less pure methyl greens. It is not impossible that some of the impurities present in Grübler's methyl green may have been of special value in staining. If this is the case, it is plainly the problem now for biologists in cooperation with the manufacturers to find out what these particular impurities were. Meanwhile it seems safe to recommend any one to buy a methyl green from either of these two companies, in as much as their methyl greens are evidently as good as any obtainable at the present time.

The findings obtained in this investigation have been very interesting in showing the amount of variation in different lots of Grübler stains. Before obtaining the satisfactory American sample of safranin O, mentioned above, data were secured concerning the properties of two different Grübler samples. One proved to be actually safranin O, but with considerable inert material (dextrin). The other proved, as stated above, to be a mixture of safranin and auramin, and contained fully 90 per cent. dextrin. Although considerable variation has been found in the samples now on the market in this country, no two samples of safranin have been found differing from each other to such an extent as these two samples, one imported before the war, the other during the war.

Attention is called to this fact to show that standardization can not be obtained by going back to imported stains. There is, moreover, very good reason to believe that the imported stains now on the market are still different. Investigation of this point is in progress at present. Meanwhile we have learned of one well-known German laboratory which has just ordered stains from America, with the comment that the European products are now very unsatisfactory.

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GENEVA, N. Y.,
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SPECIAL ARTICLES

FURFURAL AS A BIOLOGICAL REAGENT

IN spite of its wide range of solvent power, preserving qualities and rapid penetration of tissues, furfural has remained until recently a chemical curiosity, its properties and even its appearance practically unknown even to many who have frequently employed it. Investigations concerning its uses as a biological reagent have been wholly confined to its physiological effects. This is perhaps due to the fact that until recently it has not been manufactured in commercial quantities, being little used in the industries. Now, however, the "Miner Laboratories" of Chicago have developed a process of manufacturing furfural from oat hulls which are obtained in large quantities as a by-product in several industries. At the same time several commercial uses have been developed in the manufacture of resins, varnishes, rubber, dyes, perfumes, anesthetics, antiseptics and germicides. Thus larger demand and increased efficiency of manufacturing process have made possible the reduction in price to a point where it bids fair to become the cheapest aldehydic body commercially available.

Furfural is an aldehyde of deep amber color and a pungent odor, having the formula C_4H_3OCHO, which, in general, resembles the reactions of benzaldehyde on the one hand and formaldehyde on the other. It differs from either of them in being a liquid of very high boiling point and wide range of solvent power. As a biological reagent its chief interest lies in the fact that its properties closely resemble those of formaldehyde, suggesting its use as a preservative, and secondly its wide range of solvent power including most of the coal tar dyes, hæmatoxylin, alcohol, xylol, toluol, benzole, balsam and parlodion, suggesting its possibilities as a vehicle for stains as well as a general reagent in micro-technique; and thirdly, its reaction with acids forming resins, suggesting its use as an injection fluid.

In connection with current laboratory procedure we have had occasion to test out furfural in these three fields and the results are herewith reported.

The qualities of furfural as a preservative were investigated for a period of four months on several animals used in the laboratory for dissection purposes, such as cats, frogs, fish, mussels and some plant forms. Although H. McQuigan ('22) has shown the germicidal and toxic properties of furfural to be less than that of formaldehyde it has nevertheless been adequate to preserve these specimens in good

condition. Two strengths of solution were used, ninety-five per cent., or commercial furfural, and a seven and one half per cent. aqueous solution, both of which have proved successful. Furfural is soluble in water only to the extent of eight per cent. at room temperature. We therefore used a solution slightly below the point of saturation. This strength of solution seems to be preferable as it does not discolor one's hands or the tissues to so great an extent and the odor is not as objectionable as with the commercial furfural. Such stock solutions for preserving purposes are most conveniently prepared by adding five pounds of furfural to a carboy of water and decanting off the saturated solution as it is needed, refilling with water until the furfural has been used up.

In each case the body cavity was opened so that the viscera were well exposed to the solution. After one to three months the specimens examined showed organs in a good state of preservation and did not show as great shrinkage or hardening as in those preserved in formaldehyde. In the case of frogs and mussels, the viscera were preserved in nearly as plastic a state as when living.

In general it has a tendency to discolor the tissues a yellowish brown, and the musculature of those specimens into which the ninety-five per cent. solution had been injected turned a deep brown color. This effect which would render furfural objectionable as a preservative for museum specimens is not very objectionable for dissection purposes. The mould Penicilium which here grows so profusely on formaldehyde solutions did not develop at all on the seven and one half per cent. furfural, although the solutions were repeatedly inoculated. Tested on pieces of muscle it also showed more rapid penetrating qualities than in the former. Although it has a somewhat pungent odor, its low vapor tension renders it less offensive than formaldehyde and in the seven and one half per cent. solutions the odor is scarcely noticeable. The irritating effect on the nose and eyes, so objectionable in the case of formaldehyde solutions, is here eliminated entirely. The same may be said with regard to its effect on the skin, where, although it does cause a yellowish discoloration it does not have the tendency to harden and shrivel it. The discoloration can readily be removed by washing the hands in warm water to which has been added a little ammonia.

If an acid such as hydrochloric or sulphuric is added to furfural it forms a resin. The rapidity with which the reaction takes place depends to some extent upon the amount of acid used. One cubic centimeter of HCl to one thousand cubic centimeters of commercial furfural completed the reaction in about thirty-six hours. The resultant product was a semi-solid spongelike, jet-black resin. This reaction was made use of for injection purposes and rendered the arteries and veins very conspicuous. Cats were used for this test, which were injected through the femoral artery with a ninety-five per cent. solution of furfural to which had been added, just previous to injection, one cubic centimeter of HCl per one thousand cubic centimeters of the former. Such an injection fluid is much more conveniently prepared and injected than the usual injection mass and is also cheaper.

In the field of micro-technique furfural promises to be a very useful reagent because of its wide range of solubility. Its penetrating qualities, together with the fact that it dissolves the majority of the coal tar dyes, makes it possible to use it as a vehicle for these stains. Secondly, it is miscible with alcohol in all proportions and can be used as a substitute for the higher percents in the dehydration process. Thirdly, it is soluble in all the aromatic hydrocarbons such as benzol, toluol and xylol. The same is true with regard to the oils such as bergamot, cedar and clove, and lastly even gum damar or Canada balsam. Thus it shows a wider range of adaptability to the different formulas than the alcohols, with a corresponding shortening and simplifying of several of the processes. It is the most rapid solvent of Celloidin or Parlodin that I know of and makes possible the elimination of the slower and more expensive ether alcohol method. At present tests are in progress in this laboratory on these properties of furfural with a view to determining its adaptability to this phase of the work.

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