ICE-CREAMS : THEIR MANUFACTURE AND BACTERIOLOGY.

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I HAVE recently visited a number of ice-cream shops, to ascertain their sanitary condition and obtain particulars of the method of manufacture of ices. One shop may be described in detail, as representing a fair sample of the low-class shop where are retailed custard-and-water ices and custard.

The ground-floor consists of a shop and a back room, where all the cooking is done, this latter room being also the living room. In the shop—11 feet 6 inches long, 11 feet wide, and 8 feet high—the counter extends from end to end. Behind the counter are kept the ices in their freezing-pails. Ginger-beer and fruit juice are also sold in the shop. A door leads from the shop into the kitchen, which is 12 feet 3 inches long, 11 feet wide, and 8 feet high, and has a good-sized window looking on to the yard behind. Upstairs there are four bedrooms.

At the time of my visit both shop and kitchen were dirty, and littered with a variety of household articles. One could hardly expect the rooms would always be clean, as there were, besides children, eight adults living on the premises.

The yard is 8 feet 3 inches long, by 11 feet wide. In one corner is the water-closet, and in the opposite corner a sink draining into a gully-trap. From the sink to near the kitchen door is a shelf, on which, close to the sink, there was, when I visited the house, an uncovered pan half full of custard. On the shelf and sink were also a number of unclean kitchen utensils, and under the shelf an uncovered dust-bin. A partial roof, 7 feet from the ground, extends over the shelf and sink, the rest of the yard being open (Plate I.).

[Plates II. and III. are from photos of similar yards in which these creams are made.]

The drains have been recently altered by the Sanitary Authority. The water-closet was in good working order, but there were no grids over the yard gulleys, and the gulleys were full of grease, tea-leaves, etc.

The method of manufacture of the ices has a practical bearing on their bacteriology. They are made as follows : For each quart of milk $\frac{1}{2}$ lb. of sugar, 2 to 3 eggs, and 1 oz. of cornflour are required.

The sugar is dissolved in the milk by boiling ; the eggs are well beaten and mixed with the cornflour ; the boiling milk is then added to the mixture of eggs and cornflour. This custard is made in a large pan, like an ordinary tin fish-kettle, and after making, is left to cool in the uncovered pan in whatever place may be most convenient, usually on the floor of the yard, or on a shelf in the yard ; in some cases the water-closet acts as a larder during the night.

Ice-creams are made differently to the custard-ices : fresh cream is flavoured with raspberry or other flavouring, and frozen.

On the 24th of August, accompanied by the senior inspector of the Strand district, I obtained the following examples for analysis, viz. : two custard-ices, one custard, two washing-waters, and one ice-cream.

From street-barrow A,	custard-ice A.
" "	A, washing-water A.
From low-class shop B,	custard-ice B.
" "	B, custard B.
From street-barrow D,	washing-water D.
From good-class shop C,	cream-ice C.

Each sample was taken in a sterilized glass-stoppered jar, and the examination commenced as soon as possible.

METHOD OF EXAMINATIONS.

1 c.c. of each sample was mixed with 250 c.c. of sterilized water, and from each of these dilutions plates were made and tubes inoculated. For each sample I used three gelatine plates, two agar plates, three broth tubes, and one Parietti broth tube. From the Parietti tubes, after incubating for twenty-four hours at 37.5° C., plates were made.

ANIMAL INOCULATION.

Broth tubes, inoculated with one platinum loopful of the ices, were incubated at 37.5° C. for twenty-four hours, 2 c.c. of the culture from custard-ice A being injected into guinea-pig A, and the same quantity of cultures from ices B and C into guinea-pigs B and C respectively.

A general microscopic examination was made of the undiluted ices, and, after diluting a portion of each ice with water and centrifugalizing, twelve cover-glass preparations were made of the sediment from each sample and stained for tubercle bacilli.

RESULTS OF THE EXAMINATION.

1. *General Microscopic.*—Beyond the presence of some indefinite undetermined débris no foreign matter was found in the ices or custard.

PLATE I.

J. F. A.

To face p. 256.

J. W.

PLATE II.

SHOWING ICE-CREAM CANS. THE OPEN DOOR OF THE W.C.
IS ON THE LEFT.

J. W.

PLATE III.

SHOWING DUST-BIN ON THE RIGHT. ALONGSIDE THIS IS
AN ICE-TUB, AND BEHIND THESE WAS THE
CUSTARD-PAIL.

To face p. 257.

2. *Quantitative*.—The number of micro-organisms per c.c. were estimated from the gelatine plates as follows :

Custard-ice A	...	...	250,000
Custard-ice B	...	...	1,248,000
Cream-ice C	...	...	1,504,000
Custard B	...	...	500
Washing-water A	...	...	Uncountable
Washing-water D	...	...	Uncountable

3. *Qualitative*.—The micro-organisms isolated from the samples were :

Micrococcus agilis, *Staphylococcus pyogenes aureus*, *Staphylococcus cereus albus*, *M. aurantiacus*, *B. subtilis*, *B. fluorescens liquefaciens*, *B. figurans*, *Proteus vulgaris*, *B. Prodigiosus*, *Streptococci*, *Sarcinæ*, *Yeasts*, *Pink Torula*, *B. coli communis*, *B. fluorescens non-liquefaciens*, and *B. fluorescens tenuis*.

Each of the above organisms was subcultured and its character noted ; for example, *B. figurans* was isolated from the agar plate of custard-ice A, and gave a non-liquefying feather or fern-like growth on gelatine, with fine filaments extending upwards from the surface and downwards into the medium. In gelatine stab the growth was very slow and only slight along the line of stab. At the upper part a few fine filaments radiated out from line of stab. From agar stab at 37·5° C. a similar growth was obtained, but more marked.

B. fluorescens tenuis was isolated from wash-water D, and gave well-marked growth on gelatine, which was not liquefied but was coloured green ; on agar well-marked growth, but the medium was not coloured at the end of seven days ; on potato a brownish growth, on blood serum a slight growth and the medium tinged green. The bacilli did not retain the stain with Gram's method.

The more important organisms in the above list may now be noted under the head of the sample from which they were obtained.

CUSTARD-ICE A.

This contained *B. coli communis* and an organism allied to the coli group, but very motile. The following is a description of this organism.

From an opalescent white colony on agar plate, showing very motile bacilli, subcultures were made, of which the characters were : Gelatine stroke, non-liquefying thin whitish growth ; agar stroke, opalescent white growth, showing very motile small bacilli, with round ends, no spores ; the bacilli did not retain the stain with Gram. In gelatine stroke-culture gas developed ; glucose-agar stab, gas

developed; milk, no coagulation in seven days at 37·5° C.; in peptone broth marked indol in forty-eight hours.

Guinea-pig A, which had received an intraperitoneal injection of the broth-culture from the ice A, died in twenty-four hours. The peritoneal cavity contained a quantity of blood-stained serum, with which agar tubes were inoculated and incubated at 37·5° C. Subcultures from these tubes gave the same characters as those from the agar plate described above.

CUSTARD-ICE B.

Chief organisms present: *B. prodigiosus*, *B. coli communis*.

Guinea-pig in twenty-four hours showed, around the site of the wound, considerable œdema, with discharge of blood-stained fluid. From this fluid an organism giving the characters of the *Bacillus coli communis* was isolated. This guinea-pig died within forty-eight hours, but had been so eaten by its comrades as to be useless for examination.

CUSTARD B.

B. coli communis was not present. *Staphylococci* and *Pink torula* were isolated.

CREAM-ICE C.

B. coli communis present.

Guinea-pig C, which received 2 c.c. of the broth culture of the cream, was in no way affected, and was alive 14 days later.

WASH-WATER A.

Proteus vulgaris and *B. coli communis* present.

WATER D.

B. coli communis present.

CONCLUSIONS TO BE DRAWN FROM THE EXAMINATION.

The number of micro-organisms in cream and custard ices vary widely, as shown by the numbers found by different observers.

McFadyen found	...	119,000 to 7,000,000 per c.c.
Nield Cook found	...	10,000,000 to 14,000,000 "
Kanthack found	...	8,000,000 to 13,000,000 "
Foulerton found	...	500,000 to 7,000,000 "
My own results give	...	250,000 to 1,500,000 "

It is almost impossible to fix a standard for the number of micro-organisms in ice-creams. Ordinary milk contains from 3,000,000 to 4,000,000 micro-organisms per c.c., and cream may contain as many as 10,000,000, so that a cream ice-cream, without being

further contaminated, may still contain an enormous number of organisms derived from the original milk or cream. In these cream-ices we may expect not infrequently to find the *B. coli communis*, on account of its not uncommon presence in milk. The case of the custard-ices is different. We know that the organisms in milk are much reduced in number by boiling the milk, and the method of manufacture of these custard-ices should make the comparison between the cream-ices and the custard-ices more favourable for the latter than we find to be the case.

In custard B only 500 micro-organisms were found per c.c., while in custard-ice B, obtained from the same shop, and made presumably from a custard under the same conditions as custard B, the number of micro-organisms was 1,250,000 per c.c.

Is such a number of organisms permissible in a custard-ice? I think not, for these reasons:

1. The milk is well boiled, and the great majority of organisms in the milk are thus destroyed.

2. The quantity of boiling milk used for each batch of custard is 6 quarts, and the bulk of the beaten-up eggs may be estimated at 1 pint. The resulting temperature of the mixed fluid of 6 quarts boiling and 1 pint cool should be sufficiently high to destroy some organisms, especially as the fluid retains a high degree of heat for some time. The resulting mixture should therefore be fairly free from organisms.

If these points are granted, how is it such a number of organisms are found in these custard-ices?

The sources of contamination are varied, and include any of the following:

1. Dirty vessels used in the preparation of the ices; the pans are washed in cold water, rarely in hot, and almost never scalded out.

2. Dust, etc., from the air (during cooling of the custard). The positions in which the custards are placed to cool, close to dirty pans, near refuse-bins, in dirty yards or in kitchens, small, ill-ventilated, and far from clean, with a number of young children constantly about—make, to say the least of it, an unfitting preparation for a food intended for human consumption. The houses are not suitable for the manufacture of these custards. They have no accommodation for storing the custards; the number of people inhabiting the houses is often excessive, and their habits far from clean. Ice-cream vendors inform me that if the custard is covered over while standing to cool it sours. At the same time it might be possible, by making a gauze covering to the custard-pans, to improve the custards as a food. One vendor has promised to do this, and I

intend to examine samples of the custard thus covered and compare the result with those obtained from uncovered cans.

3. Dirty ice in the freezing-pails (during freezing). When the inner vessel containing the custard is moved there is a possibility of some of the ice-water getting into the custard; possibly the organisms may enter the custard-cans from this source.

4. During delivery to the customer dust from air and dirty washing-water.

The street-barrow ices are specially liable to receive organisms from dust such as *B. subtilis* and *B. coli communis*. The washing-water may also be a fruitful source of contamination. The customer likes the ice out of a glass, the glass is washed and dried on a not over-clean towel and filled again for the next customer. During these proceedings we have the possibility of organisms introduced on to the glass from one customer, being transferred to water, towel, and ice-pail, a supply of organisms being thus obtained for other customers.

Should the custard-ices A and B and the cream-ice C be considered fit for food? and if not, why not? Custard-ice A, made with boiling milk, contained 250,000 organisms per c.c. Among them were *B. coli communis* and an allied organism which was also isolated from the guinea-pig inoculated with broth-culture from the ice. This guinea-pig died in 24 hours. With regard to this ice a favourable opinion or otherwise should be withheld until the pathogenic effects of this second organism have been more fully tested.*

Custard-ice B contained 1,240,000 organisms per c.c., among which were *B. coli communis* and *B. prodigiosus*. The custard from the same shop contained 500 organisms per c.c. (the sample being taken 3 hours after the custard was made). The milk had been boiled, the shop was so situated that street-dust, which would probably contain *B. coli communis*, could not likely enter. On these grounds, therefore, I consider the ice unfit for food.

Cream-ice C. There is nothing unsatisfactory in this ice as a food.

NOTE.—My thanks are due to Mr. Foulerton, who kindly performed the inoculations in animals at the Institute of Preventive Medicine when the laboratory at King's College was closed for repairs, and to Dr. F. J. Allan, Medical Officer of Health of the Strand district, for the facilities he gave me for obtaining the samples.

* The organism was a bacillus of well-marked rod-form, with no filaments, and not forming spores. It stained with ordinary dyes, but not by Gram's method. The characters of its various cultures have been described above (see p. 257).