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Emerald Article: MICROBIAL QUALITY OF ICE CUBES: A SURVEY

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Introduction

Today many drinks and beverages are kept cold and palatable by the addition of ice. Most establishments have a machine for making ice cubes, and many have equipment for producing crushed or flaked ice.

Tjoa *et al.* (1977), studying the association of popular drinks and travellers' diarrhoea in Central America, examined the survival of four entropathogenic organisms in ice: *Shigella flexneri, Shigella sonnei, Escherichia coli* and *Salmonella typhi*. The results showed that all the organisms survived freezing for 24 hours followed by melting in alcohol, even when this was 86° proof tequila. A low mortality of *E. coli* at -2°C was found by Russel (Russel and Osterud 1945). This was confirmed in recent work when it was found that coliform bacteria can grow slowly at temperatures as low as 1.5°C (Gross, 1984). A pilot study was undertaken in Leeds (Environmental Health Department, 1984) on samples of ice taken from various ice buckets. Total viable counts (TVC) in excess of 1,000 organisms per millilitre were recorded.

These findings indicate the possible risk posed by enteric pathogens, once introduced into or onto ice that is to be served with drinks. This survey aims to investigate whether the techniques, used to produce and handle ice in British public houses, can create a significant health risk to the customer.

Experimentation

A survey of licensed premises within the Leeds area was undertaken. The biological quality of ice in twelve of these premises was investigated and a survey sheet was completed at each of the premises.

Sampling Procedure

Over a period of three months (July to September 1986), samples were taken from twelve public houses. Each of the premises was visited three times within this time period. On each visit the following samples were taken:

(a) a sample of water which supplied the ice-making machine — taken from the nearest open point in the system;

(b) a sample of ice from the ice-making machine;

(c) a sample of ice from the ice bucket at the bar.

Samples were taken within the period of 11.00 a.m. and 12.30 p.m., and were immediately conveyed to the Public Health Laboratory in Leeds.

Microbiological Examination

The ice was allowed to melt under ambient conditions. Once melted and with the minimum of delay, total viable counts at 22°C and 37°C, *E. Coli* and coliform counts were performed. Random coliform organisms isolated were further identified using AP120 Enterobacteriaceae System (API Laboratory Products Ltd, UK).

Method Used to Determine Total Viable Colony Counts

1 ml of each sample was aseptically transferred to a petri dish and melted yeast (approximately 20 ml) at 50°C was added. The contents of each dish was rotated and allowed to solidify. Two petri dishes were prepared from each sample and one incubated at 22°C, the other at 37°C for 24 hours. The colonies that had grown were then counted.

Method Used to Test for Coliform Bacilla

Coliform were enumerated by the membrane filtration method as recommended in the *Ministry of Health Reports on Public Health and Medical Subjects*, No. 71 (revised edition, 1982) using Sodium Lauryl Sulphate Broth (Oxid MM615). Coliforms which produced acid from lactose were regarded as presumptive coliforms.

All membranes were examined under good light, when necessary with a hand lens. Yellow, lactose fermenting colonies were counted, irrespective of size. Pink or colourless non-lactose fermenting colonies were ignored.

Method Used to Test for Escherichia Coli

Depending on the number of coliform organisms isolated from a sample, up to six of these yellow colonies were subcultured to tubes of Lactose Peptone Water containing an inner (Durham) tube to detect gas formation. The tubes were incubated at 44°C ±0.5°C, and examined for the presence of acid and gas formation after 24 hours which was presumed to indicate the presence of *E. coli*.

The Survey Sheet

This was devised in order to obtain an overall impression of the techniques used in producing, storing and serving the ice at each of the premises. The sheet was as follows:

(1) How is the ice produced?
(2) Description of the production machinery used:
  (a) make,
  (b) age,
  (c) condition and locality,
  (d) temperature of storage.
(3) How is the ice transferred from its source of production to where it is to be stored prior to serving?
(4) Where is the ice stored prior to serving?
(5) What is the ice stored in and has this a cover?
(6) Who serves the ice (staff/customers)?
(7) With what is the ice served?
(8) What drinks is the ice put into?

Further questions were asked of tenants/managers. First, had staff received any training or instruction about how to handle the ice or how to clean the ice-making machine and any equipment coming into contact with the ice. Second, the frequency at which machines and equipment were cleaned, and with what were they cleaned. Third, the frequency at which machines and equipment were serviced. Finally, whether managers/tenants had an instruction manual to cover the operation and maintenance of their machine and, if so, had this been read?

Results

Microbiological Examination

From Table I it can be seen that at both incubation temperatures the ice samples from the bucket were found to have the highest TVC, being greater than 1,000 cfu/ml in twelve cases at 22°C. The mains water samples, as expected, had the lowest TVC. Table II shows that the ice samples taken from the buckets had the highest coliform counts, in six of the samples, being greater than 180 cfu/100 ml. None of the coliform organisms examined were found to be *E. coli*. However sub-species of Citrobacter, Enterobacter and Klebsiella were identified.

Survey Results

It is interesting to note that few public houses had the machine that their breweries recommended, which suggests that breweries have had little involvement when choosing a machine for one of their premises.

Little thought seemed to have been given about siting of machines, most were found in cellars, usually where access for servicing purposes was difficult, and contamination of the ice was likely from surrounding dirty and dusty areas. None of the landlords thought it necessary to service their machines, hence it is quite possible that some machines had never been serviced even though most were several years old. Few operatives had read an instruction manual. Although they may have been provided when the machine was installed, all had since disappeared.

The temperature within the holding bins, in seven of the twelve machines surveyed, was above the manufacturers' recommended range of 2°C-4°C. In three cases this temperature was above 8°C. The temperature recorded on each visit to each of the premises remained approximately the same; it therefore seemed likely that the higher readings were due to some malfunctioning of the machines, possible causes being inadequate servicing or poor location.

Sample	Sample size	Range (cfu/ml) 22°C	Range (cfu/ml) 37°C	Mean (cfu/ml) 22°C	Mean (cfu/ml) 37°C	Standard Deviation (cfu/ml) 22°C	Standard Deviation (cfu/ml) 37°C
Mains water	36	0-64	0-124	7	12	12	24
Ice from machine	36	0-592	0-488	74	34	114	86
Ice from ice bucket	33	1->1,000	3-892	380	81	483	162

Table I.
Comparison of Total Viable Bacteria Counts of Mains Water, Ice from the Machine and Ice from the Ice Bucket

Sample	Sample size	Range(cfu 100 ml)	Mean (cfu/100 ml)	Standard Deviation (cfu/100 ml)
Mains water	36	0-14	1	2
Ice from machine	36	0-80	12	22
Ice from ice bucket	33	0-180+	56	55

Table II.
Comparison of Coliform Counts of Mains Water, Ice from the Machine and Ice from the Ice Bucket

The majority of machines were in a poor condition. In several cases there was evidence of rust, dirt, scum and slime within the holding bin. Operatives at three premises did claim to clean the bin, but only one used a sanitiser. None of the ice production areas were cleaned.

At all premises little concern was shown about the equipment that came into contact with the ice. From a visual inspection the surveyor got the impression that scoops and buckets were rarely if ever cleaned. Staff received no instructions about handling or cleaning practices, and at two premises it was noted that servicing implements were missing from the ice buckets, indicating that ice was being served with hands.

Only half of the ice buckets had covers, and four of these were situated on the bar as opposed to the back of the bar. It is logical to assume that a higher risk of contamination exists when the bucket is on the bar as the ice can be contaminated by customers as well as staff.

Two of the breweries investigated gave advice on how to handle ice, but it was clear that this advice was not followed, showing that breweries exert little management control in this area.

Discussion and Conclusions

There are no legal standards specifically governing the bacterial quality of ice which is used for drinks. However the consumer has the right to expect ice to have a similar microbial standard to the water from which it was made. There is a high probability that ice from ice buckets will exceed the EC standard for drinking water.

Fifty-eight per cent of samples exceeded the standard at 22°C, 61 per cent at 37°C and 82 per cent of samples contained coliforms. Even if ice does not pose a risk of infection, it has been found to be of such poor quality that that alone warrants improvements in management techniques.

Ice is likely to become contaminated by airborne particles, contaminated hands, or from dirty utensils

In addition to the water supply, ice is likely to become contaminated by airborne particles, contaminated hands, or from dirty utensils. It is clear from other investigations that pathogenic bacteria can survive and in some cases slow-multiply on ice (Gross, 1984). Viruses may also be a possible source of infection once introduced on to ice cubes. They are viable at 0°C, and can be transmitted by ice as only a small infective dose is required for infection.

This study has found poor hygienic practices within premises which, coupled with the fact that contamination of the ice did occur, suggest that ice can be a potential risk to health. The contamination appears to be a management problem, with a distinct lack of care shown regarding good hygienic practices where ice is concerned. There are many vehicles that spread infectious diseases, of which ice could possibly be one, and one which could easily be removed by improving management controls. Admittedly ice could not be a major factor, but by reducing the risk posed by this potential vehicle, the general risk of spread would be reduced.

Recommendations

It is likely that total viable counts and the incidence of contamination would be reduced if the recommended cleaning/disinfection procedures and good hygienic practices are followed. The responsibility falls on the managers of establishments to ensure that sufficient advice and information is given, so that good practice will occur and continue to occur.

Instruction about how to operate and maintain the ice-making machine
Most manufacturers give instructions in their information manuals which are supplied with each machine sold. Instructions should include:

(a) *The frequency that the ice-making machine needs to be serviced*: most must be serviced at least twice a year, and possibly more frequently if a malfunction becomes apparent.

(b) *Considerations for a location site for the ice-making machine*
  (i) In an area free from dirt and dust, preferably off the ground.
  (ii) Where there is sufficient ventilation for efficient air removal around the unit, and adequate spacing for service access.
  (iii) A minimum room temperature of 10°C. A maximum room temperature of 40°C.

(c) *The connecting of the ice-making machine to a water supply*: it must be connected to a "direct" mains water supply.

(d) *The frequency that the ice-making machine needs to be cleaned*
  (i) The ice production area should be cleaned at least four times a year to prevent the build-up of micro-organisms in this compartment. In most machines it is possible to see into the ice production area. This should be monitored for any growth of scum or slime, and if such growths become apparent, it should immediately be cleaned according to the manufacturers' instructions (i.e. with the use of a recommended sanitiser).
  (ii) The ice storage compartment should be inspected for any obvious contamination. If necessary the ice should be removed and the compartment wiped with a taintless sanitiser. Even if contamination is not apparent this storage bin needs to be cleaned weekly.

Improved Handling Techniques
The ice should *always* be transferred by using some utensil (i.e. hands should never be used). Ice buckets must always have lids which once removed must immediately be replaced. The buckets should be kept behind the bar where staff alone can serve the ice, hence reducing the risk posed of contamination from customers.

Environmental health officers have an important role to play in ensuring that these improvements are sufficiently implemented and that they continue to be practised. Routine visits by EHOs to establishments that serve ice in drinks should include an examination of the practices used to produce and handle the ice.

Additional Research

It would be advantageous to do a similar investigation but across a wider survey area to further justify the recommendations. Specific pathogens were not identified, but had more tests been carried out they may have been. Therefore a higher degree of sensitivity could be used to look for pathogens using a larger sample size.

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References

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