

Department of Scientific and Industrial Research

REPORT OF THE FOOD INVESTIGATION BOARD FOR 1933*

THE Annual Report of the Food Investigation Board for the year 1933 reviews the aims of the research work, now costing about £45,000 a year, carried out by the Department on the transport and storage of foodstuffs. These aims, the Report states, have not always been fully understood. The object of the work is, and always has been, the improvement of the food-supply for the people of this country.

The General Report of the Board (pp. 1-16) is followed by the Director's Report, which comprises an Introduction, and accounts of the work done at the Low Temperature Research Station (pp. 19-164), The Torry Research Station (pp. 167-190), and the Ditton Laboratory (pp. 193-211), and of the Extra-Mural work (pp. 212-230), which includes researches conducted at the National Physical Laboratory, and at the Imperial College of Science and Technology.

SECTION A. MEAT.—Investigations on the physiology of muscle protein, on the evaporation of water from tissues, and on the freezing of tissues (*cf.* ANALYST, 1933, 58, 611) have been continued, and the results have been published (references

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given). A new method has been devised for determining the amount of ice in muscle at different temperatures.

The Freezing of Eggs.—In contradistinction to the equilibrium between yolk and white in fresh eggs, it has been found that after slight freezing and thawing the freezing-points of yolk and white rapidly move towards the same value. Eggs have been frozen at -1° , -3° , and -5° C. with the same result; there is no evidence of a critical temperature of freezing, as found with living muscle.

The Colour of Beef-fat.—The chief factors which determine the appearance of the external adipose tissue of a carcass of beef are, (i) the concentration of the yellow carotinoid pigment in the fat, (ii) the quantity of haemoglobin present, and (iii) the optical properties of the superficial layer of connective tissue and the fat immediately beneath it. There is usually a marked variation in appearance at different points on the surface.

From further experiments on the effect of carbon dioxide on the colour of beef-fat the conclusion has been drawn that the addition of 10 per cent. of carbon dioxide to the air does not increase, to any significant extent, the rate of oxidation of the haemoglobin present in the fat. With high concentrations of carbon dioxide the rate is markedly increased.

Aldehydes in Rancid Fats.—The bisulphite method of determining aldehydes in rancid fats has been investigated, and the results have been published (*Ind. Eng. Chem., Anal. Ed.*, 1934, 6, 241; see Abst., p. 702). Preliminary experiments have indicated that zero values are obtained with perfectly fresh samples of fat.

Minimum Temperatures of Growth of Bacteria.—The further results obtained indicate that bacteria of the *Achromobacter* and *Pseudomonas* groups are capable of growth on frozen meat and potatoes down to at least -3° C. Those bacteria having optimum temperatures for growth at 37° C. cease growth, or grow very slowly, in the range $+5^{\circ}$ to 0° C., notably *Staphylococcus aureus*, *B. coli communis*, etc. On the other hand, such organisms as have optimum temperatures for growth around 20° C. usually grow well at 0° C., most strains of *Pseudomonas* and *Achromobacter* growing slowly at -3° C., but not below. One strain of *Pseudomonas*, however, grew at -5° C. in ten weeks on supercooled agar. Up to about 90 per cent. of the individual bacteria comprising the pure strain are capable of growth down to -3° C., but in the single case of growth so far obtained at -5° C., the viable percentage had fallen to about 70 per cent.

Preliminary work suggested that when whole carcasses are hung in cold stores at 0° C., with still, unconditioned air-supply of relative humidity varying from 70 to 80 per cent., little, if any, multiplication of the bacteria present takes place on the fatty or connective tissue.

Effect of Ozone on the Growth of Bacteria.—Preliminary experiments indicate that organisms vary in their resistance to ozone, *Staphylococci* and *Proteus* being more resistant than *Achromobacter*.

The germicidal concentration towards *Achromobacter* of ozone, introduced at the same time as the inoculation, appears to be about 300 parts per million by volume at 20° C. and 10 to 100 parts per million by volume at 0° C. Ten parts per million had some inhibitory effect on certain bacteria at 0° C.

Storage of Meats in Carbon Dioxide.—The maximum permissible concentration of 20 per cent. of carbon dioxide in the atmosphere is dictated by considerations of bloom. If it is desired to store the meat in higher concentrations of carbon dioxide, it is necessary to increase the proportion of oxygen, since otherwise the colour or bloom of the meat rapidly disappears, owing to the formation of methaemoglobin.

The respiration of dead muscle is between 10 and 50 per cent. of that of living muscle, the amount depending upon the method of killing and on the *post-mortem* history. Carbon dioxide can be absorbed by meat by solution in both muscle and fat, and, to a slight extent, by conversion into bicarbonate ion.

If any benefit is derived from inflating carcasses with carbon dioxide, it is probably due to the introduction of sterile gas rather than the ordinary infected air of the slaughter-house.

The storage of meat has been made the subject of a special report (No. 43, *cf.* ANALYST, 1934, 175).

SECTION B. FRUIT AND VEGETABLES.—It was reported last year (*loc. cit.*) that ripe apples give off some substance which, even when present in the air in very small quantities, stimulates the irreversible change, termed the climacteric, which ushers in the senescent phase of life, and which is accompanied by a marked increase in respiratory activity. It has now been shown that bananas, peaches and pears, but not oranges and grapes, also produce this or a similar substance.

The fact that post-climacteric apples evolve a substance which induces the climacteric in other apples which have not yet reached the stage at which it is auto-induced, has the interesting result that when apples are kept confined together in a group, the climacteric occurs nearly simultaneously in all the individuals at about the time when it is auto-induced in the most advanced fruit of the group; while if similar apples are isolated in separate containers, the self-induced climacterics are spread over a considerable interval.

The postponement of the climacteric, and of the concomitant increase in respiratory activity, is accompanied by a corresponding lengthening of the life of the fruit. It has now been shown that the effect of carbon dioxide in the atmosphere, as in gas-storage, is not only to depress post-climacteric respiratory activity, but also to delay markedly the occurrence of the climacteric itself. In the analysis of the factors affecting the climacteric, it has been found that supernormal concentrations of oxygen in the atmosphere accelerate the occurrence of the climacteric, whilst subnormal concentrations delay it. Ozone in concentrations of about 50 parts per million appears to induce its immediate occurrence. In the absence of oxygen, the irreversible climacteric rise in respiratory activity is not induced by ethylene, as it is in air, nor is there any latent stimulus, for on return to air after such treatment the apples are still pre-climacteric. Oxygen is therefore definitely concerned in the mechanism by which ethylene stimulates the onset of the climacteric. Last year, it was suggested, by analogy, that ethylene might be the active substance evolved by ripe fruit. It has now been found that, whereas ethylene does not induce the occurrence of the climacteric in the absence of oxygen, nevertheless the climacteric can be auto-induced in such conditions.

The total volatile products of the metabolism of fruit, other than carbon dioxide, are now being measured, and it has been found that their production increases at the climacteric, and that a large part of them can be retained by phosphorus pentoxide or concentrated sulphuric acid.

Another important fact established during the year is that, with the progress of senescence of apples in air, there is a steady rise in the amount of alcohol and acetaldehyde present in the flesh. It will be recalled that the tentative conclusion has been drawn from work already reported that acetaldehyde is a critical intermediate product in the breakdown of sugar, and that the fate of the sugar, either as alcohol and carbon dioxide (fermentative end-products) or as carbon dioxide and water (oxidative end-products) depends upon the concentration of acetaldehyde in the tissues. It is now further suggested that senescence in air is characterised by a progressive failure in the mechanism for the oxidative removal of acetaldehyde, and, moreover, that this failure is due to a toxic action of oxygen.

CANNING.—The variation of the steel base of tin-plate has been further studied, but cannot yet be related to the method of manufacture. Incidentally, it has been found that hydrogen can penetrate through steel and tin-plate, and form blisters on the side of the sheet opposite to that actually in contact with the corroding medium.

Metals, such as stainless steel, copper, and various alloys containing copper which are used in the manufacture of equipment for the food industry, have been further investigated, and the breakdown of a sample of stainless steel under air-free conditions, and the methods by which it was again rendered passive, are of interest.

The rate of destruction of pectin by enzymes, as indicated by the strength of the pectin-sugar-acid gel prepared from fruits stored for six to eight months at temperatures of -10°C. and -20°C. , is being determined. No measurable destruction has been found at the lower temperature, but at the higher it was between 15 and 25 per cent. with raspberries, and 35 per cent. with gooseberries.

The effect of various methods of canning on the vitamin in apples has been considered, in collaboration with the Medical Research Council. It has been confirmed that soaking in weak brine before canning protects vitamin C, and that leaving the peel on unsoaked slices has a similar effect. The canned peel of Bramley's Seedling apples is particularly rich in vitamin C.

FISH.—At the Torry Research Station the study of the effects of cold storage on the flesh of fish has been continued. The production of "drip" in relation to temperature and length of storage, differences in response to cold storage of different species of fish, and the behaviour of thawed-out, brine-frozen fish in comparison with fresh fish when packed in ice, are topics that are under consideration.

In continuation of the work on the metabolism of fat in fish, data obtained support the theory that the high selectivity of the animal in laying down its depot fats, rests on the basis of filtration by molecular size.

Vitamin A in Halibut-liver Oil.—The large fluctuations in the amounts of vitamin A found in the halibut's liver appear to be seasonal, and to be related to the fluctuations in the numbers of diatoms in the sea.

Bacteria in Fish.—Marked differences are found in the inhibitory effect of carbon dioxide on the growth of certain bacteria isolated from fish. Thus, an *Achromobacter* of the type constantly present in the slime of fresh fish is extremely sensitive, while *Aerobacter cloacae*, an organism found on stale fish, is but little affected. It is suggested that a change in the acidity of the medium, resulting from incubation in carbon dioxide, is largely responsible for the inhibition of the *Achromobacter's* growth.

Glycogen and Lactic Acid.—The breakdown of glycogen and the accumulation of lactic acid in fish's muscle are affected by actually freezing the muscle, and in that state the maximum rate of change occurs within the range of temperature -2.5° to -3.5°C. A closer determination is aimed at. The existence of a seasonal variation, related to spawning, in the glycogen of fish's muscle is a further point of interest which has been brought out by these experiments.
