consultant and secretary-treasurer of the California Dairy Industry Association, Inc., retired last year from his position as Regional Administrator, Bureau of Milk and Dairy Foods Control, of the California Department of Food and Agriculture. Dolan served 35 years with the California Department of Food and Agriculture.

His service to IAMFES includes work on the 3A Sanitary Standards Committee and Board of Trustees of the 3A Symbol Council. He was president, vice-president, and secretary of the California Association of Dairy and Milk Sanitarians.

Dolan has also served IAMFES through work as finance chairperson of the National IAMFES Meeting Committee for the 1971 Annual Meeting in San Diego, assistant secretary-treasurer of the Board of Trustees of the 3A Symbol Council, and 20 years as chairman of the CADMS Sanitary Standards Committee.

He is a member of the California Dairy Museum Committee, and has spent 30 years judging dairy products at the California State Fair, Los Angeles County Fair, and Western Food Industry Conference at the University of California at Davis.

His work with the U.S. Public Health Service includes such positions as milk sanitation survey officer, laboratory survey officer, and sampling survey officer.

U.S. POSTAL SERVICE

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Required by 39 U.S.C. 3685)

1. TITLE OF PUBLICATION	A. PUBLICATION NO.	2. DATE OF FILING
JOURNAL OF FOOD PROTECTION	2 8 1 2 2 0	Oct. 1, 1978

3. FREQUENCY OF ISSUE	A. NO. OF ISSUES PUBLISHED ANNUALLY	B. ANNUAL SUBSCRIPTION PRICE
Monthly	12	$32.00 /1978

4. LOCATION OF KNOWN OFFICE OF PUBLICATION *(Street, City, County, State and ZIP Code) (Not printers)*
413 Kellogg, Ames, Ia. 50010 Story County

$25.00 agcy. sub.
$16.00 dir. Memb.
$14.00 affil Memb.

5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS *(Not printers)*
413 Kellogg, Ames, Ia. 50010 Story County

6. NAMES AND COMPLETE ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER *(Name and Address)*
International Assoc. of Milk, Food & Environmental Sanitarians, Inc.

EDITOR *(Name and Address)* 413 Kellogg Ave. Ames, Ia. 50010 (Box 701)
Dr. E. H. Marth, Editor, Babcock Hall, Univ. of Wisconsin 53706 Madison, WI

MANAGING EDITOR *(Name and Address)*
Earl O. Wright, 413 Kellogg, Ames, Ia. 50010

7. OWNER *(If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given.)*

NAME	ADDRESS
International Association of Milk Food & Environmental Sanitarians, Inc.	413 Kellogg Ave., Box 701 Ames, Ia

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES *(If there are none, so state)*

NAME	ADDRESS
NONE	

9. FOR COMPLETION BY NONPROFIT ORGANIZATIONS AUTHORIZED TO MAIL AT SPECIAL RATES *(Section 132.122, PSM)*
The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes *(Check one)*

☐ HAVE NOT CHANGED DURING PRECEDING 12 MONTHS ☐ HAVE CHANGED DURING PRECEDING 12 MONTHS *(If changed, publisher must submit explanation of change with this statement.)*

10. EXTENT AND NATURE OF CIRCULATION	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	ACTUAL NO. COPIES OF SINGLE ISSUE PUBLISHED NEAREST TO FILING DATE
A. TOTAL NO. COPIES PRINTED *(Net Press Run)*	3900	4119
B. PAID CIRCULATION 1. SALES THROUGH DEALERS AND CARRIERS, STREET VENDORS AND COUNTER SALES	0	0
2. MAIL SUBSCRIPTIONS	3420	3528
C. TOTAL PAID CIRCULATION *(Sum of 10B1 and 10B2)*	3420	3528
D. FREE DISTRIBUTION BY MAIL, CARRIER OR OTHER MEANS SAMPLES, COMPLIMENTARY, AND OTHER FREE COPIES	75	66
E. TOTAL DISTRIBUTION *(Sum of C and D)*	3495	3594
F. COPIES NOT DISTRIBUTED 1. OFFICE USE, LEFT OVER, UNACCOUNTED, SPOILED AFTER PRINTING	405	525
2. RETURNS FROM NEWS AGENTS	0	0
G. TOTAL *(Sum of E, F1 and 2—should equal net press run shown in A)*	3900	4119

11. I certify that the statements made by me above are correct and complete.

SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER
Earl O Wright Managing Editor

12. FOR COMPLETION BY PUBLISHERS MAILING AT THE REGULAR RATES *(Section 132.121, Postal Service Manual)*

39 U. S. C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written request for permission to mail matter at such rates."

In accordance with the provisions of this statute, I hereby request permission to mail the publication named in Item 1 at the phased postage rates presently authorized by 39 U. S. C. 3626.

SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER
Earl O Wright Managing Editor

PS Form Mar. 1977 3526 *(Page 1)* (See instructions on reverse)

Membership Dues to Increase

The Affiliate Council approved an increase in members' dues during the IAMFES Annual Meeting in Kansas City this August.

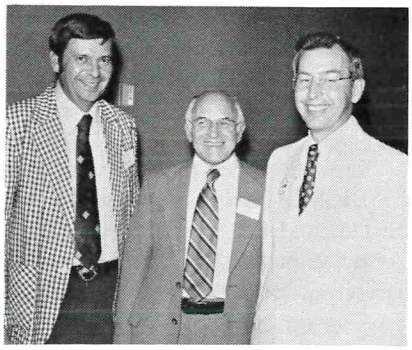
Affiliate members' dues will increase to $18 plus local dues. Direct members' dues will change to $21 per year.

The increases will cover such rising costs affecting the Association as a 15 per cent increase in paper and printing and a 12 per cent rise in postage costs for the *Journal of Food Protection.*

The change in dues for direct members becomes effective Jan. 1, 1979 and the affiliate members' new dues take effect July, 1979.

News and Events

Minnesota Sanitarians' Association Holds Annual Meeting



(Left) Ed Kaeder, Awards Chairman, presents the Achievement Award to Leonard Waldock at the Minnesota Sanitarians' Association Annual Meeting. (Right) Officers of the Association are, from left, Jim Rolloff, President, Peter Patrick, Past President, and Roy Ginn, Secretary-Treasurer.

"The Sanitarian in the Age of Proposition 13," a speech by Dr. Velvyl Greene, and a related panel discussion, "Financial Problems with Reduced Tax Revenues for Environmental Health Programs," were featured presentations at the Annual Meeting of the Minnesota Sanitarians' Association, held in September in Brooklyn Park, MN.

Through Dr. Greene's speech and the panel discussion, those present were challenged to consider the effects which California's Proposition 13 and other broad tax cuts may have on sanitarians. Discussion surrounded such points as the need to increase the public's awareness of what sanitarians do and have done to protect health, and being aware that taxpayers will look for accountability and efficiency in their government employees as they look for more value for their tax dollars.

Leonard Waldock, Supervisor, Grade A Milk Section, Minn. Dept. of Agriculture, St. Paul, was presented the Association's Achievement Award at the banquet. The group also recognized Orlowe Osten, Director of the Dairy Industries Division of the Minnesota Dept. of Agriculture, recipient of the 1978 IAMFES "Sanitarian of the Year" award.

James Rolloff, with the Plant Services Dept. of AMPI, New Ulm, was elected President of the Minnesota Sanitarians' Association and Roy E. Ginn, General Manager, Dairy Quality Control Institute, Inc., St. Paul, was reelected Secretary-Treasurer during the business meeting.

DR. H. C. OLSON (2nd from L), Dairy Consultant and Professor Emeritus at Oklahoma State University, Stillwater, Oklahoma, recipient of the 1978 ACDPI Research Award sponsored by Nordica International, Inc., is shown with (L to R): ACDPI President Bromley Mayer, Knudsen Corp., Los Angeles, California; Al Shock, President of Nordica, Sioux Falls, South Dakota; ACDPI immediate Past President Luther Elkins, The Southland Corp., Dallas, Texas.

The $1,000 award and recognition plaque, presented recently at the ACDPI Annual Meeting and Conference in Atlanta, is given annually to a college professor for excellence in cultured dairy products research.

The conclave drew over 200 delegates from the United States, Canada, and Sweden.

Laino Named NEHA "Sanitarian of Year"

Joseph M. Laino, Director of Quality Assurance of DCA Food Industries Inc., New York, has been named Sanitarian of the Year by the National Environmental Health Association (NEHA).

Laino, the first recipient of the award, was presented with a plaque at the Association's Annual Educational Conference in Snowmass, Colorado. He was honored for his "contributions to the environmental sanitation in the food industry".

In addition to being a member of NEHA, Laino is a member of the American Association of Candy Technologists, the American Public Health Association, the American Society for Quality Control, the Environmental Management Association, the International Association of Milk Food and Environmental Sanitarians, and the Institute of Food Technologists.

Pieper and Baird Elected BISSC Leaders

William E. Pieper was unanimously elected chairman of the Baking Industry Sanitation Standards Committee (BISSC) at that group's 62nd meeting in San Francisco during September.

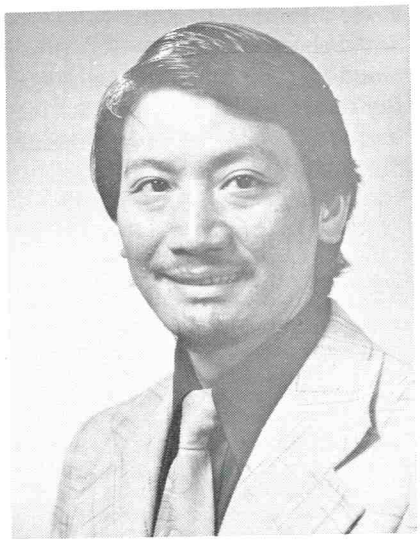
Pieper has a long history of service to BISSC, having represented the Biscuit and Cracker Manufacturers' Association on the BISSC Board of Directors for many years as well as serving on numerous BISSC Task Committees. He is currently chairman of the Sanitation Committee of the American Society of Bakery Engineers and represents that organization on the BISSC Board of Directors.

J. Allen Baird was unanimously re-elected BISSC vice chairman. Baird, who is the Executive Vice President of Mrs. Baird's Bakeries, Inc., represents the American Bakers Association on the BISSC Board of Directors.

Raymond J. Walter, attorney-at-law, continues as the Secretary-Treasurer and Counsel of BISSC with Executive Offices at 521 Fifth Avenue, New York, New York 10017.

The Baking Industry Sanitation Standards Committee was organized in 1949, to promote sanitation in the baking industry through the development, approval and publication of Sanitation Standards for Bakery Equipment and Machinery. This was a joint effort on the part of six national baking industry organizations: American Bakers Association, American Institute of Baking, American Society of Bakery Engineers, Bakery Equipment Manufacturers Association, Biscuit & Cracker Manufacturers Association, Retail Bakers of America.

Fung Joins Kansas State Faculty



Dr. Daniel Y. C. Fung joined the Department of Animal Sciences and Industry, Kansas State University, September 1, 1978, as an assistant professor of Food Microbiology. Before coming to Kansas State, Dr. Fung was an assistant director for administration and an assistant professor of Microbiology at the Pennsylvania State University. In his new position, he will teach courses in dairy and food microbiology as well as continue research work in methodologies in food microbiology, enterotoxigenesis of *Staphylococcus aureus*, and effects of food processing on microbial activities in foods.

Dr. Fung has been an invited speaker at numerous national and international symposia on automation and rapid methods in microbiology and was a symposium organizer on those topics for the annual meeting of the Institute of Food Technologists in 1978. He is a member of the Sigma Xi, Gamma Sigma Delta, American Society for Microbiology, IAMFES, and is on the Editorial Board for the *Journal of Food Protection.*

A native of Hong Kong, Dr. Fung is a naturalized citizen. He has studied, lectured, and traveled in more than 15 countries in the Far East, Europe, and North America. Dr. Fung received his B.A. at International Christian University, Tokyo, Japan, 1965, his M.S.P.H. from the University of North Carolina, Chapel Hill, N.C. in 1967, and his Ph. D. from Iowa State University, Ames, Iowa in 1969. He has authored more than 40 research publications on such topics as staphylococcal enterotoxigenesis, methods in microbiology, and effects of food processing on microbial activities.

Stauffer, Tucker, and Walker to Head CEPH

Dr. Lee D. Stauffer, dean of the School of Public Health, University of Minnesota, was reelected president of the Council on Education for Public Health (CEPH), at the Council's annual meeting in September in Albuquerque, New Mexico.

Dr. Allan Tucker, University of Florida, in Gainsville, was chosen vice president and Dr. Bailus Walker, Jr. environmental health scientist, Government of the District of Columbia and adjunct professor of environmental health at Howard University, was elected secretary-treasurer of CEPH.

The Council on Education for Public Health, incorporated by the American Public Health Association and the Association of Schools of Public Health, is the independent accrediting agency for graduate schools of public health in the United States.

The Council's primary objectives are to strengthen the educational programs in schools of public health through accreditation, consultation, research, and other appropriate services, and to encourage the development of experimental and innovative programs which ensure educational quality.

Coming Events

Nov. 9—CONTROLLING MICRO-ORGANISMS IN FOOD PROCESSING. Sponsored by Western New York section, IFT, and Institute of Food Science, Cornell University. Hilton Inn, Rochester, N.Y. Contact: D. L. Downing, New York State Agricultural Experiment Station, Geneva, NY.

Nov. 12-15—1978 NATIONAL FROZEN FOOD CONVENTION. Sponsored by National Frozen Food Assn., Inc. and the American Frozen Food Institute. San Francisco, CA. Contact: B.B. Noveau, National Frozen Food Assn., Inc., 1700 Old Meadow Rd., Suite 100, McLean, VA 22101.

Nov. 27-29—NATIONAL CONFERENCE ON QUALITY ASSURANCE OF ENVIRONMENTAL MEASUREMENTS. Plaza Cosmopolitan Hotel, Denver, CO. Contact: B. D. Zucker, Information Transfer, Inc., 1160 Rockville Pike, Suite 202, Rockville, MD 20852.

Dec. 4—SEMINAR FOR FOOD PROCESSORS/PACKAGING EQUIPMENT PRODUCERS on investment opportunites in Argentina. Ritz Carlton, Chicago. Contact: Leslie Levin, Burson-Marsteller. Tel: 212-752-8610.

Dec. 4-6—THIRD ANNUAL TOXIC SUBSTANCES CONTROL CONFERENCE. Washington, D.C. Government Institutes, Inc. 4733 Bethesda Ave., N.W., Washington, D.C. 20014.

Jan. 10-11, 1979—DAIRY PROCESSORS CONFERENCE. Sponsored by Food Science Dept., University of Wisconsin-Madison. Sheraton Inn, Madison, WI. Contact: Myron Dean, Dept. of Food Science, Babcock Hall, 1605 Linden Drive, Madison, WI 53706.

Jan. 21-24, 1979—INTERNATIONAL EXPOSITION FOR FOOD PROCESSORS. Sponsored by Food Processing Machinery and Supplies Assoc. Brooks Hall-Civic Center, San Francisco, CA. Contact: T. J. Gorman, Food Processing Machinery & Supplies Assn., Suite 700, 1828 L St., N.W., Washington, D.C. 20036.

Feb. 14-15, 1979—DAIRY AND FOOD INDUSTRY CONFERENCE. Ohio State University. Contact: J. Lindamood, Dept. of Food Science and Nutrition, 2121 Fyffe Rd., Ohio State University, Columbus, OH 43210.

Feb. 25-Mar. 2, 1979—NINTH ENVIRONMENTAL ENGINEERING IN THE FOOD PROCESSING INDUSTRY CONFERENCE. Asilomar Conference Grounds, Pacific Grove, CA. Sponsored by the Engineering Foundation. Contact: Engineering Foundation, 345 E. 47th St., New York, NY 10017, Tel: 212-644-7835, or contact: Dr. Roy Carawan, Program Co-Chairman, 129 Schaub Hall, North Carolina State Univ., Raleigh, NC 27650, Tel: 919-737-2956.

Feb. 27-Mar. 2, 1979—TECH EX '79-ANNUAL WORLD FAIR FOR TECHNOLOGY EXCHANGE. Georgia World Congress Center, Atlanta, GA. Contact: E. B. Prine, Vice President, TechEx '79, Dr. Dvorkovitz & Assoc., P.O. Box 1748, Ormond Beach, Fl 32074.

Mar. 1-2, 1979—ANNUAL FOOD TECHNOLOGY CONFERENCE. Sponsored by IFT Kansas City and St. Louis sections. Ramada Inn, Columbia, Mo. Contact: S.A. Taillie, Paniplus Co., ITT Continental Baking Co., 100 Paniplus Roadway, Olathe, KS 66061.

Mar. 19-23, 1979—MID-WEST WORKSHOP IN MILK AND FOOD SANITATION. Ohio State University. Contact: John Lindamood, Dept. of Food Science and Nutrition, 2121 Fyffe Road, Ohio State University, Columbus, OH 43210.

Mar. 27-28, 1979—WESTERN FOOD INDUSTRY CONFERENCE. Freeborn Hall, University of California, Davis. Contact: Robert C. Pearl, Food Science and Technology Dept., Univ. of California, Davis, CA 95616, Tel: 916-752-0980.

June 10-13, 1979—INSTITUTE OF FOOD TECHNOLOGISTS 39th ANNUAL MEETING AND FOOD EXPO. Alfonso J. Cervantes Convention & Exhibition Center, St. Louis, MO. Contact: C. L. Willey, Institute of Food Technologists, Suite 2120, 221 N. LaSalle St., Chicago, IL 60601.

Aug. 29-31, 1979—4th INTERNATIONAL IUPAC SYMPOSIUM ON MYCOTOXINS AND PHYCOTOXINS. Co-sponsored by World Health Organization and Swiss Socciety for Analytical and Applied Chemistry. Lausanne, Switzerland. For participation and poster presentation, contact: Prof. P. Krogh, Dept. of Veterinary Microbiology, School of Veterinary Medicine, Purdue University, West Lafayette, IN 47907 or Prof. D. Reymond, IUPAC, Case postale 88, 1814 La Tour de Peilz, Switzerland.

Sept. 18-20, 1979—WESTPACK. Convention Center, Anaheim, CA.

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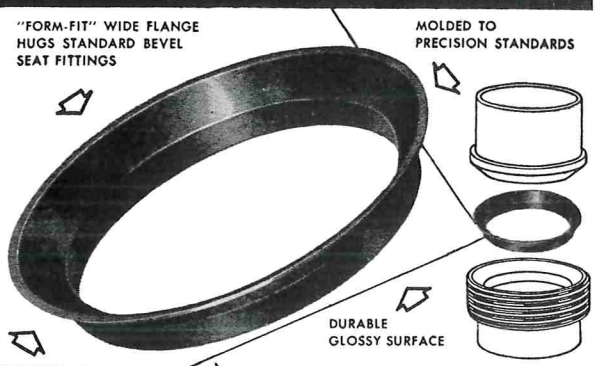

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