Quantitative Chromatographic Analysis of Tetra-, Tri- and Di-methyl Fructoses

In a recent report by Gilbert and Stacey[1] on the constitution of a bacterial levan, these authors state that a convenient chromatographic technique for the quantitative analysis of tetra-, tri- and di-methyl fructoses had so far eluded them. We have devised a partition chromatogram giving quantitative results in the analysis of mixtures of 1 : 3 : 4 : 6-tetramethyl, 1 : 3 : 4-trimethyl and 3 : 4-dimethyl fructoses which is applicable to the study of methylated fructosans based on these sugars. (3 : 4 : 6-Trimethyl fructose has also been examined ; but certain difficulties, not yet overcome, arise in analytical separations involving this sugar.)

In principle, the method resembles the separation of methylated glucoses devised by one of us[2], but it differs in practice in two important respects. First, the partitions of the sugars concerned between organic solvents and water necessitate use of a different series of solvents for the mobile phase ; and secondly, 1 : 3 : 4 : 6-tetramethyl fructose has appreciable volatility at reduced pressures, both in the dry state and in concentrated solutions, but not in dilute solutions.

The essential steps in our method are as follows. (1) The solution of the sugars is extracted ten times with its own volume of chloroform. The chloroform phase is concentrated (bath temp. 30°) to 50 ml. (no loss occurs). The chloroform is then displaced by distillation with toluene at low temperature (final volume about 50 ml.). This is pipetted on to a silica – water column prepared from a slurry of silica, containing half its weight of water, and toluene.

(2) The tetramethyl fructose is eluted by passing sixteen column-lengths of toluene containing 0·33 per cent of ethanol. The eluate is concentrated (30° C.) to 50 ml. and extracted eighteen times with 50-ml. lots of water, and the combined water phases made up to a known volume. The sugar is then estimated colorimetrically, taking an aliquot of the water phase containing approximately 0·4 mgm.

(3) The water phase from (1) is evaporated to dryness (30° C.), the residue dissolved in a little chloroform and this solution pipetted on to the column. The total trimethyl fructose is then eluted by means of eight column-lengths of chloroform containing 5 per cent (v/v) of *n*-butanol. The eluate is evaporated to dryness (30° C.), some water being added to aid removal of the butanol. The residue is dissolved in ether and this solution evaporated to dryness in a tared evaporation-flask[2]. The dried sugar is then weighed.

(4) Dimethyl sugars are extracted from the column by methanol. This solvent is evaporated, and an ethyl acetate solution of the residue is evaporated and weighed as for the trimethyl sugar.

Recoveries for all three sugars are of the order of 98 per cent (scale of working 100–1,500 mgm.). In every instance the sugars were shown by paper chromatography[3], optical activity and analysis to be pure. A full account of this work is in preparation.

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[1] Gilbert, V. E., and Stacey, M., *J. Chem. Soc.*, 1560 (1948).
[2] Bell, D. J., *J. Chem Soc.*, 473 (1944).
[3] Brown, F., Hirst, E. L., Hough, L., Jones, J. K. N., and Wadman, H., *Nature*, 161, 720 (1948).

The Teaching of Biology in Schools

I was surprised at the warmth of the hostility with which Prof. Graham Cannon reviewed my pamphlet "Social Biology for Sixth Forms" in *Nature* of April 9, p. 577.

The problem which my paper attempts to answer is this. Supposing that a headmaster will allow a biologist two periods a week to lecture to sixth-form boys specializing in history, classics, mathematics or modern languages, what should he attempt ? In my view the answer to this question must take account of three things.

First, the interests of these boys are mature interests. They want to put the questions to a biologist that an adult would ask. Secondly, if biology is worth a place in their education at all, it is because it has implications which affect their philosophy, politics and understanding of history and world problems of the day, such as soil erosion or food supplies. Thirdly, as anybody who knows sixth-form time-tables must be aware, it is unrealistic to expect more than two or three periods a week for such a course, and the time must be carefully used. If the boys have not done any practical biology at an earlier stage—and I should agree with Prof. Cannon in deploring this—it is useless to start here, and unlikely to impress them with the importance of the subject. Of course, one cannot deal exhaustively with the many applications of biology to human affairs in the time available ; but one can, as I have shown in practice, arouse interest in the work of biologists which bears on social problems, indicate the kind of answers they would give, and send the boys out keen enough to follow up the work by reading for themselves, and free from some of the superstitions and prejudices with which otherwise reasonable people sometimes approach psychology, heredity, evolution, the birth-rate, intelligence-tests and so on.

Prof. Cannon attacks my course first on the ground that it covers too large a field, and then objects strongly to the idea of selecting some aspects for more detailed treatment than others. The idea that the interests of the class should be a guide as to which problems one pursues comes as a novelty to him, apparently, as in his opinion the order of the course (as laid down by T. H. Huxley, significantly !) must not be disturbed. Later in his review it becomes clear that his eyes are really on examinations rather than education, and, of course, the need to adhere rigidly to a given syllabus is one of the few major drawbacks to an examination system.

The criticism that a course of biology should be based on adequate practical work, natural history and comparative anatomy and embryology is, of course, unanswerable when the biology students, with whom Prof. Cannon deals, are under consideration ; but completely impracticable for the history and classical scholars with whom, one suspects, he has very little contact. A good deal can be done by demonstration ; they are shown the chromosomes, and the look of an F_2 generation of *Drosophila*, or plankton samples, and they value the experience. But to ask that they should learn the technique of *Drosophila* culture, or that they should be provided with microscopes and personally record the various links in the food-chain of the herring, is unrealistic for the non-specialist.

I should also deny that a course of this kind encourages boys to learn "whole passages or whole