International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-9, Issue-6, June 2023
ISSN: 2395-3470
www.ijseas.com

The Transition from Alchemy to Chemistry: Notable Women Alchemists and the First Women Chemists in History

Juan Núñez Valdés
University of Seville. Seville. Spain

Abstract
The first people who make an important discovery, especially if it is of a scientific nature, usually go down in history and remain recognized and highly valued by society. However, this generally occurs in the case of men and not so much in that of women, since many of those women have enjoyed important milestones in their lives throughout history and, despite this, either they have not been recognized as they should or, in most cases remain completely forgotten. This article shows the life of several of them, specifically the most relevant female alchemists and the first female chemists in history, all of them born before the 18th century, who were pioneers of chemistry in their respective countries, contributing notably to the current development of that discipline and, however, they do not have deserved recognition.
Keywords: *Women chemists before the 18th century, relevant female alchemists, pioneering women of science, alchemist, chemist.*

1. Introduction

Experiences had by the author during his time as a university professor in a chemistry faculty show that when students are asked to name some famous chemical woman, the first answer they get is, invariably, Marie Curie and another also frequent, although least, is that of her daughter Irene Joliot-Curie.

Those two chemical women chemists are certainly famous, but they both practiced their profession in the 20th century. This comes to mind because it is very rare for a student to answer the previous question with the name of a woman related to chemistry from centuries prior to that and, however, there were many women currently very unknown to society, who made important discoveries in chemistry or worked in many aspects related to that discipline.

In particular, in this article we are going to focus on women related to chemistry, either because they graduated in that discipline or because they carried out activities closely related to it, who exercised their activity before the 19th century, a period that alternated with women alchemists in its beginnings with already graduates women in chemistry at its end.

The structure of the article is as follows. Section 2 is devoted to show a brief information on the origins of chemistry and alchemic, respectively, by way of contextualization. Section 3 gives some biographical notes of women related to chemistry in the sense that has been indicated, who were alchemists and carried out their activity before the 16th century. All of them were alchemists (remember that alchemy is considered a precursor to chemistry), since the birth of the latter as a scientific discipline did not occur until after the second half of the 17th century. Section 4 shows biographies of the last women of whom it can be said that they practiced alchemy in history, that is, those who developed their work in the 16th century. Section 5 deals with biographies of the first women properly chemist in history, that is to say, those who practiced chemist in the 17th century. A brief section of conclusions ends the article, whose main objective is to complete the already existing biographies of these women and above all, to place them as references and models to society.

The methodology followed has consisted in the search for new data about all f these women, in different bibliographical and digital sources, which complete some of the magnificent contributions already existing in

the literature on them, such as those by Haines, in 2001 [1], Bret, in 2008 [2], Rayner-Canham, in 2008 [3], Muñoz and Garritz, in 2013 [4], Ruley, in (2013 [5] and Lindblom, in 2014 [6], for example.

2. The origins of chemistry and alchemy

In a colloquial way, it can be said that chemistry, as we know it today, is a scientific discipline whose object is the study of chemical elements, their structure and organization in the periodic table and the chemical reactions in which they interact. Chemistry is also an integral and interdisciplinary science, since it is the basis of other sciences, such as biochemistry, biology, physiology, and physical chemistry.

Its basic principles are considered to appear for the first time in the work of the British scientist Robert Boyle (1627 - 1691) entitled “The Skeptical Chymist”, written in 1661. That publication gave rise to humanity, a century later, having full proof of the existence of this discipline thanks to the work of the French Antoine-Laurent de Lavoisier (Paris, 1743 - 1794), considered the "father of modern chemistry", on the oxidation of bodies, the phenomenon of animal respiration, the analysis of air, the law of conservation of mass, caloric theory, combustion and his studies on photosynthesis.

It is true that, prior to Lavoisier, the works of various experimentalist scientists produced numerous discoveries, but their interpretations through the phlogiston theory prevented any progress in the knowledge of all these phenomena, and therefore only Lavoisier, with the publication of his "Treatise Elementary Chemistry”, in 1789, was who definitively destroyed the phlogiston theory, in force until then, and established the foundations of modern chemistry.

Among those scientists prior to Lavoisier, we can mention the Swedish Carl Wilhelm Scheele (1742-1786), discoverer of many elements and chemical substances, among which oxygen stands out, which he obtained independently and sometime before another of them, the British Joseph Priestley (1733 - 1804), also considered the discoverer of this element (although as it has been said, this fact has also been attributed, with some foundation, to Scheele and Lavoisier himself. In any case, he was one of the first to isolate oxygen in gaseous form, and the first to recognize its fundamental role for living organisms). And also the British Henry Cavendish (1731 - 1810) should be given his importance for being the discoverer of hydrogen and the composition of water.

For the previously mentioned reasons, a vast majority of researchers place the beginning of Chemistry at the end of the 18th century, although this does not mean that before that date (much earlier, in fact) there had not been men and women who had dedicated part or all their life to carry out experiments that could be considered precursors of current chemical experiments. These people were both men and women, although in a much greater proportion the former than the latter, those called, since the beginning of time, alchemists.

For its part, it can be said that alchemy has a much older origin than chemistry, to such an extent that it can be considered its precursor. In ancient Egypt the word “Khem” was used to refer to the fertility of the floodplains around the Nile River. Egyptian beliefs that there was life after death and the mummification procedures they developed to safeguard their lifeless bodies produced a rudimentary chemical development, which would be the germ of this knowledge.

Later, towards 332 A.C., after the conquest of Egypt by the Greek army of Alexander the Great, the Greek idea that matter was made up of the four elements of nature: air, water, fire and earth was combined with Egyptian sacred science, giving birth to word “Khemia”, for this knowledge.

Later, when Egypt was occupied by the Arabs in the 7th century, they added the prefix “'al-“' to the word “Khemia”, giving rise to the Arabic word “al-Khemia”, which means “the Black Land”. It is currently considered the origin of the word “alchemy”.

Alchemy was also developed independently by Taoist monks in China, trying to get the “waidan” or outer elixir (minerals, plants, etc. that could prolong life) as the “neidan” or inner elixir, consisting of the use of exercise techniques to manipulate the life force of the body.

In India, alchemy knowledge was also developed independently. They invented steel and used the color of the flame to identify metals.

The introduction of alchemy in the West occurred in the eighth century after the Arabs brought it to Spain, from where it spread rapidly to the rest of Europe.

According to the Arabs, the metals were composed of mercury and sulfur in variable proportions. They considered gold as the perfect metal, all others being inferior to it. From there came the popular idea among Western alchemists that these inferior metals could be transmuted into gold by means of a substance they called the Philosopher's Stone. They also believed that the Philosopher's Stone could provide immortality.

In the 16th century, alchemists in Europe split into two groups. The first of them focused on the discovery of new compounds and the reactions between them, which led to the appearance of chemistry, as seen. The second group dedicated itself to the more spiritual and metaphysical side of alchemy, continuing the search for immortality and the transmutation of base metals into gold. It can be checked further information in [7].

In the early times and until the fifteenth century there have been several relevant women in the history of alchemy, although the data that is known about most of them is scarce, partly due to the secrecy of the alchemists to bring their knowledge to light. Next section deals with brief biographies of the main alchemist women from the earliest times to sixteenth century exclusive (recall that chemistry, as a science, had not yet been introduced).

3. Alchemist women from the earliest times to sixteenth century exclusive

This section deals in particular with those women alchemist who dedicated themselves to this activity before the 16th century.

Among the oldest alchemist women of this period can be cited the following,

3.1 Tapputi Belatekallim

Tapputi Belatekallim, who around 1200 B.C. developed certain techniques for the production of perfumes and cosmetics in ancient Babylon.

Many authors consider that this woman, born in Babylon in the year 1200 B.C., who was a councilor of the palace, is the first female chemist in history. This assumption is based on the fact that a cuneiform tablet found in Mesopotamia, which constitutes the first record of what could be a pharmacy as it is known today, could indicate that she worked in that place creating perfumes through mixtures of flowers, plants, such as Cyperus calamus, myrrh and balms, through the use of distilled water, which was filtered several times.

3.2 Keng Hsien-Seng

The Chinese Keng Hsien-Seng (some authors refer to her as Fang), born around 975 A.C.

She was the earliest recorded woman alchemist. Raised in a scholarly family skilled in the alchemical arts, she

studied alchemy with one of wives of Emperor Han Wu Ti, therefore having access to the highest levels of society.

According to the science writings of Wu Shu, she “mastered the art of the yellow and white [alchemy] with many other strong transformations, mysterious and incomprehensible” [8].

Wu Shu also described her as being acquainted with other Taoist techniques and was believed able to control the spirits. As it has been indicated, she also mastered the transformation of mercury and "snow" into silver, probably using the technique of extraction of silver from its ores and used a primitive type of Soxhlet process to continuously extract camphor into alcohol.

3.3 Other Chinese female alchemists

Rayner-Canham, M. and Rayner-Canham, G. (2001) cite in one of their contributions the names of other Chinese female alchemists. They are Pao Ku Ko (4th century B.C.), Thai Hsuan Nu, Sun Pu-Eh (12th century) and Shen Yu Hsiu (15th century).

Pao Ku Ko, also known as Bao Gu (4th-century), was a Chinese Taoist physician. She is considered as one of the famous four female physicians in Chinese history, joint with Zhang Xiaoniang (Northern Song dynasty), Yi Xu (Western Han dynasty) and Tan Yunxian (Ming dynasty). She was active during the Eastern Jin dynasty.

There are hardly any data in the literature on Thai Hsuan Un. Two of Sun Pu-Eh's main writings have been preserved: “Secret Book on the Inner Elixir as Transmitted by the Immortal Sun Bu'er” and “Model Sayings of the Primordial Immortal Sun Bu'er”. For her part, Shen Yu Hsiu lived during the Ming dynasty. She was taught by her father, Shen Wan-Sun, who is said to transmute copper and iron into gold and silver using mercury [9].

3.4 María the Jewess

Many researchers consider that María la Judía, also known as María la Hebrea or Míriam la Profetesa, is the first female scientist in history. Her works in the world of alchemy have reached our times through the writings that have been found, where she was labeled "wise". Thanks to them we know that in addition to inventing the distilling apparatus called "dibikos" (if it had two feet) or "tribikos" (if it had three), she also developed a chemical method that has survived to this day, a kind of “bain-marie”, consisting of applying fire to the bodies in a smooth and uniform way to warm them up. Another of her great inventions was the “kerotakis”, a reflux apparatus used to heat substances used in alchemy and collect their vapors. She used mercury, sulfur and arsenic, and through heat she managed to make them go from solid to gaseous. In addition, the steam obtained in this process was used to dye common metals.

Thanks to the writings of her countryman Zosimus of Panopolis, a Greek alchemist from the end of the 3rd century who compiled the first data on the existence of Mary, it is known that she was born in Alexandria and lived between the 1st and 3rd centuries B.C., but the data available on her life are very scarce or confusing. Zózimo described her as an "ancient wise" woman in his texts. In addition, she is credited with the invention of instruments and the development of various experiments.

Jorge Sincelo, a Byzantine chronicler of the 8th century, quotes her in his catalog of the 52 most famous alchemists, published in the year 879. Ancient alchemists associate her with Miriam, Moses' sister, and there were those who identified her with Mary Magdalene, but all these data carry very little weight. What is known is that the Arabs called her "Daughter of Plato", a nickname used to refer to white sulphur, the material with which Maria worked.

Maria the Jewess had as reference the Persian alchemist Ostanes (in the 3rd century B.C.) and it is known that she had a direct disciple, Agathodaimon. María la Judía probably died at an early age, a victim of the toxicity of the materials she used. It is also believed that her work disappeared in the burning of the library of Alexandria in 273, although her texts could also have been lost with the decree against alchemy issued by Diocletian in 296.

Among her main inventions, apart from her distillation devices, the already mentioned “bain-marie” (a name given after her) stands out in particular. It is used to heat a material in an indirect and regulated way, and is still used today as, for example, when heating a baby's bottle [10].

3.5 Cleopatra the Alchemist

Cleopatra, born in 3rd century B.D. was a Greek woman from whom some researchers think that she was the inventor of the alembic, a distillation apparatus (on the one hand, she should not be confused with Queen Cleopatra, and on the other, that name is also used as a pseudonym to designate an unknown author or group of authors). She is also credited as one of the four female alchemists who could produce the philosopher's stone, and also for trying to quantify alchemy and its experiments by using weights and measures.

At present, three alchemical texts written by her survive. They have the titles (translated to English) “On Weights and Measures”, “Gold Making of Cleopatra” and “A dialogue of the Philosophers and Cleopatra”, respectively [11].

4. Women alchemists of the XVI century

This section shows the biographies (in an alphabetical order) of the most notable women who practiced alchemy in the 16th century.

4.1 Isabella Cortese

Isabella Cortese, an Italian woman of the Renaissance, wrote in 1561 a treatise on alchemical practices translated into the main European languages, entitled "I secreti di la Signora Isabella Cortese" (the secrets). In it she dealt with the manufacture of perfumes, cosmetics, artificial pearls, oils and essences.

That book, dedicated to her brother, the Archdeacon of Ragusa, belongs to the so-called "literature of secrets" or "book of secrets", for some authors one of the most popular literary genres of the Modern Age. In the preface, Isabella Cortese provides some personal information about her, such as the fact that she was born in the first half of the 16th century and belonged to an aristocratic Venetian Renaissance family, stating that she traveled extensively throughout Eastern Europe for more than 30 years, where she learned the arts of the alchemy.

The book, unlike the hermeticism followed by traditional alchemists, was advertised for sale by vendors in the squares and markets of Venice and had several editions in the 17th century, both in that city and in Germany (one of its covers can be seen in Figure 1). It was divided into four sections: the first contained a set of advice on cosmetics and perfumery: creams and oils to preserve youth, soaps with perfumes. The second, tips on how to run the house and cooking recipes: how to make inks to dye different fabrics, how to wash a dress. In the third, remedies were provided for different ailments and in the fourth, the one that gave the work its name, alchemical formulas and detailed secrets of various alchemical and metallurgical processes were indicated.

Figure 1. Portada de “I Secreti... “ edition of 1687. Source: [12]

In turn, the fourth section, that of the secrets, was divided into three subsections: the first, dedicated to remedies of a medical nature; the second, to what today we could call industrial chemistry; and the third, to cosmetics. The secrets that Isabella Cortese describe in them are compilations of recipes and formulas of a marked alchemical nature, classified, according to their usefulness, into medicinal, domestic and technical. The medicinal secrets collected recipes for all kinds of diseases, although they had no relation to those compiled in pharmacopoeias and conventional medicine treatises. The domestic ones included various recipes to make perfumes, soaps, body lotions and liquids to fumigate clothes and rooms, in addition to various ways of making jams and the technical ones, finally, referred to formulas to make colors, as well as detailed descriptions of various alchemical and metallurgical processes [1].

4.2 Marie de Gournay

Marie de Gournay (name she adopted later, since she was born Marie Le Jars), who came into the world in Paris on October 6, 1565, can also be considered an alchemist, since in 1615 she published a work in which she explains how she used various amounts of gold, copper, lead, iron, tin and mercury, with the aim of studying their composition, a task that she also carried out with corrosive salts such as vitriol or chlorides. Figure 2 shows her image.

However, she is best known for her activity as a writer, philologist, translator, poet and philosopher. In Paris, in 1588, she met the French philosopher, humanist and writer Michel de Montaigne (1533 - 1592), whom she invited to spend several months at the Château de Gournay, where she lived, to share with him ideas and opinions and discuss his works and thoughts. In 1595 he wrote the Preface to Montaigne's Essays, plus all the manuscript corrections to it.

As a result of these conversations, she began her literary production on inequality based among the sexes, which earned her the opposition of the most conservative intellectuals. She brought together all her publications

in a book under the title “Les advis ou les presens de la demoiselle de Gournay”, published in 1641 [14].

Marie de Gournay (Figure 2) died in 1645, at the age of 79, without having married, since she considered marriage a burden that would prevent a life dedicated to study.

Figure 2. Marie de Gournay. Source: [15]

Because of her work, she is considered one of the historical precursors of feminism. Feminist movements at the end of the 20th century recovered her figure and made her recognized not only as Montaigne's elective goddaughter, but also for herself.

5. Women alchemists and chemists of the 17th century

Expanding something already commented and although this statement is subject to different observations and nuances, chemistry, as a science, was born in 1661, when Robert Boyle, a natural philosopher of Irish origin, published the very important work "The Skeptical Chemist", in which it was introduced for the first time the concept of "chemistry", causing it to be born officially as a science respected and separate from alchemy. Boyle, in his treatises, said that chemistry should not focus on the search for magical substances, but on finding the differences in properties of the compounds present in nature [16].

The most relevant women who in the 17th century continued to work in the non-disappeared alchemy or in the recently introduced chemistry, were the following.

4.1. Floriana Canale

A woman who continued with the genre of alchemical secrets initiated by Isabella Cortese was the Italian Floriana Canale, who in 1613 published the book “De secreti universali raccolti et esperimentati” (of collected and experienced universal secrets), which later, in 1622, was expanded and published under the title “Officina Medicinale. Trattati novi con l´aggiunta d´alcuni secreti curiosi scielti” (Medicinal Workshop. New treatises with some peculiar secrets (1622).

4.2. Marie Meurdrac

Marie Meurdrac was born around the year 1610 in a French commune located about 20 kilometers from Paris, Mandres-les-Roses. Her parents were the notary by profession Vincent Meurdrac and Elisabeth Dovet and she had a younger sister, Catherine, born in 1613 [17].

At the age of 15, she married the military commander Henri de Vibrac in 1625 and moved to the Château de Grosbois, becoming close friends with the Countess de Guiche.

In a self-taught way, as she herself commented in the preface to her main scientific work, which will be commented on later, María Meurdrac learned chemistry thanks to the Countess de Guiche, who provided her with chemistry and alchemy books from her library, allowed her to have of her is own laboratory in which to carry out experiments and obtained permission from the king to build a high-temperature oven on the castle premises to use in those experiments [18].

In 1656 or 1666, she published one of the first known works on chemistry written by a woman (Figure 3), which was approved by the Regent Masters of the Paris Faculty of Medicine: a 6-chapter book, entitled (in French) “La Chymie Charitable et Facile, en Faveur des Dames” [19], although several current authors, Feinstein, for example, believe that this work is more typical of alchemy than chemistry [20]. In any case, this work represents an important milestone for this woman, since it had 5 subsequent editions in French, 4 in German and 1 in Italian.

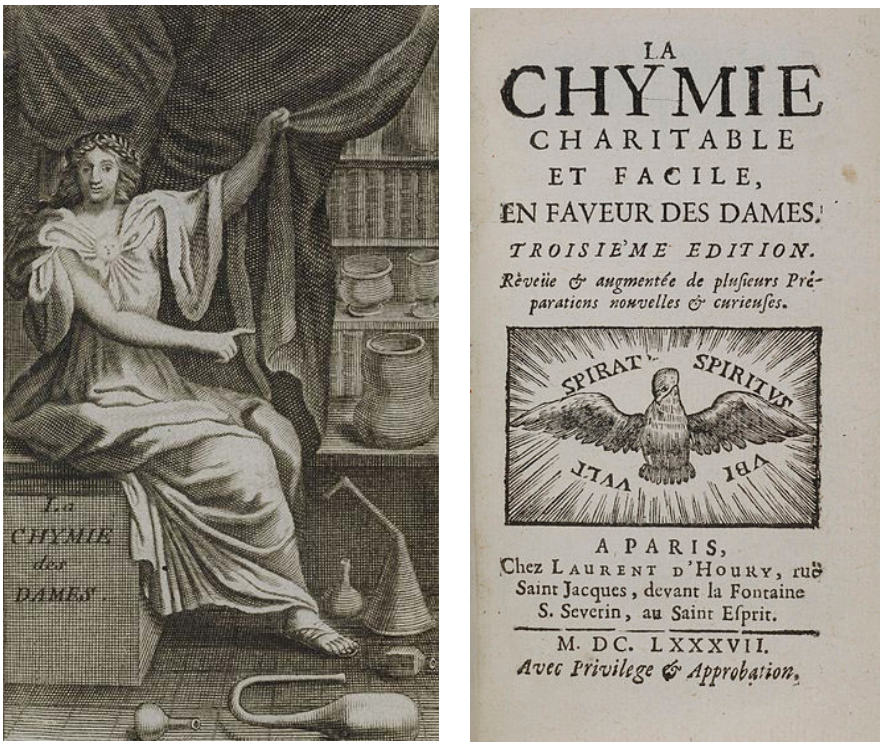

Figure 3. Covers of two editions of “La Chymie...” in 1687.
Source: [21]

In the Introduction to her book, Maria Meurdrac wrote the following [4]:

> I have been very careful not to go beyond my knowledge, and I can assure that everything I teach is true, and that all my remedies have been tested; for which I praise and glorify God.

Marie Meurdrac, who was really a spagyrist, understanding as such the practitioner of alchemical processes applied to medicine, considered herself as follows [4]:

> I prided myself that I am not the first woman to have placed something under the press, that mind has no sex, and if the minds of women were cultivated like those of men, and if we employed as much time and money in their instruction, they could become their equal.

4. Conclusions

From the research carried out, it can be deduced in the first place that the transition from alchemy to chemistry was not traumatic, rather it developed quite naturally, since the domination of alchemy in the 16th century led to a coexistence of this with chemistry in the seventeenth century, to later impose completely that second from the following century.

Secondly, it can also be concluded that all the women mentioned in this article have been pioneers in chemistry, since both their discoveries and other more important milestones in the development of their personal and professional lives prove it. Therefore, all these women, including alchemists, can be considered precursors of chemistry.

Hence, the author believes it convenient to bring to light the biographies of all of them, as well as of many other women who have also carried out similar work in other disciplines, so that society, especially women, knows them and can take them as models and referents to follow.

References

[1] C.M.C. Haines, International women in science: a biographical dictionary to 1950, Santa Barbara, California: ABC-CLIO, 2001.

[2] P. Bret, Picardet, Claudine. Complete Dictionary of Scientific Biography, Charles Scribner's Sons., 2008.

[3] M. Rayner-Canham and G. Rayner-Canham, M., Chemistry Was Their Life: Pioneering British Women Chemists, 1880–1949, London: Imperial College Press. 2008.

[4] A. Muñoz Paéz and A. Garritz, “Mujeres y química Parte I: De la antigüedad al siglo XVII”, Educación química, Vol. 24, No. 1, 2013, pp. 2-7

[5] A.Y. Rulev and M.G. Voronkov, “Women in chemistry: A life devoted to science”, New Journal of Chemistry, Vol. 37. No. 12, 2013.

[6] K.L. Lindblom, Rachel Lloyd, Ph.D. Pioneering Woman in Chemistry, National Historic Chemical Landmarks, American Chemical Society, 2014.

[7] University of Bristol School of Chemistry, A Brief History of Alchemy. Available in https://www.chm.bris.ac.uk/webprojects2002/crabb/history.html

[8] M. Rayner-Canham and G. Rayner-Canham, Geoffrey, Women in chemistry: their changing roles from alchemical times to the mid-twentieth century, Philadelphia: Chemical Heritage Foundation, 2001.

[9] F. Pregadio, Chinese Alchemy: An Annotated Bibliography of Works in Western Languages, Golden Elixir Press, 2009.

[10] R. Medina, L. García, M., Carranza, L. Sacasa, P. Daniels and A. Horan (ed.), Misterios de lo desconocido. Secretos de los Alquimistas, 1989.

[11] J. Lindsay, The Origins of Alchemy in Graeco-Roman Egypt, New York: Barnes and Noble, 1970.

[12] Web Image 1. Available in https://www.elsevier.es/es-revista-educacion-quimica-78-articulo-mujeres-quimica-parte-i-de-S0187893X13731872

[13] Blog Espacio Misterio, Mujeres alquimistas, 1 de mayo de 2005. Available in https://www.espaciomisterio.com/civilizaciones-perdidas/mujeres-alquimistas_32579

[14] C. Ambrosini, "Marie de Gournay. Escritos sobre la igualdad y en defensa de las mujeres", Perspectivas Metodológicas, Vol. 18, No. 21, 2018, pp. 57-64.

[15] Web Image 2. Available in http://cornucopia16.com/blog/event/gournay-philosophe/

[16] P. Bertrán Prieto, Historia de la Química: evolución e hitos de esta ciencia. Available in https://medicoplus.com/ciencia/historia-quimica-evolucion-hitos

[17] P.E. Noyce, Magnificent Minds: 16 Pioneering Women in Science & Medicine, Boston: Tumblehome Learning, 2015.

[18] S. Findlay, "Mind has no sex: The story of Marie Meurdrac, First Lady of Chemistry", Electromaterials Science, March 10, 2015.

[19] S. Gordon, Chemistry, Medicine, and Beauty on the Edge: Marie Meurdrac. In Women on the Edge in Early Modern Europe (Ed. L. Hopkins and A. Norrie), Amsterdam: University Press, 2019.

[20] S. Feinstein, "La Chymie for Women: Engaging Chemistry's Bodies". In Early Modern Women: An Interdisciplinary Journal, Vol. 4. 2009.

[21] Web Image 3. Available https://mujeresquehacenlahistoria.blogspot.com/2011/06/siglo-xvii-marie-meurdrac.html

Juan Núñez Valdés is a PhD. in Mathematics (1991) and in Pharmacy (2021) from the University of Seville. Since 1989 he has been a professor in the Department of Geometry and Topology, at the Faculty of Mathematics of that University. At present, he is an Honorary Researcher of the same. His research in Mathematics focuses on Differential Geometry, Lie Theory, Non-associative Algebras and Discrete Mathematics. He also investigates the History of Pharmacy and Chemistry and gender issues. He has more than 200 publications including teaching and research books and articles and the same number in popular science and gender journals. As well as he has presented more than 150 communications at research and popular science conferences. He belongs to the Royal Spanish Mathematical Society and is a member of the Board of Directors of the Andalusian Society of Mathematical Education "Thales".