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Chemical evolution studies: The radiation chemistry and thermal decomposition of malonic acid

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A cornerstone of modern biology is Darwinian evolution. By accepting the Darwinian evolution, we must postulate another form of evolution before this, and it is called chemical evolution. Thus, chemical evolution encompasses the study of physical and chemical events leading the formation of biological relevant molecules for the probiotic milieu. This process is considered a necessity for the emergence of recognizable living forms. Early Earth was extremely dynamic and chemically complex because the existence of different environments (atmosphere, lithosphere and hydrosphere, and the interfaces among them) where chemical evolution proceeded complicating the scenario. For the chemical processes a source of energy was also necessary. Several sources of energy have been proposed to contribute for the chemical evolution; among them are high-energy radiation and thermal energy.
Several environments on Earth have temperature gradients. These gradients chemical reactions, for example, in volcanic hot springs, and especially in hydrothermal vents on the bottom of the ocean (some at moderately high temperatures). In these environments, the presence of radionuclides was also important for the synthesis or degradation of the present chemical compounds. Thus, radioactivity must be important because it has been present since the formation of the planet. During the supernova explosion, many of the chemical elements were synthesized, many of them with radioactive nature, allowing the synthesis /decomposition of organic molecules.
In this context, the radiolysis and thermolysis of malonic acid in aqueous solution has been studied. The importance of this compound is because it might play a dual role as intermediate in the synthesis of other polycarboxylic acids and inhibiting important metabolic processes such as the Kreb's cycle.
In our experiments, malonic acid was irradiated with gamma rays in oxygen-free aqueous solutions. The thermal decomposition was studied in a static system at temperatures from room temperature up to 90 ℃ simulating a hydrothermal vent. The main products obtained by the thermal treatment were acetic acid and CO2. The radiolysis of malonic acid yields carbon dioxide, acetic acid and di and tricarboxylic acids such as succinic, carboxy- succinic tricarballylic and citric acids. A numerical simulation of the chemical process taking place under irradiation was developed and it was being able to reproduce the time evolution of the products of irradiation and the consumption of the malonic acid.
Finding these compounds are very important in chemical evolution studies as they are the source of the important building blocks of metabolic pathways. We experimentally identified the products by gas chromatography, and gas chromatography coupled to mass spectroscopy.

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