MENTAL EFFICIENCY, CARBOHYDRATE METABOLISM AND NUTRITIONAL HYDRATION

Various investigators[1] have called attention to the value of insulin in the treatment of some cases of schizophrenia, but a satisfactory explanation of the results does not seem to have been arrived at. The possibility does not appear to have been considered that the mental improvement noted in schizophrenics may primarily be a physiologic improvement in mental efficiency, such as Glaze observed in presumably normal subjects after fasting.[2]

As one of the subjects for Dr. Glaze's study at the University of Chicago, I fasted 33 days. For a study of hunger during this fast,[3] blood-sugar determinations were made upon me by Dr. Larson at the College of Medicine of the University of Illinois. On the ninth day of the fast, the blood-sugar level was down to 0.043 per cent. After that, the level was somewhat higher, but the final determination made during the fast was so low that it was thought best to discard the result in the absence of further confirmation. Unfortunately, I already broke the fast before another determination could be made, but increasing weakness and difficulty with air-hunger suggest that a blood-sugar level lower than 0.043 per cent. may actually have been reached. In any case, the accepted data indicated that the blood-sugar level was substantially below normal throughout this fast, and Lennox, O'Connor and Bellinger reported similar observations.[4] This makes it evident that the improvement in mental efficiency which was noted by Glaze followed periods in which the blood-sugar level was kept low by fasting, just as the mental improvement in some schizophrenics seems to be a consequence of hypoglycemic states induced by insulin.

A less obvious parallelism is indicated by the fact that the insulin treatment of schizophrenics does not bring about improvement in some apparently uncomplicated cases and fasting likewise does not always lead to mental and/or physical improvement in so-called normal subjects. In fact, the results of fasting at different times may vary widely in the same individual. This conclusion is based mainly upon a personal evaluation of the results of various fasts undertaken by me during the past thirty years. Thus, I have sometimes noted a striking improvement in general well-being, including a brief period of elation with increased self-confidence and sociability, after a fast of only one day or a few days, while the result of my longest fast (41 days) proved to be one of the greatest disappointments. In my estimation, the differences in the results were chiefly due to variations in the degree of hydration experienced after fasting. Post-fasting edema may indeed be severe enough to completely obscure any possible benefit from fasting. An inadequate protein intake and an excessive carbohydrate intake after fasting increase hydration,[5] and this raises the question whether the administration or ingestion of excessive amounts of carbohydrate following the use of insulin in the treatment of schizophrenics may not also, in some cases, counterbalance any possible benefit.

It is still a question whether the favorable results of the insulin treatment of schizophrenics will be more or less permanent and, similarly, some may wonder whether the possible benefits of fasting are worth the price. Obviously, the benefits of fasting have not been cumulative in my own case. Anything that may be gained by fasting can be lost again by an unsuitable food intake after fasting. My opinion of the value of fasting is perhaps best reflected by the fact that, after having previously fasted altogether over 500 days, I have not fasted a single day during the past five years. The chief reason for this, however, is that I have been increasingly impressed with the importance of nutritional and post-fasting edema. Besides this, I never liked fasting and would welcome a practical substitute, such as the insulin treatment may be in some cases of schizophrenia and the ketogenic diet seems to be in some cases of epilepsy. My impression, nevertheless, is that no simple and entirely satisfactory substitute for fasting will be found, although repeated short or modified fasts may prove to be adequate and practical substitutes for prolonged fasts.

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[1] Among others: H. E. Himwich, K. M. Bowman, J. Wortis and J. F. Fazekas, SCIENCE, 86: 271, 1937; J. Steinfeld, *Jour. Amer. Med. Assn.*, 108: 91, 1937; H. M. Smith, *ibid.*, 108: 1959, 1937; D. E. Cameron and R. G. Hoskins, *ibid.*, 109: 1246, 1937; and C. A. Rymer, J. D. Benjamin and F. G. Ebaugh, *ibid.*, 109: 1249, 1937.

[2] J. A. Glaze, *Am. Jour. Psychol.*, 40: 236, 1928.

[3] F. Hoelzel and N. Kleitman, *Arch. Internal Med.*, 39: 710, 1927.

[4] W. G. Lennox, M. O'Connor and M. Bellinger, *Arch. Internal Med.*, 38: 553, 1926.

THE GERMINATION OF LETTUCE SEED STIMULATED BY CHEMICAL TREATMENT

PREVIOUS investigations have been reported showing that the germination of dormant lettuce seed is influenced by temperature, light, oxygen and the CO_2 content of the surrounding atmosphere. In investigating various methods of treating such seed to promote prompt germination it was found that the percentage of germination of certain lots of lettuce seed could be greatly increased by treating the seed with weak solutions of certain chemicals. Many lots of lettuce seed of the varieties Grand Rapids and Hubbard Market have been found to germinate poorly on damp filter paper in Petri dishes in darkness at 25° C., whereas other lots germinated very well when the paper in the

[5] F. Hoelzel, SCIENCE, 86: 399, 1937.

dishes was moistened with 0.5 per cent. solutions of thiourea, allyl thiourea, ammonium thiocyanate and potassium thiocyanate. Germination was greatly increased above that obtained from lots of the same seed germinated on filter paper moistened with distilled water. The comparative tests were all made in darkness at 25° C.

On one lot of dormant lettuce seed the 0.5 per cent. solutions of these four compounds gave the following percentages of germination: Thiourea, 94.25 per cent.; allyl thiourea, 83.25 per cent.; ammonium thiocyanate, 69.75 per cent.; and potassium thiocyanate, 36.25 per cent. as compared with 22.75 per cent. for the check lots germinated on filter paper moistened with water. Differences of 5.8 per cent. or greater are significant.

Seeds were treated with 0.1, 0.2, 0.5 and 1.0 per cent. concentrations of each compound. The optimum concentrations for the four most effective compounds were found to be near 0.5 per cent. In each case the highest germination was obtained with the 0.5 per cent. solution.

Other chemicals, including urea, sodium nitrate, ammonium sulfate, potassium ferricyanide, potassium ferrocyanide and calcium sulfate, were also used in the above four concentrations. While some of these in certain concentrations gave some increase in germination over the untreated check, the differences were not statistically significant. None of these approached the effectiveness of the 0.5 per cent. solutions of thiourea, allyl thiourea, ammonium thiocyanate and potassium thiocyanate, and in many cases the chemical definitely retarded germination.

Although thiourea gave the greatest increase in germination, the development of the embryo was abnormal in that the hypocotyl elongated much more rapidly than the radical. In many cases there was little or no radical development. Ammonium thiocyanate and allyl thiourea both resulted in normal embryo development.

That the failure of dormant lettuce seed to germinate is not in all cases due to the same conditions is indicated by the fact that all lots of such seed do not respond to the same treatment. Some lots respond to low temperature, while others do not. Some require exposure to light in addition to low temperature. In some cases a varying temperature is more effective than a constant temperature. Different lots of dormant seed were found to vary greatly in their response to chemical treatments. Thiourea was the only chemical that was effective on all lots of dormant seed tested. Some lots of seed gave no response to various concentrations of allyl thiourea, ammonium thiocyanate and potassium thiocyanate. One lot of seed that gave a check germination of 69 per cent. germinated 97 per cent. when treated with the 0.5 per cent. concentration of thiourea. The other three chemicals failed to give a significant increase in germination above the check at any of the four concentrations.

The most effective concentration of urea (0.2 per cent.) gave only 15 per cent. germination as compared with 94 per cent. for the 0.5 per cent. concentration of thiourea. The most effective concentration of potassium cyanide (0.2 per cent.) gave only 33 per cent. germination, as compared with 50 per cent. germination for the 0.5 per cent. solution of potassium thiocyanate. In these comparisons differences of 14.11 per cent. are significant. In both comparisons the occurrence of the element sulfur in the compound resulted in a marked increase in germination. The increase in germination can not be attributed to sulfur alone, since various concentrations of other sulfur-containing compounds, including ammonium sulfate, sulfuric acid, sulfanilic acid, and calcium sulfate, failed to increase and, in most cases, retarded germination. The point of interest here is the striking difference between thiourea and urea which differ only in the presence of sulfur in thiourea. Thiourea always gave some increase in germination, while urea in every case retarded it.

The writers offer no explanation for the role these chemical compounds may play in stimulating germination in certain lots of lettuce seed that show marked dormancy when germination tests are carried out in darkness at 25° C.

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EXCEPTIONAL TEMPERATURES OF CENTRAL ATLANTIC WATER[1]

CHURCH[2] summarizes the analysis of numerous thermograph records of the surface waters of the western North Atlantic. Used in the analysis were the records obtained by the Biological Board of Canada through the courtesy of the Canadian National Steamships. A recent record, August 28 to August 30, 1937, on a route between Boston and Bermuda indicates exceptional water temperatures of Central Atlantic water north of Bermuda. The instruments were checked at the end of the voyage.

On this route, Central Atlantic water lies south and southeast of the Gulf Stream, and is characterized by the comparative homogeneous nature of the surface temperatures. Minimum temperatures are attained in late winter, and maximum temperatures are reached in late August. According to Church and Iselin,[3] the

[1] Published with the permission of the Biological Board of Canada.

[2] P. E. Church, Assoc. d'Oceanographie physique, Publ. Scien. 4, 1937.