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THE ROMANCE AND ENGINEERING OF FOOD PRESERVATION[1]

By W. R. WOOLRICH
UNIVERSITY OF TEXAS

THE ELEMENTAL FOOD CYCLE

NATURE has provided a cycle for the conservation of the plant foods of this earth from one generation to another. Man in creating certain processes of civilization has defeated some of the purposes of nature by diverting constituent parts of the plants and animals from this cycle to uses for commercialized civilization.

In this diversion process these essential elements have been directed into modern sewage systems comprised of drainage streams and canals, and hence they have been deposited far from their points of origin. This diversion of the elements from the lands of their origin has slowly impoverished in strategic populated regions the animal-plant cycle established by nature. It has reduced the effective value of the essential elements where life has elected to live, and this to a critical degree especially in some regions.

It is very significant and fortunate that many of the elements to create food for living organisms are inexhaustible. As an example, carbon, oxygen, nitrogen and hydrogen are found in limitless and bountiful quantities in the air and water. From these elements starch, sugar, fats, fibers and protein are all produced. In other words, these several foods are made from unlimited constituents of air and water, transformed under the influence of the sun by the several botanical and biological processes into edible products. Chemically, each of these products originates from an inexhaustible source of supply.

On the other hand, many of the essential plant food elements that are contained in the soil are exhaustible. Potash, phosphate, calcium, magnesium, sulphur, iron,

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[1] Address of the retiring vice-president and chairman of Section M (Engineering), prepared for the New York meeting of the American Association for the Advancement of Science.

termination of muscle adenylic acid (adenosine-5-phosphate). If a few micrograms of Schmidt's deaminase are added to a solution of adenylic acid and the absorption at 2,650 Å is determined in the Beckmann spectrophotometer one observes a steady decrease in absorption, proportional to time within the first few minutes, decreasing in rate later. The absorption decreases to less than half (45 per cent.) of the original but seems to come to a standstill before complete deamination has been reached. It has not so far been possible to observe any amination of inosinic acid with ammonia salts.

The deaminase test is performed in the following way. To 10 or 15 μ g adenylic acid per ml (5×10^{-5} M) containing 0.05 M succinate buffer pH 5.9 is added to 2 to 5 μ g of Schmidt's deaminase, purified through isoelectric precipitation and ammonium sulphate fractionation. The deamination takes place in a quartz vessel, 1 cm in depth, which is exposed to ultraviolet light of the wavelength 2,650 Å. The deamination causes a fall in the absorption and the decrease is read every minute on the absorption scale of the Beckmann spectrophotometer. A measurement of the absorption in the range from 2,400 to 2,800 Å before and after addition of deaminase shows the spectra of adenylic acid and inosinic acid (with traces of adenylic acid) respectively (Fig. 1). A decrease in absorption at 2,650 Å corresponding to less than 10 per cent. of complete reaction is readily detectable. If the adenylic acid concentration is $5 \times {}^{-5}$ M, a 10 per cent. decrease corresponds to a liberation of 0.07 μ g N.

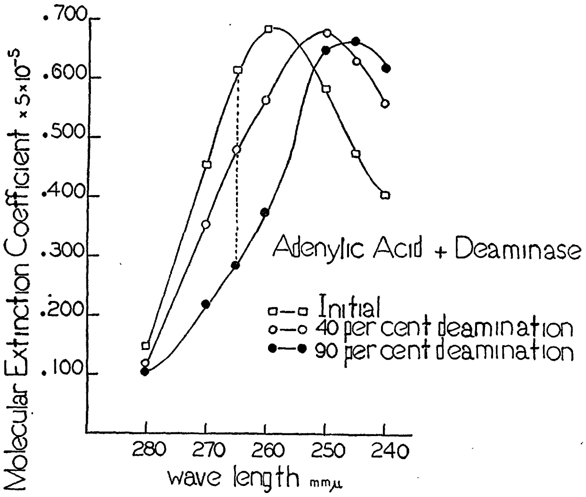

FIG. 1.

The formation of adenylic acid when myokinase[5, 6] is added to adenosine diphosphate (2 adenosine diphosphate $\rightleftarrows$ adenosine triphosphate + adenylic acid) can be also demonstrated in the micro test. Addition of purified deaminase to a 5×10^{-5} M solution of adenosine diphosphate (pH 6.2) does not give rise to any change in the absorption at 2,650 Å. If now a few micrograms of myokinase are added the absorption decreases proportionally with the amount of added myokinase, provided deaminase is in excess. Between 40 and 45 per cent. of the adenosine diphosphate is converted to inosinic acid, indicating that more than 80 per cent. of the adenosine diphosphate has been converted into the tri- and monophospho-nucleosides.

The spectrophotometric myokinase test requires one to two μ g pyrophosphate P (as adenosine diphosphate) where the hexokinase test requires 20 to 50 μ g pyrophosphate P. On the other hand, in the spectrophotometric test both the deaminase and the myokinase act outside their pH optima. The deaminase has a sharp pH optimum at 5.9[4] the myokinase a broad optimum between pH 7 and 7.5[6] and neither of the enzymes has any appreciable activity at the pH optimum of the other. At pH 6.2–6.5 both enzymes exhibit a fairly high although not optimal activity.

The deaminase preparations show a slight effect on adenosine. However, adenosine is deaminated 60 times slower than adenylic acid.

Adenylic acid from yeast nucleic acid is not deaminated by the deaminase (*cf.* footnote 4), a fact which in 1928 led Embden and Schmidt[7] to the differentiation between muscle adenylic acid (adenosine-5-monophosphate) and nucleic acid adenylic acid (adenosine-3-monophosphate).

Thus, the method is specific for muscle adenylic acid (and diadenylic acid[8]). Methods based on adenylic acid as a phosphate transfer system[9] are specific for adenosine-5-phosphate derivatives but can not distinguish between adenylic and adenosine diphosphate. The micromethod presented here does distinguish between adenylic acid and adenosine diphosphate due to a separation of the deaminase from myokinase.[6]

H. M. KALCKAR

DEPARTMENT OF NUTRITION AND PHYSIOLOGY,
PUBLIC HEALTH RESEARCH INSTITUTE OF
THE CITY OF NEW YORK

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[9] F. Schlenck and T. Schlenck, *Jour. Biol. Chem.*, 141: 311, 1941.

BOOKS RECEIVED

BAWDEN, F. C. *Plant Viruses and Virus Diseases.* Illustrated. Pp. xi + 294. Chronica Botanica. $4.75.

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