In another series with fresh peas which were overcooked to the extent of rupture of the hulls, an average destruction of 35 and 57 per cent. of the original thiamine occurred when cooked with water or water and sodium bicarbonate, respectively.

The experiments indicate that no greater destruction occurs in the thiamine remaining in the intact pea after cooking with sodium bicarbonate than when water alone is employed. Slightly greater destruction results in the thiamine leached out of the pea during cooking. The loss only amounts to 8.3 per cent. in the frozen peas and 3.6 per cent. in the fresh peas cooked with sodium bicarbonate.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR DETERMINATION OF THE BACTERIAL CONTENT OF AIR[1]

A NUMBER of devices have been employed for determining the bacterial content of air. To be satisfactory, such a device must trap all or nearly all the air-borne microorganisms, must allow quantitative recovery of the bacteria for counting, must allow sampling of a large volume of air so that the sample obtained is representative, and must be simple and convenient to operate under field conditions.

The Wells centrifuge has perhaps been used most widely for bacterial air analysis. Theoretical considerations and experimental data have been put forth by Phelps and Buchbinder[2] showing that only those bacteria carried on droplet nuclei greater than a certain minimum size can be retained by the Wells Centrifuge. Wheeler, Foley and Jones[3] have suggested bubbling air through glass beads immersed in broth, as had been done by Robertson and associates.[4] In experiments testing the recovery of bacteria from room air, Wheeler showed that the glass beads device recovered eight times as many bacteria per cubic foot of air as the Wells centrifuge. A discussion of the merits of other bacterial samplers is given by Bourdillon, Lidwell and Thomas.[5]

The apparatus described in the present paper and pictured in Fig. 1 utilizes the principle of atomization to coat the bacterial particles with a layer of liquid.[6] The mist thus produced is carried into the second chamber of the collector, where it is bubbled through liquid which absorbs the droplets.

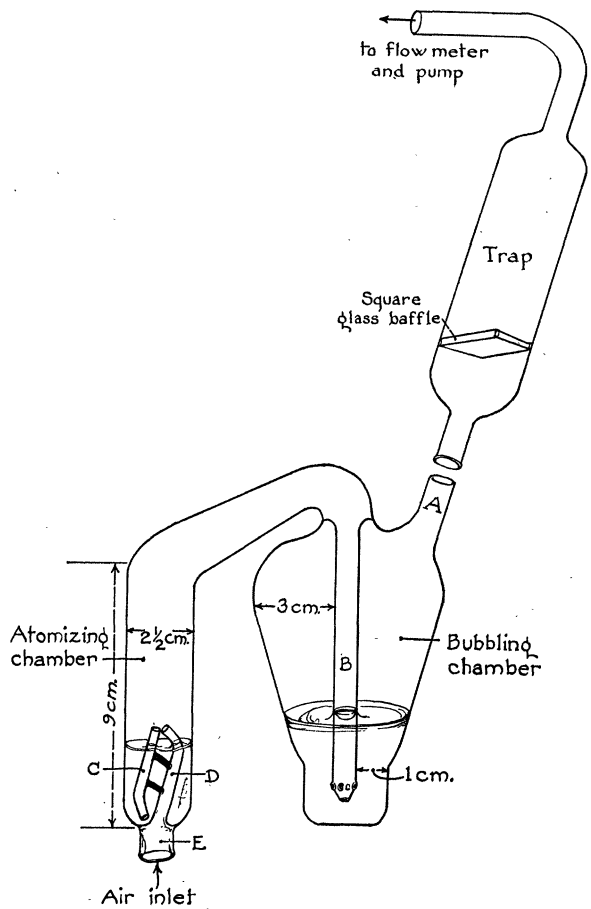

FIG. 1. Atomizer Collector for bacterial air analysis. The capillary, C, is about 1 mm, inner diameter; D is about 1.5 mm, inner diameter, at the tip. At the bottom of tube B are five holes 1 mm in diameter.

The procedure of operation is as follows: Fifteen cc of sterile broth plus two drops of sterile olive oil are pipetted into opening A of the apparatus which

[1] This investigation was aided in part through the Commission on Cross Infections in Hospitals, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Division, Office of the Surgeon General, United States Army.

[2] E. B. Phelps and L. Buchbinder, *Jour. Bact.*, 42: 321, 1941.

[3] S. M. Wheeler, G. E. Foley and T. Duckett Jones, SCIENCE, 94: 445, 1941.

[4] O. H. Robertson, Edward Bigg, B. F. Miller, Zelma Baker, SCIENCE, 93: 213, 1941.

[5] R. B. Bourdillon, O. M. Lidwell and J. C. Thomas, *Jour. Hygiene*, 41: 197, 1941.

[6] The Palmer water sampler for dust collection also has made use of this principle, G. T. Palmer, *Amer. Jour. Public Health*, 6: 54, 1916. S. H. Katz, G. W. Smith, A. M. Myers, L. J. Trostel, Margaret Ingels and Leonard Greenburg, *Pub. Health Bull.*, No. 144, 1925.

has been sterilized by autoclaving. Olive oil prevents the building up of foam masses, which would cause loss of the scrubbing fluid through bubbling over. Sufficient fluid is forced up tube B (either by tilting or by applying gentle air pressure at A) and poured into the atomizing chamber until the liquid level reaches a point about five mm below the top of the capillary tube C. The apparatus is then connected with sterile precautions to the trap[7] with a short piece of rubber tubing and air is drawn through the system by means of a small suction pump[8] at a rate measured by a calibrated flowmeter.

The air enters the inlet E and is directed through nozzle D into a jet which blows across the capillary tube C, as is done in the Graeser[9] atomizer. Liquid is thus drawn up into the capillary and atomized into the air stream. The droplets so produced either fall back into the liquid in the first chamber or else are trapped in the second chamber, where the air is bubbled through the holes at the bottom of tube B.

It was found convenient to take 10- to 15-minute samples at a rate of about three quarters of a cubic foot per minute. At the end of this time the atomizer is tilted so that all the fluid is poured into the bubbling chamber and trap. The liquid may be poured back and forth to wash off any bacteria remaining on the walls of the chambers and trap. Two tenths, 0.5 and 1.0 cc portions of the fluid in the sampler are removed for blood agar pour plates. From these plate counts the total number of bacteria in the sample are computed, and since the air volume is known, the bacterial count per cubic foot of air may be calculated. It is necessary to apply a correction factor because of loss of fluid due principally to evaporation. This correction factor is nearly constant for different samplers and varies with the relative humidity. For 10 cubic foot air samples the fluid loss varies between 1.8 cc and 3.2 cc at humidities of 70 per cent. and 30 per cent., respectively, so that an average correction of 2.5 cc may be used. This loss apparently does not interfere with the efficiency of bacterial collection.

This bacterial air sampler has been tested extensively in laboratories, offices and lecture rooms, as well as in unoccupied rooms into which broth cultures of bacteria or dried dust-suspended microorganisms had been sprayed. The completeness of removal of bacteria from the air was determined by passing the air emerging from the exhaust end of the trap through various bacterial sampling devices to determine the percentage of bacteria which had escaped. The data of Table I are representative of the results obtained.

[7] Purchasable from scientific supply houses. The trap may be sealed directly to the apparatus.

[8] Suction pump was purchased from V. Mueller Company, Chicago, and was driven by a 1/6 H.P. motor.

[9] J. B. Graeser and A. H. Rowe, *Amer. Jour. Dis. Child.*, 52: 92, 1936.

TABLE I

Kind of air sampled	Arrangement of samplers	Bacteria per cubic foot
Normal air of inhabited room	Atomizer sampler with its exhaust connected to a Wheeler glass beads sampler	Atomizer sampler: 508 Wheeler sampler: 6.5
Air into which a mixture of Staphylococcus Albus and Pneumococcus Type I broth cultures was sprayed	Two atomizer samplers in series	*1st atomizer sampler:* 22,400 staphylococci 4,080 pneumococci *2nd atomizer sampler:* 71 staphylococci 51 pneumococci

Relative completeness of collection was also tested by simultaneously sampling the air of a room with several different types of bacterial collectors. Data from a typical experiment are presented in Table II.

TABLE II

COMPARISON OF EFFICACY OF BACTERIAL COLLECTION BY THE WELLS CENTRIFUGE, THE WHEELER GLASS-BEADS COLLECTOR, AND THE ATOMIZER SAMPLER. IN EACH EXPERIMENT THE COLLECTORS WERE OPERATED SIMULTANEOUSLY AT THE SAME LOCATION IN THE ROOM

Kind of air sampled	Samplers compared	Bacteria per cubic foot
Normal room air	Wells Centrifuge	9.3
	Atomizer Sampler	160.00
Room air into which a suspension of Staphylococcus Albus and Beta Hemolytic Streptococcus Group C had been sprayed	Wheeler Glass-beads Sampler	46,800
	Atomizer Sampler	53,040

On the average, the Wheeler sampler recovered 86 per cent., and the Wells centrifuge 15 per cent. of the bacteria collected by the atomizer sampler.

The atomizer type of bacterial sampler here described has been found very simple and convenient to operate. Loss of a sample through contamination or other reasons almost never occurs. This sampler can be easily made by a competent glass blower. The auxiliary equipment is inexpensive and available.

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