Evaluation of Packaged Ice Sold in Iowa

Prepared by Nelson P. Moyer, Ph. D., George M. Breuer, Ph. D., Nancy H. Hall, John L. Kempf, Lee A. Friell, M. S. and Gene W. Ronald, M. S.

Executive Summary

The quality of packaged ice has been investigated by examination of physical, chemical and microbiological characteristics of 22 ice samples purchased at retail stores throughout Iowa. Only one sample exceeded a primary health standard under the Safe Drinking Water Act (SDWA) and that sample contained Klebsiella pneumoniae, a member of the total coliform group of bacteria. Several samples of ice manufactured in convenience stores had heterotrophic plate counts which exceeded the recommendations (<500 CFU/mL) established by the Packaged Ice Association and all samples failed to meet the package labeling recommendations of that organization. While ice consumption does not represent an immediate threat to personal or public health, the potential for disease transmission exists in an industry which is voluntarily self-regulated.

Background

Ice has long been associated with food preservation by regulation of temperature of foods to levels which restrict microbial growth. During the past 50 years, ice has become an increasingly important aspect of the recreational pursuits of Americans. The Packaged Ice Association estimates that 86 million tons of ice are sold in the United States each year, or approximately two pounds per person per day (6).

Ice is defined as a food in the U. S. Public Health Service Food Service Sanitation Manual (PHS Publication 78-2081, 1976). As a manufactured food, ice is covered by the Good Manufacturing Practices (GMP) Regulations for foods contained in CFR 21, Chapter 1, Parts 20 and 110. These regulations address the facilities where ice is manufactured, the quality of source water and the sanitary practices of employees during ice production. States are granted the option of regulating ice manufacture further within their jurisdiction but most state laws only restate the federal GMP regulations.

Despite the elaborate precautions taken to insure the quality and safety of water and food, federal, state and local health officials have done little to inspect or sample ice to insure its safety. In a recent survey sponsored by the Association of Food and Drug Officials, 33% of responding states had no information on the number of ice plants in their states, and 72% of states did not know how many on-premises ice machines were packaging ice for sale in retail stores (6). To understand the potential for exposure of the population to disease from contaminated ice, consider that soft drinks served in fast-food restaurants are 40% crushed ice, millions of drinks are sold daily and most of the ice used is manufactured and distributed without regulatory oversight. Clearly, ice is taken for granted by modern society.

The medical literature over the past ten years has documented ice-related nosocomial transmission of Escherichia coli, Pseudomonas aeruginosa, Legionella pneumophila, Salmonella enteritidis and Hepatitis A virus. Pseudoepidemics of Mycobacterium gordonae have been attributed to contaminated cold water lines feeding ice machines in hospitals.

The literature on illness associated with commercially manufactured ice is sparce. In 1972, CDC investigated 98 cases of infectious hepatitis associated with commercially produced ice pellets (3). The private well providing source water for ice manufacture was contaminated by sewage from the tile drainage field of an adjacent septic tank serving a house where several people with known hepatitis had lived six weeks before the outbreak occurred. In 1985, human illness was attributed to ingestion of carbonated beverages served with contaminated ice (5). However, the 1987 outbreak of viral gastroenteritis involving over 5000 people in Pennsylvania and Delaware (4) was the crucial event which focused public health attention upon the problems associated with ice manufacture, distribution and consumption.

Investigations following complaints of illness associated with ice revealed that sanitation during production and packaging of ice was a major problem. Violations to existing federal regulations included improper facilities, poor source water quality, microbial contamination, filth and foreign objects and poor personal hygiene of employees. Investigators have documented the presence of insect parts, fibers, glass, metal and plastic fragments and sand in packaged ice (7,10).

By 1989, minimal voluntary standards in addition to GMP regulations for ice manufacture were adopted by members of the Packaged Ice Association and endorsed by the Association of Food and Drug Officials (1,8,9). Key features of these standards require that:

- Ice manufacturing facilities must be maintained indoors in a room separate from other non-manufacturing activity.

- Product ice must be regularly tested for total and fecal coliforms (MPN <2.2/100 mL) and heterotrophic plate count (<500 CFU/mL).

- Packaging must be clearly labeled to show name of manufacturer, location of the plant and production code to facilitate investigation of complaints.

The Iowa Department of Agriculture and Land Stewardship published a Notice of Intended Action in the Iowa Administrative Bulletin on February 21, 1990, proposing the creation of a new chapter in the Iowa Administrative Code, pursuant to Iowa Code Chapter 159.5(11) and to implement Chapter 159.5(15). The general intent of the new rule was to impose drinking water regulatory standards for physical, chemical and bacteriological quality upon manufacturers of bottled and vended water and packaged ice in conformance with Iowa Code Chapter 455B. It recommended that tests for coliform bacteria be conducted every three months and that chemical and physical testing occur annually to ensure that ice sold in Iowa and consumed by the public be free of undesirable microorganisms.

A public hearing regarding the proposed rule was held on March 13, 1991. A study bill (SSB 2) to regulate the commercial production, processing and distribution of water products was introduced in the Iowa Senate on January 16, 1991, and assigned to the Senate Commerce Committee for consideration. The legislature did not act on this proposed legislation prior to its adjournment. The quality of packaged and vended ice consumed in Iowa is still unregulated and thus is not periodically tested for purity.

The monitoring tests mandated in the proposed new rule noted above were few in number and would have been conducted infrequently. The Packaged Ice Association had previously established voluntary sanitary standards for packaged ice, including annual physical and chemical testing, radiological testing every four years, and monthly random sample testing for total and fecal coliform bacteria and heterotrophic plate count in compliance with U. S. Environmental Protection Agency drinking water regulations. Its members are encouraged to implement process testing for ethylene glycol, propylene glycol, lead, cadmium, zinc, chromium and nitrate, and to test quarterly by random sample of finished product for glycols and chlorides. However, the level of compliance with these voluntary sanitary standards is currently unknown.

The quality of packaged ice sold in retail establishments in Iowa has not been examined. We report results of a prospective study which examined the physical, chemical and microbiological quality of packaged ice in Iowa.

Experimental Design

To insure a geographical representation of ice samples to be included in the study, the telephone directories of several cities throughout Iowa were reviewed to determine the number and location of commercial ice manufacturing establishments and distributors. Fifteen manufacturers were identified but it was determined that ice sold in many convenience stores was produced and packaged on the premises. A list of manufacturers from whom samples were obtained appears in Table 1. Sampling was performed by Hygienic Laboratory staff during April 1991. All samples were purchased at retail establishments as staff traveled during the course of their normal duties. Ice was marketed in 5, 6, 7, 8, 8.5, and 16 lb. bags. Because 7-8 lbs. of ice was required to produce the required total melted sample volume of 3 liters, two each of the 5, 6, and 7 lb. bags were purchased and combined for melting and subsequent analytical procedures. All samples were placed in insulated coolers and immediately transported to the laboratory where they were stored at -20 C awaiting sample processing. The period of time between purchase and sample processing never exceeded 72 hrs. and no noticeable thawing occurred during transit or storage. To prepare samples for analytical procedures, bags of ice were removed from the freezer, a lower corner of the bag was wiped with 70% ethanol and a sterile scalpel was used to aseptically cut a 3 inch opening which allowed ice to fall directly into a previously sterilized 10 liter Nalgene carboy. A screw-cap was placed on the carboy and samples were left at room temperature overnight for melting. The resulting water remained cold after 12 hrs. at room temperature. Water was mixed to insure sample homogeneity and poured into specially prepared sample containers for microbiological, particulate, inorganic and organic analyses. Samples were transported to the respective analytical laboratories under standard conditions and analyzed within the holding times specified by the analytical method. Samples for microbiological analysis were processed first after melting and were tested within 2 hours. Sample bags were saved and all information printed on the bags was transcribed onto project worksheets.

Analytical procedures conformed to quality guidelines established by the Association of Food and Drug Officials, the Food and Drug Administration, the U.S. Environmental Protection Agency, Standard Methods for Examination of Water and Wastewater and sound laboratory practice. The list of analytes selected and methods used in this study is presented in Table 2. Primary and secondary federal standards established for drinking water are listed with study results, however these standards are not legally binding for ice producers. The quantitative detection limit of each method is indicated by use of a less than (<) indication before the numerical result.

The heterotrophic plate count (HPC) was performed by the spread plate method using 1 mL and 0.1 mL volumes of undiluted sample on pre-dried were determined by the spread plate method using 1 mL of undiluted sample on Sabouraud Dextrose agar containing choloramphenicol to inhibit bacterial overgrowth. These plates were incubated for 5 days at 25 C.

Particulate analysis was performed by passing 300 mL of sample through a 0.4 m, 47 mm diameter polycarbonate membrane filter (Nucleopore). Direct microscopic examination of the filters was performed at total magnifications of 27x, 100x and 900x. Fibers and inanimate particulates were identified by the UHL Senior Microscopist, Air Quality Section, using micro-chemical, physical and morphological properties. Insect parts were confirmed by the UHL parasitologist. Bacteria and mold identifications were performed in the UHL Reference Bacteriology and Mycology Laboratories, respectively. Algae, iron bacteria and hyphal elements of fungi were identified by the UHL Environmental Microbiology Laboratory staff.

A telephone survey of ice producers was undertaken to determine the extent of compliance with the voluntary guidelines prepared by the Packaged Ice Association. Questions covered the source and quality of water used for ice production and manufacturing and labeling practices.

Quality Assurance

The Hygienic Laboratory is certified by EPA for analytical testing of drinking water under the Safe Drinking Water Act (SDWA). Samples were transported to the laboratory in insulated coolers together with a field blank to control for introduction of organic contaminants during transit or processing. New Nalgene carboys were purchased for this study. These containers were filled with water, autoclaved and emptied. This cycle was repeated 2-3 times and water from the last cycle was examined for residues which could result in false positive analytical tests.

Results and Discussion

A summary of information obtained from the telephone survey and directly from ice bags is presented in Table 3. Five of 21 manufacturers were members of the Packaged Ice Association and the membership status of one manufacturer could not be determined. Private wells were used as source water for ice production by four manufacturers and the remaining 18 producers used source water from a public water supply. Water treatment methods varied from no additional treatment of municipal source water to various combinations of softening, demineralization, filtration, chlorination and in one case, treatment by reverse osmosis. Managers of convenience stores were generally uncooperative and no information about water treatment or production methods could be ascertained. Eleven of 22 manufacturers performed some analytical tests on their product to monitor microbiological safety. The most common test employed was analysis for total coliform bacteria but the frequency ranged from monthly to once every two years. The quantity of ice per bag varied from 5 lbs to 16 lbs. Bags were all made of plastic but there was considerable variation in the thickness and strength of the bags. All bags had at least one hole and thinner bags had numerous stretches and tears which could allow contamination of ice from environmental surfaces. Bag closures included metal staples (13), twist-ties (2) hard plastic clip (1), plastic tape (1), draw-string (1) and a heat sealed bag (1). All product purchased was in the form of cubes except one which was manufactured as "tubes". Bags contained a variable amount of printing on the bags from less than 10% of the total surface area to 100% of the available area. There was no correlation between the amount of printing on the bags and lead concentrations of samples. Labeling of bags was checked against the voluntary guidelines of the Packaged Ice Association (name of manufacturer, location of plant and production code). Two manufacturers advertised membership in this organization on their labels. All bags from large commercial suppliers contained the name and location of manufacture except one. Those products produced on the premises of convenience stores contained only the corporate address, not the location of manufacture. None of the bags were identified with a production code which could facilitate epidemiological follow-up during investigations of a disease outbreak. Several manufacturers claimed their product was produced under sanitary conditions, cited a municipal water source for their product or made other claims about the superiority of their product (Table 3). Ironically, one product claiming to be "untouched by human hands" contained Acinetobacter lwoffi, an organism found on skin and in soil. Most general claims are impossible to validate in a quantitative fashion and some claims may violate truth in advertising laws, eg. "Lasts Longer", "Holds the Cold", etc. Value conscience consumers should be aware of the variation in net weight of ice bags while comparison shopping.

The microbiological quality of ice was evaluated by performing heterotrophic plate counts (HPC), mold counts, and tests for total and fecal coliform bacteria and Pseudomonas aeruginosa (Table 4). Total HPC counts ranged from <1 to >54,000 colony forming units (CFU)/mL. Ice produced on the premises by convenience stores demonstrated consistently higher bacterial counts than ice produced by commercial ice companies and all ice produced on the premises of convenience stores exceeded the upper limit of 500 CFU/mL recommended by the Packaged Ice Association. While no standards have been developed for mold contamination of ice, mold counts paralleled bacterial counts and served as an indication of unsanitary conditions at the production site. One sample was positive for total coliform bacteria (MPN 2.2 organisms/100 mL) and all tests for fecal coliforms and Pseudomaonas aeruginosa were negative. Klebsiella pneumoniae was identified as the predominant organism in the total coliform positive sample. This organism may be found in the intestinal tract of humans and animals and in soil, vegetative matter and water. K. pneumoniae causes various infections in humans and is considered a primary opportunistic pathogen.

The identifications of bacteria and fungi isolated from ice during this study is shown in Table 5. Many organisms isolated from environmental sources grow poorly on culture media used in identification of medically significant organisms and are thus difficult to identify by the methods used at UHL. The common sources and medical significance of these organisms is shown in Table 6.

The results of particulate analysis is presented in Table 7. Algae, mold spores and insect parts were common in ice produced by convenience stores. Hair and glass were found in a preliminary ice sample purchased from a convenience store as an internal control for the filtration procedure. No other analytical tests were performed on this sample, therefore these results were omitted from Table 7. The presence and nature of particulate materials in ice reflects the conditions under which it was produced, packaged and stored. Dust mites were the most common insect parts found.

The inorganic chemical analytes for this study were selected to provide an indication of source water quality and to detect potential contamination during secondary water treatment or ice manufacturing. No primary inorganic SDWA standards were exceeded (Table 8). However, the secondary standard for pH (acceptable range 6.5-8.5) was exceeded by samples 28311, 29072, 29504 and 30244. Sample 28311 contained a level of potassium higher than would be expected in a public drinking water supply. This sample also contained the highest level of sulfate (30 mg/L) and zinc (0.22 mg/L) encountered in the study. Detectable zinc concentrations may result from use of galvanized materials (auger, bin, etc.) in production or packaging of ice. Sample 29072 had an unexplained pH of 9.8 and reportable levels of copper and lead. The lead level of 0.028 mg/L exceeds the proposed screening level but does not violate current regulations. Sample 30243 contained a chloride level of 22 mg/L yet remained well below a level which would be detected by taste. Softening may contribute to the detectable chloride concentrations of some samples. No MCL has been established for chloride. This sample had an iron level of 0.21 mg/L which may result from processing equipment.

The results of organic chemical analyses are presented in Table 9. The total trihalomethane (THM) concentrations result from the action of chlorine residuals on water containing organic material. Of the halogenated hydrocarbons included in the screening test (chloroform, bromoform, bromodichloromethane and chlorodibromomethane), only chloroform was detected. All THM levels were below the MCL of 100 g/L as a yearly average for drinking water. The absence of THM in most samples may indicate the loss of volatile organic compounds during freezing of ice. 1,1,1-Trichloroethane was observed in one sample, however the level detected is well below the MCL for drinking water (200 g/L). This organic compound is associated with cleaners and degreasers and may represent residual contamination from mechanical equipment or storage of cleaning agents in the room where ice is produced. Ethylene and propylene glycols were included as a screen for refrigerants used in ice production. The analytical method used was direct aqueous injection into the column of a gas chromatograph equipped with a flame ionization detector. The detection limit reported represents the concentration of the low standard used which varies slightly between runs. No standards for glycols have been established for drinking water and all ice samples were below the detection limit of the method.

Conclusions

The quality of packaged ice sold in Iowa reflects the quality of source water and the sanitary conditions during manufacture. Ice produced in convenience stores was of consistently poorer microbiological quality than ice produced by major commercial producers. No manufacturer fully complied with the recommendations of the Packaged Ice Association regarding use of a product code which would facilitate investigation of disease outbreaks. The overall quality of ice is much like the quality of bottled water (2). However, unlike bottled water, ice is not ingested in quantities which represent a significant threat to personal or public health. Nevertheless, the potential for disease transmission exists in an industry which is voluntarily self-regulated.

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References

1. Association of Food and Drug Officials. 1989. Guidelines for the Inspection and Enforcement of GMP Regulations for Handling and Manufacturing Packaged Ice. JAFDO 53: 70-74.

2. Breuer, G. M., L. A. Friell, N. P. Moyer, G. W. Ronald and W. J. Hausler, Jr. 1990. Testing of Bottled Waters Sold in Iowa. UHL Technical Report 91-1.

3. Centers for Disease Control. 1972. Infectious Hepatitis- Wickes, Arkansas. EPI 71-130-2.

4. Centers for Disease Control. 1987. Outbreak of Viral Gastroenteritis - Pennsylvania and Delaware. MMWR 36:709.

5. Dickens, D. L., H. L. Dupont and P. C. Johnson. 1985. Survival of Bacterial Enteropathogens in the Ice of Popular Drinks. JAMA 253:3141-3143.

6. Felix, C. W. 1989. Ice-the Forgotten Food. JAFDO 53:19-24. Ladanzi, P. A. and S. M. Morrison. 1962. A Sanitary Survey of Ice. J. Milk and Food Technol. 30: 253-258.

7. Packaged Ice Association. 1989. Sanitary Standards for Packaged Ice. Packaged Ice Association. A Guide to the Sanitation of Packaged Ice (Undated Brochure). Raleigh, North Carolina.

8. Young, T. R. and G. J. Barela. 1975. Sediment Testing of Ice Proves of Value in Denver. J. Environ. Health 38:92-93.

Table 1
Producers of Ice Samples Examined

Harney Ice Co.	213 E 11th St.	Coralville	52241	319-351-4850
Hubbard Ice & Fuel	1126 1st St. N.W.	Cedar Rapids	52405	319-365-1488
Krieg Boys Ice Corp.	19 Nightingale Lane	Dubuque	52001	319-556-7626
HyVee	1801 Osceola Ave.	Chariton	50049	515-724-2121
Hawkeye Ice Co.	7510 Northwest Blvd.	Davenport	52806	319-386-4738
Crystal Ice		West Point	52656	319-837-6452
Burlington Ice & Cold Storage	1012 Agency	Burlington	52601	319-752-5455
Messerschmitt Ice Services	1118 Hayme	Ottumwa	52501	515-684-6207
Mason City Artificial Ice Co.	515 6th N.W.	Mason City	50401	515-423-0814

Star Ice Co.	18 Fay St.	Waterloo	50703	319-235-9365
Crystal Ice & Cold Storage	1442 Sycamore St.	Waterloo	50703	319-234-6606
Crawford County Ice Co.	Hwy 30 E.	Denison	51442	712-263-3135
Valley Ice Co.	8211 F St.	Omaha	68127	402-592-9262
Artesian Ice Co.		Zwingle	52079	319-773-2489
Finnegan's Ice	1407 17th Ave. E.	Oskaloosa	52577	515-673-3481
Kwik Shop	820 1st Ave. S.	Iowa City	52245	319-338-7008
Millermart, Inc.	2303 Muscatine Ave.	Iowa City	52240	319-351-2372
QuikTrip	123 W. Benton	Iowa City	52246	319-337-3346
QuikTrip	323 E. Burlington	Iowa City	52240	319-351-6455
QuikTrip	25 W. Burlington	Iowa City	52240	319-351-1585
QuikTrip	301 E. Market	Iowa City	52245	319-354-2139
QuikTrip	822 1st Ave. S.	Coralville	52241	319-351-7851

Table 2
Analytes and Methods for Laboratory Examination of Packaged Ice

Physical Parameters
- Particulates (Gross and microscopic examination of filter membranes)
- Total Dissolved Solids (EPA 160.1)
- Conductivity (EPA 120.1)
- pH (EPA 150.1)

Chemical Parameters
- Organic Analytes
- Ethylene or Propylene Glycol (Direct aqueous injection, GC-FID)
- Trihalomethanes (EPA 502.2)
- Inorganic Analytes
- Lead (EPA 239.2)
- Copper (EPA 220.2)
- Zinc (EPA 289.1)
- Cadmium (EPA 213.2)
- Chromium (EPA 218.2)
- Aluminum (EPA 200.7)
- Iron (EPA 200.7)
- Manganese (EPA 200.7)
- Sodium (EPA 373.1)
- Potassium (EPA 258.1)
- Chloride (EPA 325.3)
- Fluoride (USGA 1432-7/84)

Nitrate (EPA 353.2)
Sulfate (EPA 275.4)

Microbiological Analytes

Total and Fecal Coliform Bacteria (SMWW 9221B and 9221C)
Heterotrophic Plate Count (SMWW 9215C)
Pseudomonas aeruginosa (SMWW 9213F)

Table 3
Ice Sample Identification and Packaging Information

Sample	Manufacturer	Location	PIA	Water Source	Treatment	Product Name*	Product	Manuf. QC	Package	Closure
28311	Harney Ice Co.	Coralville	No	Coralville	Softening	Harney's Pure Ice	Cubes	No	8 lbs.	Metal Staple
28312	Hy Vee	Chariton	No	Chariton	Demineralization	Krystal Klear Pure Ice	Cubes	No	8 lbs.	Metal Staple
28313	QuikTrip	Coralville	No	Coralville	Unknown	QT Ice	Cubes	No	8.5 lbs.	Metal Staple
28314	Krieg Boys Ice	Dubuque	Yes	Dubuque	Filtration, Softening	Packaged Ice Tubes*	Tubes	Yes	5 lbs.	Heat Sealed
29063	QuikTrip	Iowa City	No	Iowa City	Unknown	QT Ice	Cubes	No	8.5 lbs.	Twist Tie
29064	Miller Mart	Iowa City	No	Iowa City	Unknown	Crystal Clear Sparkling Ice	Cubes	No	Unknown	Twist Tie
29065	Messerschmitt Ice Co.	Ottumwa	No	Ottumwa	Softening	Ice Nuggets*	Cubes	Yes	8 lbs.	Metal Staple
29066	Kwik Shop	Iowa City	No	Iowa City	None	Kwik Shop Ice	Cubes	No	8 lbs.	Draw String
29067	Star Ice Co.	Waterloo	No	Waterloo	Filtration	Pronto Markets Ice	Cubes	Yes	8 lbs.	Metal Staple
29068	Crystal Ice & Cold Storage	Waterloo	Yes	Well	Softened	Iceman's Crystal Pure Ice*	Cubes	Yes	8 lbs.	Metal Staple
29069	QuikTrip	Iowa City	No	Iowa City	Unknown	QT Ice	Cubes	No	8.5 lbs.	Twist Tie
29070	Artificial Ice Co.	Mason City	No	Mason City	Filtration, Reverse Osmosis	Mason City Ice*	Cubes	Yes	7 lbs.	Metal Staple
29071	QuikTrip	Iowa City	No	Iowa City	Unknown	QT Ice	Cubes	No	8.5 lbs.	Twist Tie
29072	Artesian Ice Co.	Zwingle	No	Well	Chlorination, Filtration	Serv-Ice	Cubes	Yes	Unknown	Plastic Tape
29073	Finnegan's Ice	Oskaloosa	Unknown	Unknown	Unknown	Finnegan's Ice*	Cubes	Yes	6 lbs.	Metal Staple
29074	QuikTrip	Iowa City	No	Iowa City	Unknown	QT Ice	Cubes	No	8.5 lbs.	Twist Tie
29444	Burlington Ice & Cold Storage	Burlington	No	Burlington	None	Serv-Ice*	Cubes	No	8 lbs.	Metal Staple
29445	Crystal Ice	West Point	Yes	West Point	Chlorination, Filtration	Crystal Ice	Cubes	Yes	16 lbs.	Metal Staple
29504	Hawkeye Ice	Davenport	No	Well	Chlorination,	Ice	Cubes	Yes	7 lbs.	Metal

	Co.				Filtration					Staple
30243	Crawford Ice Co.	Denison	No	Denison	None	Poor Rebel Ice	Cubes	No	7 lbs.	Metal Staple
30244	Valley Ice Co.	Omaha	Yes	Omaha	Demineralization	Ice*	Cubes	Yes	7 lbs.	Plastic Clip
31887	Hubbard Ice & Fuel Co.	Cedar Rapids	Yes	Well	Filtration, Softening	Iceman's Ice*	Cubes	Yes	8 lbs.	Metal Staples

* See footnotes for additional labels and product claims

28314	Water Quality Test A-1; Certified by Water Test Corp., London, NH; Bottled Water Quality - Just Colder!
29065	Sodium Free; Water source Ottumwa Water Works
29068	Member PIA
29070	Crystal Clear; Pure Sparkling; Water contained in this ice is supplied by Mason City Municipal Water Supply
31887	Ready to Use; Taste Free; Diamond Bright; Lasts Longer; Crystal Clear; Holds the Cold; Solid Frozen
29073	Made from Finnegan's Pure Water; What you can't taste is the difference
29444	Taste Free; Ready to Use; Crystal Clear; Diamond Bright; Hard Frozen
30244	The Difference is Clear; Satisfaction Guaranteed; Untouched by Human Hands; Packaged Under Sanitary Conditions; Member PIA

Table 4
Microbiological Quality of Packaged Ice

Sample	HPC (CFU / mL)	Mold (CFU / mL)	TC (MPN / 100mL)	FC (MPN / 100mL)	PA (MPN / 100mL)
MCL (Standard)	(<500 CFU/mL)	None	(<2.2/100mL)	(<2.2/100mL)	None
28311	<1	1	<2.2	<2.2	<2.2
28312	<1	1	<2.2	<2.2	<2.2
28313	>54,000	1	<2.2	<2.2	<2.2
28314	13	1	<2.2	<2.2	<2.2
29063	36,000	56	<2.2	<2.2	<2.2
29064	1,500	11	<2.2	<2.2	<2.2
29065	91	<1	<2.2	<2.2	<2.2
29066	4,000	5	<2.2	<2.2	<2.2
29067	<1	<1	<2.2	<2.2	<2.2
29068	12	<1	<2.2	<2.2	<2.2
29069	23,000	19	<2.2	<2.2	<2.2
29070	19,000	1	<2.2	<2.2	<2.2
29071	37,000	64	<2.2	<2.2	<2.2
29072	<1	1	<2.2	<2.2	<2.2
29073	120	5	<2.2	<2.2	<2.2
29074	>54,000	51	2.2	<2.2	<2.2
29444	63	2	<2.2	<2.2	<2.2
29445	20	<1	<2.2	<2.2	<2.2
29504	<1	2	<2.2	<2.2	<2.2
30243	21	<1	<2.2	<2.2	<2.2
30244	87	<1	<2.2	<2.2	<2.2
31887	17	<1	<2.2	<2.2	<2.2

Legend

HPC	Heterotrophic Plate Count
TC	Total Coliform
FC	Fecal Coliform
PA	*Pseudomonas aeruginosa*
CFU	Colony Forming Units
MPN	Most Probable Number
MCL	Maximum Contamination Level

Table 5
Identification of Organisms Found in Packaged Ice

Sample	Mold Identifications	Bacterial Identifications
28311	*Phoma* spp.	
28312	*Phoma* spp.	
28313	*Phoma* spp.	*Methylobacterium* spp.
28314	*Phoma* spp.	*Alcaligenes faecalis*
29063	*Phoma* spp., *Acremonium* spp.	*Pseudomonas* spp. *Flavobacterium* spp.
29064	*Phoma* spp.	*Pseudomonas paucimobilis*
29065		*Bacillus cereus* *Pseudomonas paucimobilis* *Corynebacterium* spp.
29066	*Phoma* spp.	*Methylobacterium* spp. *Spirasoma* spp. *Rhodococcus* spp.
29067		
29068		*Rhodococcus luteus* Unidentified Nonfermenter
29069	*Phoma* spp.	*Xanthomonas* spp. *Pseudomonas maltophilia* Unidentified Nonoxidizer
29070	*Phoma* spp.	*Flavobacterium* spp.
29071	*Phoma* spp.	*Flavobacterium* spp.
29072	*Cladosporium* spp.	
29073	*Penicillium* spp. Yeast	*Xanthomonas* spp.
29074	*Phoma* spp.	Unidentified Oxidizer
29444	*Penicillium* spp.	*Acinetobacter lwoffi*
29445		*Pseudomonas cepacia* Unidentified Nonfermenter
29504	*Cladosporium* spp.	

30243		*Corynebacterium* spp. *Methlyobacterium* spp.
30244		*Staphylococcus epidermidis* *Rhodococcus* spp. *Corynebacterium* spp. *Bacillus* spp.
31887	Sterile hyphae	*Corynebacterium* spp. *Micrococcus luteus* *Alcaligenes faecalis*

Table 6
Significance of Organisms Isolated from Ice

Pseudomonas cepacia	Isolated from rotten onions, soil and animals. Colonizes cleaning products and disinfectants. A primary opportunistic human pathogen.
Pseudomonas maltophilia	Isolated from soil, water, animals and plants. Causes opportunistic infections in humans.
Pseudomonas paucimobilis	Isolated from water, air and plants. Causes opportunistic infections in humans.
Flavobacterium spp.	Isolated from soil and water. Causes opportunistic infections in humans.
Acinetobacter lwoffi	Isolated from skin of humans, soil and animals. Causes opportunistic infections in humans.
Corynebacterium aquaticum	Isolated from skin, soil and water. Causes opportunistic infections in humans.
Staphylococcus epidermidis	Isolated from skin and environmental surfaces. Causes opportunistic infections in humans.
Alcaligenes faecalis	Isolated from the gastrointestinal tract, soil and water. Causes opportunistic infections in humans.
Bacillus cereus	Isolated from soil and water. Causes opportunistic infections in humans and food poisoning outbreaks.
Rhodococcus spp.	Isolated from soil and water. Causes rare opportunistic infections in humans.
Xanthomonas spp.	Isolated from soil and water. Rarely pathogenic for humans.
Methylobacterium spp.	Isolated from soil and water. Rarely pathogenic for humans.
Micrococcus luteus	Isolated from soil, air and water. Not known to cause human infections.
Spirasoma spp.	Isolated from soil and water. Not known to cause human infections.
Yeast	Isolated from skin, soil and sewage.

Rarely pathogenic for humans.

Table 7
Particulates in Ice

Sample	Fibers	Insect Parts	Algae	Mold Spore	Iron Bacteria	Plastic	Paint Chips	Carbonates
28311	-	-	-	-	-	-	-	-
28312	-	-	-	-	-	-	-	-
28313	2	-	1	25	-	-	-	-
28314	-	-	-	-	-	-	-	-
29063	1	-	-	-	-	1	-	-
29064	1	-	-	-	-	-	-	-
29065	3	-	-	-	-	-	-	-
29066	5	-	-	-	-	-	-	-
29067	1	-	-	-	-	-	3	-
29068	1	-	-	-	-	-	-	-
29069	2	13	-	-	-	-	-	-
29070	1	-	-	-	-	-	-	-
29071	-	-	-	13	-	-	-	-
29072	Many	-	-	-	1/10 fields	Many	-	Confluent
29073	1	-	-	-	-	-	-	-
29074	-	2	-	-	-	-	-	-
29444	1	-	-	-	-	-	-	-
29445	1	-	-	-	-	-	-	-
29504	-	-	-	-	-	-	-	Confluent
30243	-	-	-	-	-	-	-	-
30244	-	-	-	3	-	-	-	-
31887	-	-	3	-	-	-	-	-

Table 8
Inorganic Analysis of Packaged Ice

Sample	Nitrate	pH	Conductance	TDS	Potassium	Sodium	Chloride	Fluoride	Sulfate	Aluminum	Cadmium	Chromium	Copper	Iron	Lead	Man-ganese	Zinc
	45 mg/L	(6.5 - 8.5)	(850 MHOS)	(500 mg/L)	None	None	(250 mg/L)	4 mg/L	(250 mg/L)	None	0.01 mg/L	0.05 mg/L	(1 mg/L)	(0.3 mg/L)	0.05 mg/L	(0.05 mg/L)	(5 mg/L)
28311	1	9.4	200	108	38	12	3.5	0.25	30	<0.1	<0.001	<0.01	<0.01	0.06	<0.001	<0.02	0.22
28312	<1	7.1	30	4	<1	0.7	0.5	0.2	<0.1	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
28313	<1	6.7	20	2	<1	1.1	0.5	0.1	3.1	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
28314	<1	6.4	11	2	2.4	<0.5	0.5	0.2	<0.1	<0.1	<0.001	<0.01	<0.01	0.03	<0.001	<0.02	<0.02
29063	<1	7.4	16	<1	<1	0.6	1	0.1	5.3	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29064	<1	7.1	18	<1	<1	0.8	1	0.15	6.1	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29065	<1	7.2	11	<1	<1	2	1	0.15	3.5	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	0.03
29066	<1	6.8	19	<1	<1	0.6	1	0.15	5.9	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29067	1	8.4	55	<1	<1	1.3	3.5	0.3	4.6	<0.1	<0.001	<0.01	0.03	0.05	<0.001	<0.02	0.04
29068	<1	7.8	17	<1	<1	<0.5	0.5	<0.1	5.2	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	0.04
29069	<1	6.7	14	<1	<1	<0.5	0.5	0.1	3.4	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29070	<1	6.8	17	<1	<1	1.1	0.5	0.1	2.2	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29071	<1	6.6	10	<1	<1	0.5	1.5	0.1	4.6	<0.1	<0.001	<0.01	<0.01	<0.02	0.003	<0.02	<0.02
29072	6	9.8	130	70	<1	2.6	5	<0.1	9.8	<0.1	<0.001	<0.01	0.2	0.02	0.028	<0.02	0.02
29073	<1	5.4	2.2	<1	<1	<0.5	1	<0.1	2.2	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29074	<1	8.2	22	<1	<1	0.6	0.5	0.1	3.8	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	<0.02
29444	<1	4.75	17	<1	<1	0.7	1.5	0.35	2.3	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	0.02
29445	<1	6.7	19	<1	<1	0.5	1	0.3	3.4	<0.1	<0.001	<0.01	<0.01	0.12	<0.001	<0.02	<0.02
29504	<1	9.4	130	12	<1	1.7	2	0.1	1.5	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	0.02
30243	<1	7.3	180	94	<1	9.6	22	0.4	20	<0.1	<0.001	<0.01	<0.01	0.21	<0.001	<0.02	0.03
30244	<1	9.1	82	8	<1	4.5	4	0.3	4.2	<0.1	<0.001	<0.01	<0.01	<0.02	<0.001	<0.02	0.02
31887	<1	9.8	130	50	<1	33	7	0.1	3	<0.1	<0.001	<0.01	<0.01	0.04	0.005	<0.02	<0.02

Table 9
Organic Chemical Analysis of Packaged Ice

Sample	**Methylene Chloride**	**1,1,1-Trichloroethane**	**Total Trichloroethane**	**Ethylene Glycol**	**Propylene Glycol**
MCL(Standard)	(2 g/L)	200 g/L	100 g/L	None	None
28311	<2	<0.5	<0.5	<50	<51
28312	<2	<0.5	2.6	<50	<51
28313	<2	<0.5	1.5	<50	<51
28314	<2	<0.5	<0.5	<50	<51
29063	<2	<0.5	<0.5	<55	<51
29064	<2	<0.5	<0.5	<55	<51
29065	<2	<0.5	<0.5	<55	<51
29066	<2	<0.5	<0.5	<55	<51
29067	<2	<0.5	<0.5	<55	<51
29068	<2	<0.5	<0.5	<55	<51
29069	<2	4.3	<0.5	<55	<51
29070	<2	<0.5	<0.5	<55	<51
29071	<2	<0.5	<0.5	<55	<51
29072	<2	<0.5	2	<55	<51
29073	<2	<0.5	<0.5	<55	<51
29074	<2	<0.5	<0.5	<55	<51
29444	<2	<0.5	<0.5	<55	<52
29445	<2	<0.5	<0.5	<55	<52
29504	<2	<0.5	3.1	<55	<52
30243	<2	<0.5	0.6	<55	<52
30244	<2	<0.5	<0.5	<55	<52
31887	<2	<0.5	<0.5	<50	<50