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Brief History of Chemistry in the Philippines

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The history of chemistry in the Philippines can be traced back to the pre-Hispanic era, when chemical processes have been widely used for the production of metals, ceramics, dyes, sugar and alcohol. Chemistry as a science emerged only in the second half of the 20th century and was taught in universities as part of a humanistic course. The subsequent development of chemistry in the Philippines was pursued in the field of pharmaceutical chemistry during the last decades of the Spanish regime. The growth of chemistry in the country accelerated during the American occupation of the country when a course on chemistry was offered by universities, and chemical industries were established. The momentum of growth increased during the period of the Philippine Republic when more chemical industries were founded and chemistry education was enhanced. This growth formed the basis for the present status of chemistry in the country.

Key words: History of chemistry; Philippines

INTRODUCTION

The closing of the century is an appropriate time to look back and summarize the progress and developments made during this period. This retrospection will reveal how much we have moved during the hundred-year span of time. It will allow us to examine the conditions which contributed to the success achieved and to the failures committed.

A limited number of reference materials have been written which present the history of chemistry in our country. A series of papers in a 1935 issue of the Bulletin of the National Research Council of the Philippines [1] traced the growth and development of chemistry in the Philippines. A book [2] was published in 1954 which compiled historical reviews on the chemical industries, chemical education and other areas of application of chemistry. In 1992, Miranda [3] wrote a retrospective survey of the state of chemical science and technology in the country during the first half of this century.

This paper hopes to make a contribution to the reference materials on the history of chemistry in the Philippines. It will enrich the information on chemistry during the Spanish era of our history. It will likewise present a cursory look on the growth of chemical science and technology in the country during the second half of the century.

CHEMISTRY IN THE PRE-HISPANIC TIMES

Historical evidences show that the ancient Filipinos possessed a considerable knowledge of chemical processes. These processes involved the transformation of some materials into more useful forms. It is highly probable that these operations were empirical in character and were learned through the ages. Chemistry was practiced as an art, with most of the methods kept as trade secrets that were known only to the members of the craft.

Our forefathers were skilled in the extraction and treatment of metals. Numerous artifacts have been found which provide proof to the existence of metallurgical expertise in the country before the arrival of the Spanish. Metals, such as gold, silver, tin, copper, and iron, were common materials used in the production of tools, utensils, ornaments, and weapons. The existence of uniquely Filipino names for these metallic elements provides proof to the familiarity of the ancient Filipinos with these materials. Perhaps, the best

known master of the metallurgical arts of this era is Panday Pira, a maker of weaponry whose skills were later acknowledged by the Spaniards.

Dyeing was another chemical process practiced by Filipinos during the pre-Hispanic times. The dye materials were extracted mostly from plants and the soil, and were used as body paints and textile coloring. The ancient Filipinos were familiar with techniques of how to extract the coloring matter and make these substances adhere well to the surface on which the dyes were applied. Historical accounts about the *pintados* and the longevity of the bright colors of the old native cloths are evidences of the dyeing skills existing during the ancient era.

The manufacture of sugar was another chemical process known to Filipinos. A Chinese traveler in the fifth century recorded the Philippines, together with Java and Hawaii, as a producer of sugar. The early Filipinos employed a method similar to what the Chinese used to produce pure and white sugar. They boiled partly classified sugar cane juice into a thick mass and poured it into a conical clay mould. Porous clay moulds used in this ancient technology can still be found in remote towns where the sugar industry has gained foothold [4].

Fermentation was another process that was known in the ancient times. Alcoholic drinks and food sauces were produced through changes promoted by microorganisms. Of course, the early Filipinos were not aware of the participation of microorganisms in the process, but they were familiar with the techniques on how to promote the growth of these organisms.

Indeed, our forefathers were adept in operations that are essentially chemical in nature. However, very little documentation has been made on the technologies practiced by the Filipinos before the arrival of the Spanish. Products of the ancient technologies comprise the archaeological artifacts collected from several regions in the country. Some of these technologies might have been originated from the neighboring countries, and a few might be a Filipino invention.

CHEMISTRY DURING THE SPANISH ERA (1521-1898)

Chemistry evolved into a science only during the second half of the 17th century. Prior to this period, the chemical transformation of substances was practiced as an ancient "black" art by the alchemists and later was discussed by the philosophers as part of the natural phenomena. It gradually developed into an experimental science through the works of Robert Boyle in the seventeenth century, Antoine Lavoisier in the eighteenth century and John Dalton in the early part of the nineteenth century. Rapid growth in the stock of chemical knowledge took place in the nineteenth century, setting the pace for the continuous development of chemistry into a highly dynamic field of science.

The impact of the scientific progress that occurred in Europe took some time to reach the Philippines. Though colleges and universities were instituted in the country by the Spanish as early as 1611, these education institutions focused on philosophy, theology, and law. It was only in 1867 that elementary chemistry was first taught, as part of a system of Secondary Education (*Segunda Enseñanza*) involving a five-year humanistic course leading to a degree of Bachelor of Arts. During this time, only the University of Santo Tomas and the Ateneo Municipal de Manila were authorized to offer this course and were required to set up a chemistry laboratory [5].

Higher chemistry subjects were introduced in the Philippine education system when the University of Santo Tomas founded the Faculty of Pharmacy in 1871 and offered a five-year course on pharmacy. Included in the curriculum for this course were the following subjects: (a) *quimica inorganica aplicada a farmacia con las practicas corresoindientes*, (b) *quimica organica aplicada a farmacia con las practicas corresoindientes*, and (c) *analisis quimico y en particular de los alimentos, medicamentos y venenos con las practicas corresoindientes* [6]. The lecturers were mostly Dominican priests who obtained academic training in European universities, and the books and laboratory facilities for these subjects were of European origin.

Through the university courses, the scientific ferment in Europe reached the country and some scholarly work on chemistry were produced mainly in the University of Santo Tomas during the last half of the nineteenth century. In 1886, Fr. Marcos Lainez, a Spanish Dominican priest, wrote a treatise on physical chemistry entitled "*La Combinacion y Compuesto Quimico*" [7]. In the same year, Don Anacleto del Rosario, a Filipino professor, published his work "*Los Olores del Pasig*" which dealt with the analysis of the water of Pasig River [8]. In the early 1890s, Fr. Jose Ramon Gonzalez, a Dominican professor, worked on the chemical composition of the hot springs in Laguna and wrote a paper entitled "*Aguas Minero-medicinales de la Laguna*" [9]. In 1897, Fr. Felix Oses, another Spanish Dominican priest, worked on a modification of the Kjeldahl method for the determination of nitrogen [10].

Chemistry was employed by the government during this regime for public health protection and for commercial transactions. In 1888, the *Laboratorio Municipal* was established and had a section of *Laboratorio del Analisis Quimico*. Chemical analysis was carried out on drinking water, pharmaceutical products, and food materials. Don Anacleto del Rosario was the first head of this laboratory.

Chemistry was practiced in the Philippines during the Spanish era because of its pharmaceutical applications. Perfumes generated some interest, since most of these cosmetic products came from Europe. Several drug stores manufactured perfumes in their laboratories using local materials. Among

these were Botica Boie, Gallardo of Tacloban and Victoriano Luciano of Cavite [11]. The good quality of the ilang-ilang oil produced by Friedrich Steck and Paul Sartorius in the Laboratory of Botica Boie was acknowledged by awards in the European Exposition in 1887.

The local manufacture of medicinal products also attracted great interest. For a long time, medicines were imported from Spain and were prescribed by physicians who had no knowledge of the composition of these materials. When laws were passed which required labels giving the composition of imported pharmaceutical preparations, the Filipino pharmacists realized that these materials could be prepared locally. Towards the end of the nineteenth century, the leading pharmaceutical manufacturers in the country were Botica Boie (which was founded by a Spanish physician Dr. Lorenzo Negrao). Botica de Santa Cruz (which was established by a German pharmacist), Botica de Binondo (which was owned by Don Leon Ma Guerrero) and Licenciado Torres (a Filipino pharmacist). Among the products were peptones, pepsin, pancreatin, an iron-containing wine known as *Vino de Quina*, expectorants (*Expectorante*) and castor oil preparations (*Castoria*) [11].

The chemical technology employed during the ancient pre-Hispanic times were sustained because of their useful products. Records exist showing the establishment of a tannery in Meycauayan, Bulacan in the 1850s [12]. This tannery produced low quality leather for slippers, harness, and soles. The manufacture of fireworks and pyrotechnics was another chemical industry which was started during the Spanish era. It was set up in small scale in many towns to provide the pyrotechnic materials during *fiestas*. In 1896, two companies in Bocaue, Bulacan (National Fireworks and Victory Fireworks) started to produce firework materials in large scale [13]

The chemical processes involved in the chemical technologies retained their empirical character, since the chemical science pervading in the country during this period was directed towards pharmaceutical applications.

CHEMISTRY DURING THE AMERICAN REGIME (1898-1940)

After a brief period of independence from Spain, the Philippines was colonized by the United States of America. The dawning of the 20th century witnessed a change in the colonizing power in the country. It also saw a gradual increase in the dissemination and application of chemical knowledge in the country.

Immediately after the Revolution of 1898, higher chemistry subjects continued to be taught as part of the professional course on pharmacy. A Faculty of Pharmacy was instituted in the Universidad Literaria de Filipinas established by the short-lived Philippine revolutionary government. The professors and lecturers in this faculty included Dr. Leon Ma. Guerrero, Dr. Alejandro Albert and Dr. Mariano del Rosario, all of whom completed their studies in pharmacy at the University of Santo Tomas.

A year later, the University of Santo Tomas resumed its offering of the pharmacy course where higher chemistry subjects where included in the curriculum. Later on, the Liceo de Manila (the predecessor of Manila Central University) instituted a Faculty of Pharmacy where chemistry subjects were taught.

Elementary chemistry was part of the academic requirements in the Bachelor of Arts program in the Ateneo Municipal, the Colegio de San Juan de Letran, and the University of Santo Tomas. In 1901, it was also taught in government-run institutions [6], such as the Philippine Normal School, the Manila High School (then the only public high school in Manila) and the Junior College (the precursor of the University of the Philippines).

In 1908, the University of the Philippine Islands was founded and offered instruction in general inorganic chemistry, general organic chemistry, qualitative analysis, quantitative analysis and principles of chemistry to students of preparatory medicine, pharmacy, engineering, veterinary science and agriculture. In 1913, the state university began to offer in its College of Liberal Arts an undergraduate and graduate chemistry curricula which were oriented to train chemists for employment in industries such as sugar mills, cement plants, distilleries, essential-oil factories, and analytical laboratories. In 1920, the state university established in its College of Agriculture a Sugar Technology program which included advanced chemistry courses such as biochemistry, colloid chemistry and physical chemistry. The first teaching staff for these courses were mostly American professors, and the Filipino teaching staff were trained by sending them to the United States as *pensionados*.

In the 1920s, chemistry was taught in more universities, such as Centro Escolar University, National University, and Philippine Women University, which began to offer courses in pharmacy. In 1925, the Ateneo de Manila initiated a course in Sugar Chemistry which included laboratory subjects on the chemical control of cane sugar factories [4].

In the 1930s, several universities began to offer a B. S. program in chemistry that was intended for the training of chemists for employment in government and industrial chemistry laboratories. These universities were the University of Santo Tomas, the Adamson University, and Siliman Institute (later Siliman University).

Chemical research was boosted in the country through the establishment of the Bureau of Government Laboratories in 1901. Intensive chemical investigations were initiated in this bureau by an American chemist and physician, Dr. Paul C.

Freer. who headed the bureau until 1934. The initial studies, which were conducted in collaboration with the Bureau of Health, were directed on drug materials for the improvement of local health conditions. Among the products of these studies are the preparation of tiki-tiki extract from rice bran for use against beri-beri, the manufacture of chaulmoogra oil for use in the treatment of leprosy, the manufacture of sera and vaccines against rabies, cobra bites, cholera and dysentery. When the health conditions in the country improved, the bureau focused on basic and industrial research such as the processing of Philippine vegetable oils for industrial and medical uses, the reclaiming of by-products from waste materials in the sugar, rice and coconut industries.

Extensive studies were done in government and university laboratories on the extraction on coconut, from the extraction process to the purification and improvement of the properties of the extracted oil. The research output were published in the Philippine Agriculturist, the Philippine Journal of Science and the University of the Philippines Natural and Applied Science Bulletin.

Other vegetable oils, such as oils from lumbang, kapok, peanut. and rice bran, were also studied for their potential industrial use. The studies carried out on the extraction and characterization of lumbang oil led to its commercial application as a substitute to linseed oil in the manufacture of paints. The Ynchausti & Company (YCO), the first paint factory in the Philippines by the Elizalde brothers, produced paints using locally prepared lumbang oil as the vehicle.

Another popular research area during this time was the analysis of the food composition of Philippine fruits, vegetables and local foods. A great number of papers on this topic appeared in local journals, such as in the Philippine Agriculturist, the Philippine Journal of Science, the Bulletin of the National Research Council of the Philippines and the University of the Philippines Natural and Applied Science Bulletin.

The chemical characterization of local ceramic materials was also well investigated by chemists in the Bureau of Science and the University of the Philippines. The Philippine Journal of Science included a number of papers featuring chemical studies on ceramics.

During the American era, chemical industries were set up in various places in the country. Cement plants were put up on 1914 in Binangonan, Rizal (Rizal Cement Co.) and on 1922 in Cebu (Cebu Portland Cement Company). The first sugar central was established in Mindoro on 1910. In this same year. oxygen and acetylene were locally produced by the Philippine Acetylene Company in Paco, Manila for the consumption of the welding industry. The Luzon Industrial Corporation produced hydrogen gas for the hydrogenation of fats and oil. The local production of paper was started in 1939 by the La Tabacalera's Compania Celulosa de Filipinas in Bais, Negros. The large scale manufacture of glass in the Philippines was started in 1936 by the San Miguel Brewery.

As the number of chemists increased, the need to band together and work for the further advancement of the science was realized. Thus, in 1935, the Chemical Society of the Philippines was founded with Dr. Amando Clemente as the first president.

CHEMISTRY DURING THE JAPANESE REGIME (1940-1945)

During the brief period of the Japanese occupation, chemistry provided a means for overcoming the shortage in the supply of chemicals, drugs, and medicines. Chemists and other people with a knowledge of chemistry utilized local raw materials to produce chemicals and pharmaceuticals that were badly needed by the people. For instance, soap was manufactured from coconut oil and alkali solutions obtained from ashes. Totaquina needed for the treatment of malaria was produced from the barks of the cinchona trees in Bukidnon. Coconut oil and alcohol were used as fuel for vehicles.

CHEMISTRY DURING THE PERIOD OF THE PHILIPPINE REPUBLIC (1946 TO PRESENT)

After the war, the government instituted national programs directed towards economic and industrial development. Industries were developed, and chemical and pharmaceutical manufacturing plants were established by local and foreign investors in different parts of the country. Shortly after liberation, a number of mills, for the production of coconut oil, such as the Philippine Manufacturing Co. (PMC), the Philippine Refining Company (PRC), the International Oil Company, were put up because of the high prices of coconut products in the world market. Likewise, sugar mills damaged during the war were immediately rehabilitated and several new mills were opened to supply the international demand for sugar. In the early 1950s, large-scale paper factories was opened by the National Development Company and the Philippine Paper Mills. In 1950, the Superior Gas and Equipment Co. (SUGECO) opened its plant for the manufacture of caustic soda and chlorine gas. In 1952, the Marcelo Tire and Rubber Company and the El Provenir Rubber Products began the local production of rubber products.

The newly established industrial plants operated analytical and quality control laboratories which require the services of chemists. This demand provided impetus for the offering of a professional course for chemists in Philippine colleges and universities, such as the Mapua Institute of Technology, the Centro Escolar University, and the University of San

Carlos. More programs involving chemistry were offered, such as Industrial Chemistry and Industrial Technology, by institutions such as the University of the Philippines, the University of Santo Tomas, and the Siliman University.

In 1952. the practice of chemistry in the Philippines was regulated by Republic Act No. 754, which required chemical plants and laboratories to obtain a license before they can operate and extended the services of chemists to a professional level. side by side with other technical men. This act created the Board of Examiners for Chemists which administered a licensure examination for the registration of chemists. The members of the first Board of Examiners for Chemists were Benito Legarda, Marcos Alicante, and Eduardo Taylor.

As the number of chemists grew in the succeeding decades, new chemistry organizations were founded. In the early 1960s, the Philippine Association of Chemistry Teachers (PACT) was founded, and in 1971, the Organic Chemistry Teachers Association (OCTA) was established. Both organizations involved members who are chemistry teachers, but not necessarily chemists. In the mid-1970s, the biochemists and biochemistry teachers organized the Philippine Biochemical Society, which was later renamed Philippine Society for Biochemistry and Molecular Biology. In the late-1970s, the Integrated Chemists of the Philippines, an organization composed only of registered chemists was founded upon the encouragement of the Professional Regulation Commission. In 1989, these chemistry organizations banded together under the Philippine Federation of Chemistry Societies.

Chemical research was carried out in the universities as a requirement in the undergraduate and graduate courses in chemistry. A survey carried out in 1982 [15] revealed that almost two-thirds of the graduate these done from 1916 to 1980 were on natural products. It also showed that 20% of the graduate research were basic, and 80% were applied research. Most of the investigative work were on agricultural products. such as coconut, rice and sugar cane, medicinal plants and water analysis.

During the first decade after the war, research work involving chemistry were done in government laboratories, such as the Institute of Science and Technology (the former Bureau of Science. and Institute of Science, and now the Industrial Technology Development Institute), the Institute of Nutrition (now the Food and Nutrition Research Institute) and the Bureau of Plant Industry. In the succeeding decades, more research laboratories involving chemistry were set up, such as Philippine Atomic Energy Commission (now the Philippine Nuclear Research Institute) where chemical research involving radioisotopes was carried out.

The closing of the century sees a greater variety of research work being done in academic and government laboratories. Natural products chemistry is still a popular topic, but now both terrestrial and marine plants are being studied and state-of-the-art techniques are being employed for structural elucidation and for the assay of biological activity. Agricultural products are also widely studied, but now biotechnology and molecular biology methods are applied in the investigations. Analytical chemistry is another active research area, wherein are included studies on the development of new analytical technologies, such as instrumentation and sensors, and on the application of instrumental methods in the analysis of environmental and food materials. Organic chemistry is likewise a dynamic field of research, with work on the synthesis of new or modern materials and the study of organic reactions being done. Material science and polymer chemistry have emerged as a separate research area from organic chemistry. Biochemistry and molecular biology are being applied in the studies on food resources, bioresources, and waste products. A survey of the current state of chemical research in the Philippines is presently being carried out as a project of the National Academy of Science and Technology.

The improvement in the over-all profile of chemical research in the country actually occurred during the last decade. This change has become evident in the quality of the paper and poster presentations during the annual Philippine Chemistry Congress organized by the Philippine Federation of Chemistry Societies. The major factor which brought about this favorable change was the implementation of the Medium-Term Plan for Science and Technology and of the Engineering and Science Education Program of the Department of Science and Technology. These programs contributed to the improvement of the human resources and physical facilities for research in some universities.

CONCLUSION: CHEMISTRY IN THE FUTURE

In the future, chemistry research in the Philippines should be actively contributing to the world stock of knowledge in chemical science and technology. While it has been said that our research profile has improved, the present state is still far from the ideal case. While it has been said that more research work are being done in Philippine academic and government laboratories and are being presented as papers and posters in national and international conferences, the number of locally-done research work published in refereed international journals has remained low. A great number of completed research work in the universities, to my knowledge, has remained unpublished. The "culture for writing" has to be strengthened among chemist-researchers here in the country.

In the future, chemical research in the country should be actively contributing to national economic development. Presently, the goal of most researchers has been to come out with research publications. Only a small number of research work has resulted in a patent grant. A highly limited number, if ever existent, number of research work has gone into commercialization and contributed to the national economy. The success story of the lumbang oil and YCO paints has to be repeated. The government, through the Department of Science and Technology, is encouraging research collaboration between researchers in the academic and government laboratories and the industrial investors, but a "culture for venture" among researchers and a "culture for research" among industry people has yet to be developed.

Unlike a hundred years ago, the dissemination of chemical knowledge is no longer slow. It now takes only a fraction of a second for chemical information from other countries to reach the Philippines. Information technology is catalyzing the development of chemical science and technology in the global level, and there is a need for Philippine chemists to make use of this powerful technology, if they are to maintain their world-class quality.

And finally, chemists in the future should be able to communicate with the rest of the Filipino people. Presently, we pride in having great facility in expressing our chemical ideas to the rest of the world through the English language; however, we have great difficulty in letting this knowledge trickle down to the masses because we cannot discuss chemistry in our local language.

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