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Women: "the challenge of their presence in chemistry"

Abstract

This article addresses contributions of some female scientists and chemists who stood out for several centuries despite having an adverse and inequitable environment because of their gender. The objective is to create awareness that there are no pre-established roles in science; instead, the aim is to break down all the paradigms that are still present in our society today.

Keywords: distillation, infrared radiation, crystallography, DNA polymerase, glass ceiling, sticky floor

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Julia Guadalupe Pérez Arteaga
Instituto de Estudios Superiores de Tamaulipas, Facultad de Posgrado en Ciencias Exactas, México

Correspondence: Julia Guadalupe Pérez Arteaga, Instituto de Estudios Superiores de Tamaulipas, Facultad de Posgrado en Ciencias Exactas, Altamira, México,
Email julia.perezarteaga@iest.edu.mx

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Introduction

Today, women have managed to position themselves in the chemical sector, where many decades ago it was almost nil. However, the process has not been easy, and it has taken a lot of time. Women and chemistry have been linked since ancient Mesopotamia with Taputti Belatekallim, who is recorded in the history of humanity as the first woman with knowledge in this field. She developed methods such as distillation for the creation of perfumes for Royalty.[1] This article will focus on chemist women who have excelled in a scientific way, and the challenges they have faced, which remain today.

Margaret Cavendish was a noble woman of the XVII century; the first one admitted to the Royal Society and considered the forerunner of Molecular Theory. In 1652 she began to publish her first works on physics being criticized by the English Society of the time, who considered that women of her class should devote herself only on to her labors.[2] The ideas of this woman scientist are not cited in the history of atomism, and her personality has been characterized as eccentric. If she had been a man, today her work would be considered an important contribution to science, instead, today she is judged only by banal aspects of her personality. In 1663, she had a thought or premonition, when she stated "Being a woman, I cannot publicly: *"Preach, teach and declare"*.[3]

Marie Meurdrac wrote "La Chymie charitable et facile, en faveur des dames," one of the most important works in chemistry of the XVII century. Here she explained how to make homemade medicines to relieve the most common pains, in addition to feminine hygiene products. With her work, and one of her phrases: "If women were cultivated like men, and as much time and means were spent in instructing them, they could equal them", she openly challenged social norms by aiming to give women access to science.[4]

A lover of mathematics and knowledge, Emilie du Châtelet published her research based on fire science that predicted what we known today as infrared radiation and the nature of light. It was published in the Proceedings of the Academy making her the first woman to have a scientific article in the prestigious journal. She never hid her dissatisfaction that women of that time were not allowed to receive formal education Together with Voltaire, Emilie du Châtelet wrote Elements of Newton's Philosophy and although he alone appears as the author, he acknowledged in the preface that he had written it in collaboration with the marchioness. Furthermore, Du Châtelet translated Newton's Principia into French, this being the only translation accepted into this language to date. In carrying out this work, she also added, among other things, a guide for the reader about the main arguments of Newton's gravitational theory of planetary motion.[5] In the 1930, the "Café Gradot" was the most famous place to meet for discussing philosophy, science, poetry and politics among the top mathematicians, astronomers, and physical scientists but women were not allowed to enter. However, this was not an obstacle for Emilie, who had no problem dressing as a man and defying the rules in order to participate in the debates.[6]

Marie Anne Pierrete Paulze, a prominent woman of the XVIII century known as "The mother of the modern chemistry", worked with her husband Antoine Lavoisier to ensure that chemistry was considered a science. Together with her husband and other scientists of their time, they developed a systematic nomenclature to refer to chemical substances and their compounds, expanding this scientific rationality that chemistry lacked until then.[7] Marie Anne drew many sketches and carved engravings of the laboratory instruments used by Lavoisier and his colleagues. She edited and published Lavoisier's Memoirs and hosted many parties where eminent scientists discussed new chemistry and other ideas. As a result of her close work with Antoine Lavoisier, it is difficult to separate her individual contributions from his, but it is correctly assumed that much of the work accredited to him bears her fingerprints.[8]

A pioneer of Environmental Engineering, Ellen Henriette Swallow in the late XIX century became the first woman admitted by an American University to study science at MIT (Massachusetts Institute of Technology). She graduated in 1873 with a Bachelor of Science degree but was not allowed to pursue a Ph.D. because the faculty did not want the first Ph.D. in Chemistry to go to a woman. Ellen succeeded in encouraging women's participation in science studies.[9] However, being a woman, her extraordinary knowledge and dedication to work were not enough merits to pay her a salary, so Ellen had to look for other ways to support herself. She achieved this by doing "feminine" jobs, such as preparing and serving tea and meals, or cleaning. The fact that she did them in the same center where she taught classes does not seem to have caused her any major problems. This way of acting defines her attitude to life: she never accepted the status of women and worked tirelessly to pave the way for those who came after her, but Ellen always avoided direct confrontation, preferring to look for loopholes to do what she wanted without giving rise to major conflicts.[10]

Marie Curie the "Mother of Modern Physics," probably the most famous woman scientist in history, dedicated her entire life to science. In the research process of her PhD, she discovered two new elements: radium and polonium, so she decided to dedicate herself to analyzing radium. However, achieving the necessary evidence for this element to be accepted by the scientific community involved isolating it and obtaining its atomic weight, a task that took several years of work in very precarious conditions and without an income. Her research earned her two Nobel Prizes; one in Physics in 1903 along with her husband Pierre, making her the first woman to obtain this award; and another by herself in Chemistry in 1911. *"Nothing in this world is to be feared, only understood."*- These words define the perseverance and fighting character of Marie Curie, a woman who confronted the prejudices of her time.[11]

The contributions of her research to the knowledge of radioactivity allowed for spectacular advances in medicine, for example, in the diagnosis of diseases and in the treatment of cancer and other serious diseases. At the same time, her achievements facilitated women's access to spaces of knowledge previously only occupied by men.[12]

Dorothy Hodgkin in 1928 began studying chemical sciences at Oxford University, an atypical decision at a time when women usually chose a life at home away from academia. Her most well known accomplishments were the determination of the three-dimensional chemical structures of penicillin in the 1940s, vitamin B12 in the 1950s, and insulin in the 1960s.[13] Hodgkin was the first British woman to win the Nobel Prize in Chemistry in 1964 for her work on X-ray crystallography, and the third woman in history to achieve it.[14]

Rosalind Franklin British was born on July 25, 1920, London, a scientist best known for her contributions to the discovery of the molecular structure of deoxyribonucleic acid (DNA), a constituent of chromosomes that serves to encode genetic information. Franklin contributed new insight on the structure of viruses, helping to lay the foundation for the field of structural virology.[15]

Franklin was 30 years old when she began experimenting with it, which had so far been a mystery. However, at the age of 37, she died of cancer and she was never recognized with the Nobel Prize. Crick and Watson, scientists from Cambridge, thanks to Franklin's work and their own contributions, built the first correct model of the DNA molecule, with a double helix, and in 1962, they received the Nobel Prize in Medicine for their research on the DNA molecule without having also recognized her contribution.[16]

Margarita Salas was one of the most important Spanish scientists recognized for her contribution in the field of molecular biology and biochemistry. In fact, she was the creator of the famous DNA polymerase patent, which has been fundamental to the development of genetic engineering. Margarita made key contributions to understanding how DNA works thanks to her studies on the Phi29 phage in the New York laboratories of the Nobel Prize in Medicine Severo Ochoa. Her short DNA chain, of only 20 genes, makes it an ideal model to study how bacterial viruses infect and reproduce inside bacteria, by amplifying the genetic material in a simple, fast and reliable way.[17] As a woman in science, the Women's Council of the Community of Madrid selected her in 2001 as one of the 100 women of the XX century who opened the path for equality in the XXI century.[18]

Gradually, the female population has been making its mark in science; according to UNESCO data, less than thirty percent of all researchers in the world are women. Moreover, only seventeen women have won the Nobel Prize in Physics, Chemistry or Medicine since Marie Curie earned it in 1903. During the same period, 572 men received the award.[19]

There are still many challenges to overcome for the professional development of women, among them the terms "glass ceiling" and "sticky floor" which appeared around forty years ago. The "glass ceiling" enunciated by Marilyn Loden, a passionate diversity advocate, who used this concept to refer to a barrier of unwritten norms of inequality and gender stereotypes that prevent women from moving up the organizational ladder. She mentioned that it is not an internal barrier that women do not want to break, but rather a cultural and sociological issue.

The concept of "sticky floor" by Catherine Berheide in 1992 is related the labor reality of a large part of the female workforce at the time. It describes that women lead sectors with limited opportunities for promotion and lack job ladders. In addition, women have taken the decision not to accept jobs in order not to break the balance between their profession and their family role.

Added to these concepts is the "Matilda Effect", defined as the social phenomenon by which the contribution of women in the field of science and technology in public spaces, in history and in institutions, is ignored or minimized. It was named in honor of Matilda Joslyn Gage, an American suffragist who fought for the defense of women's rights and whose contributions were long ignored. Gage achieved very important milestones for women through the publication of her various books and pamphlets that document experiences and events that occurred around discrimination against women at the end of the 19th century.[20–25]

Conclusion

People's gender should not be a condition for limiting their capabilities and opportunities. Thanks to all the pioneering women who paved the way in the field of science, every day we see more and more female scientists contributing knowledge where they were not admitted before. The new generations are increasingly taking positive actions to empower, develop talent, and increase women representation at the academic, scientific and professional positions. The future of women in chemistry is bright, but undoubtedly, the most important challenge is to eliminate many barriers and prejudices imposed on the female gender. As a society, we must focus on creating a more inclusive culture where women develop equitably and eradicate all types of injustice that impede their progress.

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Conflicts of interest

Author declares that there is no conflict of interest.

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