

The development of chemistry at the National Medical Institute, 1888-1915

Liliana Schifter¹; Patricia Aceves²

Abstract

In the present paper we analyze the contributions of the National Medical Institute (NMI) to the development of chemistry in Mexico at the end of the 19th century and beginning of the 20th century mainly through the work carried out in two of its sections: Analytical chemistry and Department of Industrial Chemistry. NMI had the most modern laboratories of the time for the advancement of analytical chemistry, where leading scientists carried out research with the common goal of investigating the therapeutic effects of national medicinal plants. The Department of Industrial Chemistry began its activities in 1904 with the aim of perfecting the process for large-scale production of drugs and active ingredients obtained at NMI laboratories. This was undoubtedly the first research facility in which specialists in the field put the main methods of industrial pharmaceutical chemistry into practice. The Department was created with the double goal of obtaining raw materials and medicines useful for the public in general and to contribute to the training of skilled manpower.

Keywords

Analytical chemistry; Industrial chemical pharmacy; Mexico; National Medical Institute; Medicinal plants

O desenvolvimento da química no Instituto Médico Nacional, 1888-1915

No presente estudo analisamos a contribuição do Instituto Médico Nacional (IMN) ao desenvolvimento da química no México, nas últimas décadas do século XIX e primeiras do XX, especialmente através do trabalho realizado em duas de suas seções, Química analítica e Departamento de Química Industrial. O NMI apresentava os laboratórios mais modernos da época para o desenvolvimento da química analítica, onde cientistas destacados produziram pesquisas destinadas a investigar efeitos terapêuticos de plantas medicinais nacionais. O Departamento de Química Industrial iniciou suas atividades em 1904, estando dedicado a aperfeiçoar o processo de produção em grande escala de drogas e ingredientes ativos obtidos nos laboratórios do Instituto. Esse foi, certamente, o primeiro local que contou com especialistas na área para colocar em prática os principais métodos de química farmacêutica industrial. O Departamento foi criado tanto para produzir matérias-primas e medicamentos úteis para a população, como para contribuir à capacitação de recursos humanos.

Palavras-chave

Química analítica; Farmácia química industrial; México; Instituto Médico Nacional; Plantas medicinais

¹Head professor, Department of Biological Systems, Universidad Autónoma Metropolitana Xochimilco;

²Head professor, Department of Biological Systems, Universidad Autónoma Metropolitana Xochimilco, México. ✉ liliana_schifter@hotmail.com

Introduction

By the time of the Spaniards' arrival the ancient Mexicans had already acquired thorough knowledge of the qualities and medicinal uses of the local flora. The study and exploitation of medicinal plants continued during the colonial period and after the independence of Mexico was accomplished in 1821, this tradition was kept alive in the new Mexican nation to reach a climax with the creation in 1888 of the National Medical Institute (NMI) in Mexico city. The aim of this institution was to investigate local medicinal plants, as well as their possible applications and commercial uses.

Within the NMI, the study of the materia medica was part of the concerns of a group of physicians, pharmacists and naturalists interested in consolidating a local tradition based on national resources and oriented towards the resolution of specific health problems bedeviling the country. The second section of the Institute was dedicated to analytical chemistry, being its main aim to identify and isolate the active ingredients of medicinal plants. It is important to note that the study of materia medica of herbal origin and its therapeutic applications constituted the major line of research on Mexican pharmacy during the 19th century. With the arrival of the new century also the production of medicines derived from those medicinal plants, as well as from other species of industrial utility as natural fibers or polymers, took special interest. It was believed that the extended use and possible exportation of those products could boost the establishment of a national industry based on the exploitation of local natural resources. Thus the burdensome dependency on imports would end, as well the settlement of foreign companies in the country that exploited natural resources due to the lack of local infrastructure and qualified personnel to carry out these activities. For this purpose, the Department of Industrial Chemistry (DIC) was created in 1904.

Science during the '*Porfiriato*' and creation of the National Medical Institute

The '*Porfiriato*' was the period along which a dictatorial regimen ruled over Mexico spanning from 1876 to 1911. During this period social inequality grew, while a model of economic development based on foreign investment and export of raw materials took hold of the country. In consequence the flow of foreign capital increased, resulting in industrial development, especially as concerns extractive industries (metals, rubber, oil) and an incipient processing industry; before this period the Mexican economy was bankrupt.¹ However, despite the healthy-looking scenario, Mexico was

¹ Mauricio Tenorio, *Artifugio de la nación moderna: México en las exposiciones universales, 1880-1930* (México: Fondo de Cultura Económica, 1998).

considered as an exporter of raw materials, mainly to the United States, and an importer of U.S. products.²

The construction of the 'Porfirian national state' rested on two pillars: education and health. Within that context scientific and educational institutions were founded to provide Porfirio Díaz's (1830-1915) regimen with a body professionals devoted to the promotion of the country's economic, health and educational development policies. Thus, the 'Porfiriato' paved the road for the promotion of education and science.³

The task of modernizing and industrializing the country was entrusted to the Ministry of Development, which was charged of all the aspects of mining, industry and agriculture, as well as of everything related with natural resources such as water and forests.⁴ In terms of public health, the health policy was conceived of within a medical paradigm in which hygiene had a prominent place, being under the supervision of the Superior Health Council, which devoted part of its efforts to improve the hygienic conditions and reduce the mortality by preventable diseases.⁵ Another important element of the health policy was the creation of a national therapeutic system based on the use of Mexican medicinal plants. This task was assigned to the National Medical Institute (1888-1915).⁶

Within this context, it is worth to emphasize the work carried out by a group of pharmacists led by Leopoldo Río de la Loza (1807-1876), from the Pharmaceutical Academy of Mexico, who published the first Mexican pharmacopoeia in 1846 to meet the scientific needs for a modern and up-to-date work in which the national materia medica would be extensively represented, and the nomenclature of medicines and of the methods to elaborate them standardized.⁷ The Mexican Pharmaceutical Society was created in 1871 with the explicit purpose of preparing a new edition of this work that was published in 1874.⁸ Like its predecessor, the new pharmacopoeia allocated much space to native medicinal plants with the intention of using them to replace others with

² Daniel Cosío-Villegas, *Historia moderna de México: El Porfiriato* (México: Hermes, 1965).

³ Francois-Xavier Guerra, *México, del antiguo régimen a la Revolución* (México: Fondo de Cultura Económica, 1988).

⁴ Nina Hinke, *El Instituto Médico Nacional, la política de las plantas y los laboratorios a finales del siglo XIX* (México: Cinvestav/UNAM, 2012), 47.

⁵ The Superior Health Council was divided in 15 committees: epidemiology, theatres, hospitals, schools and nursing homes, prisons, cemeteries, foodstuffs, vaccines, statistics, meteorology and medical topography, hydrology and hydrography, sewage, drugstores, veterinary clinics and factories; see Moisés González, "El Porfiriato: vida social," in *Historia Moderna de México*, ed. Daniel Cosío Villegas (México: Editorial Hermes, 1957), vol. 4, 20-37, on 34.

⁶ Ana M. Carrillo, "La salud pública en el porfiriato," *Haciendo historia* 1, no. 2 (1999): 18-22.

⁷ Liliana Schifter, "Las aportaciones del Dr. Leopoldo Río de la Loza a las dos primeras farmacopeas mexicanas," in *Leopoldo Río de la Loza y su tiempo, la construcción de la ciencia nacional*, coord. Patricia Aceves (México: UAM-X/CNQFB/SQM, 2011): 199-233.

⁸ Liliana Schifter, "Las Farmacopeas Mexicanas en la construcción de la identidad nacional," *Revista Mexicana de Ciencias Farmacéuticas* 45, no. 2 (2014): 43-54.

similar effects which were imported from abroad. The Pharmaceutical Society published further four editions between 1884 and 1925, which included the national plants with most significant therapeutic activity. The work performed at the NMI was an important source for the editions published in 1896, 1904 and 1925.⁹

As it was already stated, the focus of the NMI at the time of its foundation was on the study of the Mexican flora and fauna and their therapeutic and industrial applications. It is worth to stress that the purpose of its creation was not only to replace foreign drugs by national equivalents, but also to contribute to the discovery of new species effective for the cure of diseases affecting the Mexican population. As a result, medical geography and the country's climate also became subjects of interest. The Institute was initially divided in five sections: Natural history, Analytical chemistry, Experimental physiology, Clinical therapy and Medical geography.¹⁰ Later, in 1904, the Department of Industrial Chemistry was created, first as an appendix to the Clinical therapy section to become an independent section in 1911,¹¹ when also a seventh section for phytogeography was established.¹²

The structure of NMI was designed in accordance to the various steps or stages of research performed at it and the various sections that constituted it. Its layout was a faithful reflection of the pharmacological experimental model then current in Europe for the study of materia medica and its therapeutic applications, which the NMI called 'experimental therapeutics' model. Basically this method required: 1) performing a botanical description and the classification of plants, 2) collecting historical data relative to their properties and therapeutic applications, (3) conducting chemical analysis once the therapeutic applications of the plants were established, and preparing active ingredients that were subsequently used in physiological experiments with animals. Until 1896, the series was concluded by the study of the therapeutic applications of the substances on human patients at the Clinical Therapy Ward of St Andrew's Hospital.¹³ Starting 1905 that part of the research was performed at a pavilion in the General Hospital specifically designed for that purpose, which allowed including the medicines prepared at NMI in the hospital's therapeutic.

⁹ Liliana Schifter, *Espíritu e identidad farmacéuticos: La construcción de la Farmacopea Mexicana*, (México: Universidad Autónoma Metropolitana/SQM/ Colegio Nacional de QFB, 2014).

¹⁰ José Terrés, "Fragmento del informe rendido por el Director del Instituto Médico Nacional a la Secretaría de Instrucción Pública y Bellas Artes, sobre los trabajos realizados en dicho Establecimiento durante el período comprendido del 1º. de julio de 1911 al 31 de diciembre de 1912," *Anales del Instituto Médico Nacional* XII, no. 3 (1913), 128.

¹¹ *Reglamento del IMN aprobado por la Secretaría de Instrucción Pública y Bellas Artes* (México: Imprenta de Stephan y Torres, 1912): 2-10.

¹² The Secretary of Education and Fine Arts hired Dr. Carlos Reiche to study phytogeography. He thus researched regional floras aiming at raising an awareness of them among farmers and industrialists and to encourage their exploitation; Hinke, 101.

¹³ Angélica Morales, & Patricia Aceves, "Datos para la materia médica mexicana (1894-1908): plantas medicinales, terapéutica y nacionalismo," *Circumscribere* 9 (2011): 11-28.

By the beginning of the 20th century, several Mexican scientific institutions were actively engaged in experimental research, which could boast of some institutional stability. Institutions like NMI had modern laboratories that allowed transforming popular medicine and empirical knowledge into scientific certainty and consequently develop a national therapeutic system with new information about plants used in the local tradition since the pre-Columbian era. Along that process, those institutions contributed to train a new generation of scientists for experimental research.¹⁴ NMI staff consisted of the scientific elite of the time, which fact naturally prompted the creation of new spaces for the development of chemistry and biological sciences.

NMI section of Analytical chemistry

Some among the first generation of professors who joined NMI, as Río de la Loza, came from families with one or several members involved in the health and education projects. Río de la Loza chaired the Analytical chemistry section of NMI for ten years (1891-1901) being charged of the study of various medicinal substances.¹⁵ He studied pharmacy in the National School of Medicine and graduated in 1877. That same year he traveled to Europe to complete his instruction and specialize in industrial chemistry. Due to his expertise in chemical analysis, upon his return to Mexico he was appointed local secretary of the Paris-based *Contrôle Chymique* office.¹⁶ As such Río de la Loza undertook numerous initiatives to establish a laboratory for chemical analysis and control of beverages and food products, and eventually got a grant from the government; however, he could not complete the task and the laboratory was never established. In 1890 he was appointed professor at NMI Analytical chemistry section and quickly promoted to the position of section chair, which he intermittently held until his death in 1901.

¹⁴ Liliana Schifter, & Angélica Morales, "La trayectoria de Francisco Río de la Loza en la Sección de Química Analítica en el Instituto Médico Nacional," *Revista Mexicana de Ciencias Farmacéuticas* 43 no. 4 (2012): 69-78.

¹⁵ Francisco Río de la Loza Miranda was born in Mexico City on January 23, 1856 and died on November 9, 1901. He was the son of the illustrious Leopoldo Río de la Loza and María Valenta Miranda. In 1874 he decided to follow in his father's steps and enrolled in the pharmacy course of National School of Medicine. He earned his pharmacy degree in 1877 with a thesis on *colorin* (*Erythrina americana* Miller). After a three-year stay in Europe, he joined NMI second section as professor of analytical chemistry in 1890; later on he was appointed section head, a position he intermittently held until his death. In 1898 he was appointed professor of physics and chemistry at "Escuela Normal de Profesores", where he taught as long as his health was sound. He was a member of several scientific societies in Mexico and abroad and had correspondents in Mexico and Europe. In addition to his scientific articles and his contributions to NMI publications and the *Mexican Pharmacopoeia*, he prepared a *Chemical Treatise* intended to serve as textbook at "Escuela Normal", as and another book on Mexican chemical products of the country; unfortunately neither work was published; *Ibid*, 70.

¹⁶ Federico Villaseñor, "Discurso en la inhumación del cadáver del Dr. Francisco Río de la Loza," *Anales del Instituto Médico Nacional* V (1903): 206-9.

The activities at the second section revolved around laboratory work; countless analyses were undertaken, leading to the identification of the components of medicinal plants and their extracts. As a rule compounds were classified as sugars, fats, acids or resins; physicochemical characterization was then performed to establish the best manners to isolate and purify them based on their properties. Alkaloids were the most desirable and sought for compounds.

It is worth to notice that until 1908 the NMI was under the Ministry of Development, which required it to produce information on the characteristics of the soil and water from lakes, wells and rivers. Therefore, in addition to the studies on national medicinal plants, the NMI served as an analytical laboratory and its personnel as a group of experts in botany and agriculture. NMI staff was compelled to respond to requests dealing with the composition of water, soils and fertilizers, being that few laboratories and even fewer staff in the country were able to perform this type of analyses. Indeed, there were chemical laboratories at the National School of Medicine and the National School of Agriculture, but they were mainly used for teaching purposes. The laboratory at the Customs Administration was used to analyze the quality of food and beverages, and the one at the Superior Health Council for the analysis of the quality of food and drugs; as a rule both institutions had large workloads and quite few personnel.¹⁷ As a result, the analysis of the aforementioned biological samples was usually performed at NMI second section, most of which staff worked in several of the mentioned institutions at the same time: Rio de la Loza and his assistants, Mariano Lozano y Castro (?) and Federico Villaseñor (?), at the Superior Health Council and James Mc Connell Sanders (?) was also a chemical analyst at the Customs Administration laboratory.¹⁸

In addition, NMI second section received medicine and pharmacy students who were working in their theses, operated as an analytical cabinet for blood, urine and sputum testing, and also ran a pharmacy - later on moved to St Andrew's Hospital to provide a more efficient service to NMI fourth section, i.e. Clinical therapy.

With this we have a picture of the many activities carried out by NMI staff, which although limited succeeded in producing valuable results.

Like the other NMI sections, also the second had an annual plan of work, which was prepared in collaboration with the others so as to select the plants that would be subjected to chemical analysis every year. Analysis included two types of studies, one focusing on the overall composition of drugs, and the other on the isolation and

¹⁷ Hinke, 76.

¹⁸ Ibid, 83. James Mc Connell Sanders was an English chemist who played a prominent role in Mexican chemistry at the beginning of the 20th century. He was a member of the Mexican Pharmaceutical Society and of the first Chemical Society of Mexico, an analyst at the General Customs Laboratory and starting 1904, head of NMI Department of Industrial Chemistry.

characterization of active substances. The former was performed by means of the method described by Johann Georg Noel Draggendorff (1836-1898).¹⁹ That technique is based on the use of solvents of different nature, whereby the various substances present in the tested drug could be distinguished as a function of their solubility and affinity. They were subsequently separated one from other according to their specific properties. For that purpose, the investigated drug was placed inside a special cylinder with a wrench at the bottom that opened to dislodge the liquid once it was 'exhausted' or saturated, and was then closed to replace the volume of solvent used. The procedure took more than three weeks in total and required petroleum ether, sulfuric ether, absolute alcohol and distilled water. In the second stage, the substances in the extracts were identified by means specific reactions, such as acid-base, precipitation or others targeting specific functional groups. Finally, calcination of the whole plant was performed to determine its total ash content. Quantification of all the compounds present in the plants was of little practical use for NMI, as its main interest was to detect active substances. For that reason, exact quantification of each component was eventually abandoned and analysis became only qualitative analysis, while quantification was reserved for the substances with therapeutic or industrial activity. In time NMI staff succeeded in reducing the extraction time; in this regard, the contribution by the pharmacist Ricardo Caturegli (1877-1959), from DIC, was highly significant: he developed a modified continuous lixiviator that allowed shortening the duration of the analyses and the amount of solvent used.²⁰

In any case, the identification of the compounds isolated from whole extracts or fractions was a long and difficult process. This fact, however, did not discourage the chemists working at NMI, who were highly productive all throughout the period of existence of NMI. For example, just between 1892 and 1896 the second section studied 115 plants and made public the complete qualitative-quantitative analysis of 42 of them. Rio de la Loza studied 18 species alone or in collaboration with colleagues and isolated 31 active ingredients from them.²¹

The results were reported in several works published by the NMI and also appeared in the editions of *Farmacopea Mexicana* from 1896, 1904 and 1925. In this regard, the first work published by NMI that should be mentioned is *Datos para la materia médica mexicana* (Data for the Mexican materia medica). The various volumes that constitute this work include the results of the investigation of more than 70 plants customarily sold in markets and that were part of the resources used by healers in cities and towns, as well as in domestic medicine. Some of them had been described in earlier works, like the ones by Vicente Cervantes (1755-1829), Francisco Hernández (1514-1578) and Mariano Mociño (1757-1820), and Martín Sessé (1751-1808), as well as in the various editions of *Farmacopea Mexicana*, as e.g., Mexican poppy (*Argemone mexicana* L.), *tlacoxiloxochitl*

¹⁹ Hinke, 176.

²⁰ *Anales del Instituto Médico Nacional* VII (1905), 170.

²¹ Schifter & Morales, 72.

(*Calliandra grandiflora* Benth) and *cuauchichic* (*Garrya racemosa* (Ramírez) Dahling). Those historical references, however, are just a part of the riches this work offers, as it also made information about the morphological characteristics, origin and possible therapeutic applications of the plants available to the general public. Unlike earlier publications on Mexican medicinal plants, *Datos para la materia médica* was grounded the work of a widely recognized group of scientists who were also backed up and certified by the State. To be sure, this was the first time the Government became directly involved in the promotion of the study of native plants.

Rio de la Loza's studies of various plants are repeatedly mentioned in the first volume of the work, like for instance: *boconia* (*Bocconia integrifolia* Bonpl.), the method for extraction of its active ingredients he corroborated; *yoloxochitl* (*Talauma mexicana* (DC.) G. Don.) the essential oil of which he succeeded to isolate; Mexican poppy; *Yerba de la Puebla* (*Senecio canicida* Moc.); and *yerba del tabardillo* (*Piqueria trinervis* Cav.) from which he isolated and identified several alkaloids. In total, the first volume of *Datos para la materia médica*, includes information about 29 plants. The second volume, published in 1898, includes further 11 monographs. The section on analytical chemistry in all the monographs was written by Rio de la Loza alone or with his collaborators, Lozano y Castro and Villaseñor. These numbers demonstrate Rio de la Loza's enormous contribution to the work.²² The third volume, published in 1900, includes nine additional plants, but Rio de la Loza had no longer been involved in their study, because his health was much deteriorated by this time. The fourth volume, with further 12 monographs, was released in 1907, while the fifth and final volume, devoted to the *azafrancillos de Mexico*, was published in 1908.²³

Datos para la materia médica pursued three objectives: to be an aid for physicians working far from urban centers; to confirm or deny the efficacy of the medicinal plants available in markets, pharmacies, drugstores and herbal stores, among others; and to make the drugs successfully used by the medical community known.²⁴ The last volume of the work coincided with the move of the NMI from the Ministry of Development to the Ministry of Public Instruction and Fine Arts, in 1908. Also Fernando Altamirano (1888 -1908), who had ruled over the internal life of NMI for little more than 19 years, died that year. Those changes triggered a period of some instability until the arrival of Dr. José Terrés (1864-1924), who remained in office until the closure of the Institute in 1915.

By instruction of General Porfirio Díaz, the NMI became responsible in 1910 for the development and publication of a *Farmacología Nacional* (National pharmacology). This worked targeted a wider audience, who would thus gain access to the knowledge

²² "Programa para los trabajos del IMN en el año de 1894," *Anales del Instituto Médico Nacional* I (1894), 215.

²³ *Datos para la materia médica Mexicana. Los Azafrancillos de México. Primer Folleto de la quinta parte.* (México: Imprenta y Fototipia de la Secretaria de Fomento, 1908).

²⁴ Morales & Aceves, 17.

produced by NMI after 25 years of work. It includes the therapeutic properties of various Mexican plants as established in scientific studies, along with the more common practices of the Mexican pharmacies. In other words, this book reunites the scientific knowledge on and specificity of Mexican plants, and the everyday activities of physicians and pharmacists. It presents the new therapeutics that NMI researchers sought to introduce in Mexico to be applied by health care professionals.²⁵ While the preparation of most of the dosage forms included in *National Pharmacology* was relatively simple, its value lies in its uniqueness, since these formulations are based on the local materia medica and in accordance with traditional medical and pharmaceutical practices. In its time this work represented the culmination of a process aiming at rescuing traditions and national therapeutic resources that go back centuries, at least to the work by Vicente Cervantes (1755-1829), and Antonio de la Cal (1766-1833), the first to systematize the Mexican materia medica.²⁶

We have already discussed NMI contributions to the editions of *Farmacopea Mexicana* published along the period of existence of the Institute. However, despite having closed its doors in 1915, the influence of the work done at NMI on pharmaceutical works published after 1915 is remarkable, especially in the case of the new *Farmacopea Mexicana*, from 1925.²⁷ Upon request by Alfonso Luis Herrera (1868-1924) president of the Pharmacopoeial Commission, the Ministry of Development transferred the copyright of *Farmacología Nacional* to the Mexican Pharmaceutical Society, which used it to enrich the content of *Farmacopea Mexicana*. Its section on natural products includes all the plant products compiled in *Farmacología Nacional*, except for three. These facts show that the Pharmacopoeial Commission decided to actively promote the research on native plants performed at NMI.²⁸ Most of the scientists at the Institute were also members of the Mexican Pharmaceutical Society, which brought together the most reputed professors, researchers, public officials and chemical analysts of the time.

So it came to be that from this alliance, which also included the National School of Medicine and the National Preparatory School, scientists engaged in the development of pharmaceutical chemistry and pharmacology and channeled their efforts to establish the conditions necessary for the enhancement of research and practice in these

²⁵ "La Nueva Farmacología Nacional," *El Independiente*, February 21 1914, 7.

²⁶ Vicente Cervantes and Antonio de la Cal y Bracho were two Spanish pharmacists associated with the Royal Botanical Gardens of Mexico City, which was founded in 1788. Cervantes was professor of botany at the Gardens and wrote the *Ensayo para la materia medica vegetal de México* in 1791 as textbook for his course. De la Cal was a student of Cervantes and also a correspondent for the Botanical Garden of Madrid in Puebla, where he published in 1832, *Ensayo para la materia medica mexicana*. Both works were the main sources for the first *Mexican Pharmacopoeia* of 1846.

²⁷ Sociedad Farmacéutica Mexicana, U.N.F.C.C., *Nueva Farmacopea Mexicana* (México: Cultura, 1925).

²⁸ Patricia Aceves, Liliana Schifter, & Angélica Morales, "La Farmacología Nacional y la Farmacopea Mexicana" in *Estudos do Século XX: Histórias da Saúde: Privada, Pública e Social*, ed. Ana L. Pereira, & Joao Rui Pita (Coimbra: Imprensa da Universidade de Coimbra, 2012): 197-216.

disciplines and eventually, as a function of their growing specialization in different areas, they created new academic and professional spaces to display their interests.

The Department of Industrial Chemistry (1904)

The arrival of the new century brought winds of change to NMI; its director, Fernando Altamirano, introduced considerable modifications in the plan of work that reoriented the activities of the Institute as part of a strategy to strengthen the bonds with the Ministry of Development.²⁹ Starting 1901, some plants with no therapeutic applications, but of interest to the industry began to be considered in the annual research plan. Such is the case of some rubber producing species, timber, and others from which fibers and resins were obtained. Another focus of attention was the lack of training of the people involved in the various stages of production of medicines from national plants, especially the collectors, manufacturers and distributors. In the opinion of the Institute members, the professionalization of these intermediaries was essential and urgent to ensure the success of the work. Without a sound infrastructure that ensured continued access to plant products and their transformation into finished pharmaceutical products of good quality, it was impossible for an independent industry to develop. Therefore, were an industrial chemistry section to be created within the Institute, it would facilitate the access to the raw materials that were needed. This idea had been previously suggested by Rio de la Loza, who proposed reserving space in the analytical laboratory for the preparation of the reagents used in large-scale production of active ingredients and drugs. Then, the initiative could include the participation of entrepreneurs and pharmacy and medicine students interested in developing their skills in industrial pharmaceutical chemistry work. It is worth mentioning that during this period, 'Chemistry' was not a part of the curricula in Mexican universities, while its advancement was mainly in the hands of pharmacists in the case of organic chemistry, and of engineers in the one of inorganic chemistry. Being the possibilities for training of human resources for the industry rather limited, the establishment of such space at NMI would represent a relevant contribution.

With these ideas in mind, Altamirano sent in May 1903 a proposal to the Secretary of Development, General Manuel González y Cosío (1836-1913), to create a section of industrial pharmaceutical chemistry at NMI.³⁰ In it Altamirano listed three main tasks that could be performed at the new section: professionalization of agents involved in the collection of plants and natural products for the Institute studies, industrial production of chemicals and pharmaceuticals and teaching of industrial

²⁹ Morales & Aceves, 11-28.

³⁰ Fernando Altamirano, "Apuntes para la historia del IMN," *Anales del Instituto Médico Nacional V* (1902): 282-9.

chemistry.³¹ The initiative was accepted by the Secretary General and DIC began to operate in 1904 as an annex to the Clinical therapy section of NMI. The latter was responsible for the preparation of the medicines administered to patients admitted to the Clinical Therapy Hall of St Andrew's from 1896 to 1904, and to the General Hospital starting 1905. In addition to the manufacture of the chemical products used in the production of medicines, such as hydrochloric acid and ether, another important task of the new Department was to optimize the chemical techniques for isolation of active substances, mainly alkaloids, and to produce controlled commercial-scale formulations of medications.

The DIC was directed by the English chemist James Mc Connell Sanders. Before his arrival in Mexico, Sanders had worked for a few years in the preparation of alkaloids at Burroughs Wellcome Laboratory, in London.³² He was also a member of the chemistry and industrial Chemistry societies of London, and thus he was the ideal candidate for Department chair. In addition, Sanders had previously worked as analyst in the Customs Administration laboratory, and by the time he was hired as Department head, in July 1904, he also joined the Institute as an "aid for the analysis of soil samples, plants and fertilizers"³³. Nevertheless, once the Department entered in full operation Sanders mostly devoted himself to perfect the techniques for isolation of alkaloids and active ingredients of pharmaceutical and industrial interest, as evidenced by the works he published in the *Annals of the National Institute*. Starting 1908, he was paid an additional salary of 121.67 pesos per month to "further pursue complex chemistry research"³⁴.

The English scientist soon joined the circles engaged in the development of chemistry in Mexico. In addition to his jobs at NMI and the Customs Laboratory, in October of 1905 he was admitted as member to the Mexican Pharmaceutical Society.³⁵ Five years later, in 1910, he was appointed to the Board of Directors of the first Mexican Chemical Society.³⁶ During his stay at NMI, Sanders published various articles in the *Annals of the National Medical Institute*. The first one, coauthored with his assistant, the pharmacist Caturegli, appeared in August 1904 and dealt with the chemical analysis of a sample of alcohol from *Gran Union* manufacturers.³⁷

³¹ Archivo General de la Nación, Instituto Médico Nacional, "Iniciativa presentada al Sr. Secretario de Fomento por el Director del IMN para establecer en dicho Instituto una sección más de trabajos científicos, que se denominará de Química Industrial Farmacéutica," no. 2518, ff.5-15.

³² Hinke, 196.

³³ "Informe mensual de las actividades realizadas en el instituto durante el mes de julio de 1904," *Anales del Instituto Médico Nacional* VI (1904): 213-4.

³⁴ "Informes de marzo de 1908," *Anales del Instituto Médico Nacional* X (1909), 134.

³⁵ "Nuevo socio," *La Farmacia* XIV, n° 10 (October 15 1905), 230.

³⁶ "Sociedad Química Mexicana," *El Tiempo*, March 3 1910.

³⁷ James M. Sanders, "Resultado del análisis del "furfurol" de la fábrica Gran Unión," *Anales del Instituto Médico Nacional* V (1905): 291-2.

Sanders, Caturegli and their assistant, Manuel Urbina (1843-1906) made many contributions to the journal and their articles were continuously published. During the greater part of 1905 and 1906, the researchers at DIC devoted most of their time to the study of *zapote blanco* (*Casimiroa edulis* La Llave & Lex) and the root of *pipitzahoac* (*Perezia adnata* A. Gray). As the latter aroused much interest in Mexico and abroad it became a priority in the research agenda of DIC, the staff of which worked hard to develop different pharmaceutical dosage forms for its active ingredient, pipitzahoic acid. The main objective of the first stage of research was to obtain pipitzahoic acid in its purest form and in large amounts, an extremely difficult task to accomplish due to the analytical and technological complexity of the process, eventually perfected by Sanders.³⁸ In the second stage, the most suitable dosage forms for administration of the drug were designed. In April 1905 Caturegli reported the preparation of: “gelatin capsules, neutral and alkaline solutions, and compressed tablets coated with keratin”³⁹.

Other projects undertaken at DIC included the extraction of the essential oil of *salvia de bolita* (*Buddleja perfoliata* Kunth), the study of *peyote* (*Lophophora williamsi* (Lem.) J.M. Coult) - which was also a priority for all NMI sections of the Institute at that time, the study of *cicutilla* (*Parthenium hysterophorus* L.) the red mangrove (*Rhizophora mangle* L.), *azafrancillo* (*Carthamus tinctorius* L.) and *zoapatle* (*Montanoa tomentosa* Cerv.).⁴⁰ As part of its functions, the Department also analyzed samples of plants shipped from all over country, waxes, resins and other materials. It was also commissioned to prepare industrial batches of ‘national medicines’, so called because they derived from the Mexican plants used at the various sections of NMI and the General Hospital, where the National Pharmacy was established. The latter provided patients medicines produced at NMI gratis; some examples of the drugs thus delivered were: tablets of *cuautecomate* (*Crescentia alata* Kunth), fluid extract of *copalchi* (*Hintonia latiflora* (Sessé et Moc. ex DC) and *zapote blanco*, and *tepozan* (*Buddleja cordata* Kunth) beads, among others.⁴¹ Collaboration with hospitals was highly relevant, because it enabled the clinical observation of the performance of drugs, which was required as a part of the “experimental therapeutics” model used.

Starting 1908 the focus of DIC work began to shift to the investigation of the composition of plants with industrial utility.⁴² During this period the number of samples sent by the Ministry of Development and the work with plants with textile applications

³⁸ James M. Sanders, “La raíz del pipitzahoac,” *Anales del Instituto Médico Nacional* VII (1906): 23-30.

³⁹ “Informe mensual de las actividades realizadas en el instituto durante el mes de abril de 1905,” *Anales del Instituto Médico Nacional* VII (1906), 145.

⁴⁰ *Ibid*, 148

⁴¹ “Informes de los trabajos realizados en el IMN durante el mes de mayo de 1906,” *Anales del Instituto Médico Nacional* VIII (1906): 285-6.

⁴² James M. Sanders, “El látex del palo amarillo. Algunos apuntes sobre su composición y su explotación como productor del caucho,” *Anales del Instituto Médico Nacional* X (1908): 69-77.

significantly increased.⁴³ This trend continued the following years, however, with poor industrial repercussion. At the conference held to celebrate the DMI anniversary, in 1908, Altamirano pointed out the lack of manufacturing partners and investment as the main causes for the impossibility to establish a powerful national industry and urged the Government to stimulate the industrial sector by “eliminating financial obstacles”. In that same speech Altamirano also called the attention to the need to promote and increase the training of human resources for technology.⁴⁴ Similarly, in other occasions he emphasized the urgency to establish legal controls on the exploitation of natural products, which was often disproportionate and in certain regions had severely harmed the farmland; he also noted the predominance of foreign investors over nationals in the sector.⁴⁵

The final years of the NMI (1908-1915)

1908 brought many changes to NMI. In January, news announcing that it was no longer attached to the Ministry of Development, but to the Ministry of Public Instruction and Fine Arts, appeared in the *Annals of the National Medical Institute*.⁴⁶ In October, Altamirano, who had ruled over the internal life of the Institute for almost 20 years, died in Mexico City. Those events led to a period of instability, made even more severe by the death, in 1909, of the following Director, Dr. Jose Ramos (?), who was briefly succeeded by Angel Gutiérrez (we do not have these dates yet) before being finally replaced by the brilliant Dr. José Terrés (1864-1924), who remained in office from 1909 until the closure of the Institute in 1915. Terrés assumed enthusiastically his duties and launched an aggressive campaign for the dissemination of the Institute work among the Mexican physicians and pharmacists. He believed it was essential for those professionals to be thoroughly acquainted with the local therapeutic resources and to employ them broadly and wisely. In his opinion, the failure to implement a therapeutic model based on the national materia medica derived from the doctors’ complete ignorance of the medicinal applications of many native plants, as well as from the insufficient stock of these drugs in pharmacies, which made it almost impossible for pharmacists to prepare the national medicines described in NMI publications. Those words were not new: proposals to correct that situation had been put forward well before Terrés had entered the picture. For example Leopoldo Flores (?) wrote, from 1905 to 1907, a work entitled *Manual terapéutico de las plantas mexicanas* (Therapeutic manual of Mexican plants) in which he compiled information from *Datos para la materia médica mexicana* with the clear intention

⁴³ James M. Sanders, “Algunos apuntes sobre el estudio tecnológico de las plantas fibrosas,” *Anales del Instituto Médico Nacional* IX (1907): 185-93.

⁴⁴ Fernando Altamirano, “Conferencia de aniversario por los 19 años de existencia del IMN,” *Anales del Instituto Médico Nacional* IX (1907): 201-10.

⁴⁵ Fernando Altamirano, “El palo amarillo,” *Anales del Instituto Médico Nacional* VII (1905): 323-44.

⁴⁶ “A nuestros lectores,” *Anales del Instituto Médico Nacional* X (1909) : 1-2.

of facilitating the actual use of the drugs studied at NMI by doctors, however, the results were not much encouraging.⁴⁷

The work continued; in 1910 the Institute focused on the elaboration of *Farmacología Nacional* (National pharmacology). Terrés made every effort to mobilize the extremely limited human and material resources towards the publication of that book. At the same time, major political and economic changes began to take place in Mexico, following the outbreak of the Mexican Revolution at the end of the 1910, which triggered a long armed conflict that lasted more than ten years. The people kept on their daily activities within a setting characterized by growing political and social uncertainty. NMI was no exception; it continued its activities with a remarkable decline in its budget.⁴⁸ In August 1912, on the occasion of NMI 24th anniversary, its Deputy Director, Adolfo P. Castañares (1880-1919) addressed a speech to the Secretary of Public Instruction and Fine Arts, in which he emphasized the “emergent affinity between organic chemistry and biology”⁴⁹. Within that context, he stressed the importance of organic chemistry for the preparation and synthesis of new organic products and the latter’s beneficial effects on the development of modern therapeutics (e.g., barbital, sulfonal, caffeine, camphor and adrenaline). Castañares also called to the attention to the rising interest in the new advances in physiological and biological chemistry (the study of fats, sugars, amino acids and enzymes) and to the need for future professionals to get involved in these nascent disciplines to be competitive. These scientific interests would end up coinciding during the next decade in the creation of the curricula of a new professional: the pharmaceutical chemical biologist, a novel career offered at the School of Chemistry and Pharmacy of the National University of Mexico.

In 1912 research at the Institute targeted plants that aroused interest abroad due to their powerful physiological effects on the central nervous system, like *ololiuhqui* (*Turbina corymbosa* (L.) Raf.) *peyote* and *tronadora* (*Tecoma stans* (L.) Juss. ex Kunth).⁵⁰ With the study of these products, and more specifically the characterization, isolation and industrial production of their active principles, the NMI pursued a possible source of income to safeguard its existence. Other materials of interest were latex and fiber producing plants.

⁴⁷ Leopoldo Flores, “Algunas palabras acerca de un nuevo Manual terapéutico de las plantas mexicanas,” *Anales del Instituto Médico Nacional* VIII (1906): 317-22; Leopoldo Flores, “Manual terapéutico de las plantas mexicanas,” *Anales del Instituto Médico Nacional* IX (1907): 297-391.

⁴⁸ Armando Marcial, “Daniel Vergara Lope y el Instituto Médico Nacional; entre lo humano y lo social en la ciencia médica del porfiriato” (tesis de licenciatura UNAM, 2004).

⁴⁹ Adolfo Castañares, “Discursos pronunciados por los señores Director y Subdirector del Instituto Médico Nacional en la sesión solemne del 14 de agosto de 1912,” *Anales del Instituto Médico Nacional*. XII (1913): 81-2.

⁵⁰ José Terrés, “Fragmento del informe rendido por el Director del Instituto Médico Nacional a la Secretaría de Instrucción Pública y Bellas Artes sobre los trabajos realizados en dicho establecimiento durante el periodo comprendido del 1 de julio de 1911 al 31 de diciembre de 1912,” *Anales del Instituto Médico Nacional*. XII (1913): 92-126.

Farmacología Nacional appeared in 1913. Doubtlessly, it was the most representative work produced by NMI throughout its existence, however, as we have said, the country was changing. With the assassination of President Francisco I. Madero (1873-1913) the promise of democratic change vanished to be replaced by the coup regime of Victoriano Huerta (1845-1946). Venustiano Carranza (1859-1920) became head of state in 1914, and the following year he ordered the closure of NMI.

The Institute never succeeded in instituting the new national therapeutics Altamirano and his successors longed for. During the 25 years of its existence and despite all the efforts made to consolidate a true national industry based on the exploitation of the country's natural resources, the NMI's project failed to become a reality. Foreign imports and enterprises, had imposed over the institution's plans for the consolidation of a national pharmaceutical industry. In this regard it should be observed that the information about the production of drugs in industrial scale as projected by DIC is ambiguous. Although there are reports indicating that large batches of drugs were manufactured, their final destination is uncertain; the product of their sale was reported and handed over to the Ministry of Development. Analysis of the monthly reports shows that the Institute was in position to sell medicinal substances, yet, the commercialization of their products in a larger scale did actually come to be, and ways to articulate production with the local industry were never found. In other words, no link was ever established between research in the national materia medica and the productive and commercial sectors that could have laid the groundwork for a national pharmaceutical industry.⁵¹ The complete lack of interest of doctors in understanding such drugs and applying them in clinical practice did little to improve the situation.⁵²

Final remarks

The National Medical Institute closed its doors in 1915 having partially accomplished its goals. It succeeded in implementing a rigorous scientific system for the experimental study of medicinal plants and many active ingredients of local medicinal plants were effectively characterized and purified, which, no doubt, represented a major contribution to the development of analytical chemistry, to wit, a professional field that was in consolidation in Mexico at that time. Another significant innovation was the creation of the Department of Industrial Chemistry, namely, a facility devoted to novel industrial practices. Those new areas of professional development bore fruit with the first generation of chemists trained at NMI, who were able to improve their knowledge to the point that the academic community, the government and the general public

⁵¹ Paul Hersch, "La industrialización químico-farmacéutica mexicana y la flora: el caso de los Laboratorios Garcol," *Boletín de la Sociedad Química de México* 1, n° 2 (2007): 5-12.

⁵² Aceves, Schifter, & Morales, 197-216.

recognized them as specialists in those fields (with the exception of Juan Salvador Agraz (1881-1949) who had learned chemistry in Europe and never was part of NMI). The sound presence of this small cluster of scientists in all the aspects related with the advancement of pharmacy and chemistry accounts for the institutional and social support they received. In time, the training of future specialists in chemistry was placed in their hands, when the new School of Chemistry and Pharmacy of National University of Mexico was inaugurated in 1919.

However, the goal of establishing a true national therapeutic model based on the use of local natural resources could not be achieved. The reasons have already been discussed; the conditions to develop a productive collaboration between NMI and the industrial sector never existed. That fact notwithstanding, those efforts crystallized in the works published by NMI, *Datos para la materia medica* and *Farmacología Nacional*, as well as in contributions to the various editions of *Farmacopea Mexicana* published by the Mexican Pharmaceutical Society from 1896 to 1925. In 1930, the edition of the *Farmacopea* was interrupted and transferred to the Department of Public Health, which had a completely different approach to the subject and oriented it towards the needs of the industry, primarily based on synthetic chemistry and patent medicines. *Farmacopea Herbolaria de los Estados Unidos Mexicanos* (Herbal pharmacopoeia of the United States of Mexico) was published (2001 and 2013). This book seeks to bridge the gap resulting from the lack of recognition and regulation of the use of medicinal plants in Mexico, although they are extensively employed. It is published by the Ministry of Health, which retrieves and recognizes the work performed by the Mexican Pharmaceutical Society, as more than 70% of its content is constituted by plants included in the six editions of *Farmacopea Mexicana*. Thus, the national therapeutic model developed at NMI is partially rescued, albeit although quite timidly when compared to the original project.