Biography: Justus von Liebig

Justus von Liebig (1803 – 1873) was a German chemist. He taught chemistry at the University of Giessen and the University of Munich. The University of Giessen currently bears his name. Liebig is called the father of fertilizers. He confirmed the hypothesis concerning the mineral nutrition of plants, which became the basis for the development of modern agricultural chemistry. Liebig's research is considered a precursor to the study of the impact of environmental factors on organisms. He formulated the law of the minimum, which states that the scarcest resource is what limits a given organism. He also developed a process for producing meat extract and founded the company *Liebig Extract of Meat Company* whose trademark was the beef bouillon cube, which he invented.

Justus von Liebig was born into a middle class family from Darmstadt on May 12, 1803. As a child, he was already fascinated by chemistry. When he was 13 years old, most of the crops in the Northern Hemisphere were destroyed by a volcanic winter. Germans were among the most affected. It is said that this experience influenced the subsequent work of Liebig and the establishment of his company.

Liebig gained experience as a pharmacist in the Gottfried Pirsch apothecary located in Heppenheim. He studied at the University of Bonn under the guidance of Karl Wilhelm Gottlob Kastner, who was his father's business partner. When Kastner moved to the University of Erlangen, Liebig followed him and later wrote his PhD there. However, he did not receive his doctoral degree until long after he had left the city. Liebig left Erlangen in March, 1822, in part because of his involvement with a radical nationalist student organization called Korps Rhenania, but also because he was looking for a place to carry out more advanced chemical research.

In autumn of 1822, Liebig went to Paris to continue his studies. He worked in the private laboratory of Joseph Louis Gay-Lussac, and became friends with Alexander von Humboldt and Georges Cuvier. After leaving Paris, Liebig returned to Darmstadt and married Henriette Moldenhauer, the daughter of a civil servant.

In 1824, at the age of 21, Liebig became a professor at the University of Giessen. While in Germany, he founded and edited the magazine *Annalen der Chemie*, which became the leading journal of chemistry in Germany.

In 1837, he was elected a member of the Royal Swedish Academy of Sciences, and in 1845, started working at the University of Munich, where he remained until his death. That same year, he received the title of baron.

Liebig's research dealt with the analysis of organic matter. In 1831, he created the "kaliapparat", which was a laboratory device used for determining the amount of carbon in organic compounds. It consisted of five glass bulbs, which were combined and arranged in the shape of a triangle. In order to use this device to determine the amount of carbon in an organic compound, the substance first needed to be burned. In doing so, each carbon atom was oxidized and converted into carbon dioxide (CO_2). The resulting fumes passed through the kaliapparat, which was filled with a potassium hydroxide solution (KOH). This solution reacted with carbon dioxide and, as a result, potassium carbonate was obtained. Ignoring ion dissociation, the reaction can be written as follows:

$$2\ KOH + CO_2 \rightarrow K_2CO_3 + H_2O$$

By subtracting the mass of the kaliapparat before combustion from the mass of the kaliapparat after combustion, the mass of CO_2 was obtained. With

the mass of CO_2, standard stoichiometric calculations could be used to find the mass of carbon in the original sample.

One of Liebig's most recognized and influential achievements was the invention of nitrogen fertilizers. He believed that nitrogen must be supplied to the roots of plants in the form of ammonia. He stated that artificial fertilizers could be replaced by natural fertilizers, such as animal droppings. Nitrogen fertilizers are now widely used around the world, and their production is an important segment of the chemical industry.

Liebig formulated the law of the minimum, which states that the development of plants is limited only by the essential mineral which occurs in the smallest (or most minimal) amount.

Liebig was one of the chemists who organized the chemical laboratory as we know it today. His method of organic analysis enabled him to guide the work of many students. Thanks to him, a popular device for condensing water vapor is known today as the Liebig condenser (or cooler), despite the fact that it was in common use long before his research began.

In 1835, he invented a process for silvering that greatly improved the quality of the reflective coating used for the manufacturing of mirrors.

Liebig's work on the application of chemistry in the physiology of plants and animals played a special role in the world of science. At a time when many chemists, including the famous Jons Jakob Berzelius, insisted on the separation of the organic from the inorganic, Liebig stated that "...the production of all organic substances no longer belongs just to the organism. It must be viewed as not only probable but as certain that we shall produce them in our laboratories. Sugar, salicin [aspirin], and morphine will be artificially produced."

Liebig played a very important role in the reform of politics in the German states through the promotion of science-based agriculture. Liebig liked John Stuart Mill's book, titled *Logic*, because it promoted science as a means to social progress and political development, and also because Mill described several examples of Liebig's research as an ideal for the scientific method.

Together with the Belgian engineer George Giebertem, Liebig developed a reliable method of manufacturing beef extract. In 1865, he founded the company that manufactured the extract as an inexpensive alternative to real meat. A few years after the death of Liebig, in 1899, this product was trademarked with the name "Oxo".

His most important contribution to the world of nutrition, "Liebig's Extract of Meat" was an accidental discovery, which was obtained while researching a cure for a friend. In 1853, Emma Muspratt, the daughter of Liebig's friend, became ill during her stay in Munich, where Liebig working as a professor. She could not eat, and her intestines were not able to process solid foods. Liebig knew that she would not be able to consume food normally. He reasoned that feeding her meat extract would be an effective method of making sure she was getting enough nutrients. The extract was obtained by grinding chicken meat, which was then placed in a solution of hydrochloric acid. After 12 hours, Liebig filtered the resulting solution, which contained nearly intact proteins. The remnants of acid were neutralized, and it was given to Emma Muspratt to drink. She quickly regained her health. The extract could not be mass produced, because its method of production was too complicated.

Liebig died on April 18, 1873. He was buried in the Alter Südfriedhof cemetery in Munich. After World War II, the University of Giessen was renamed, *Justus-Liebig-Universität Giessen*. In 1953, the West German post office issued a stamp in his honor.

His main works are:

1. *Organic Chemistry in its Application in Agriculture and Physiology (1840)*
2. *Organic Chemistry in its Application in Physiology and Pathology (1842)*
3. *Familiar Letters on Chemistry (1843)*

References

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