**RESEÑA**

# Charles-Louis Cadet Gassicourt

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Recibido: 13 septiembre de 2010. Aceptado: 31 de enro de 2011.

Palabras clave: geopónica, lima, tinturas, productos naturales, semilla de marañón, té, café, farmacia.
Key words: geoponics, lime, tinctures, natural products, cashew nut, tea, coffee, pharmacy.

**RESUMEN.** Charles-Louis Cadet Gassicourt (1769-1821), inicialmente abogado, poeta, escritor y político, cambió de rumbo e hizo una brillante carrera en farmacia, llegando a ser el farmacéutico personal de Napoleón. Publicó un diccionario de química que reemplazó el obsoleto de Macquer, y un formulario de farmacia, que pasó a ser una obra clásica. Estudió un gran número de plantas, árboles, y semillas medicinales y separó sus productos activos. Estudió los factores que afectan la fertilidad de los suelos, el apagado de la cal viva, y las propiedades del té y el café.

**ABSTRACT.** Charles-Louis Cadet Gassicourt (1769-1821), initially a lawyer, poet, writer, and politician, changed his course to make a brilliant career in pharmacy becoming the personal pharmacist of Napoleon. He published a chemical dictionary that replaced the Macquer's obsolete one, and a pharmacy formulary that became a classic. He studied a large number of medicinal plants, trees, and seeds and separated their active principles. Likewise the factors which affect soil fertility, the quenching of quicklime, and the characteristics of tea and coffee.

## LIFE AND CAREER[1-8]

Charles Louis Cadet de Gassicourt was born in Paris on January 2, 1769. Officially he was the son of the famous chemist and pharmacist Louis-Claude Cadet de Gassicourt (1731-1789) and Marie Thérèse Boisselet (1731-1800), but he was most probably the result of his mother's affair with the King Louis XV. His mother was a descendent of Antoine Vallot (1594-1671), the Principal physician of Louis XIV (1638-1715).

Charles-Louis received his initial education first at the *Collège de Navarre* and then at *Collège Mazarin* (both colleges of the University of Paris), where he distinguished in his studies. In the first institution he learned humanities, a general name for a program composed of classical languages, grammar, history, rhetoric, and poetry. In the second one he completed his studies of rhetoric. The abbé Charbonnet, rector of the *Collège de Navarre*, refused awarding Cadet the *Grand Prix de Discours Français* because his contribution contained "certain philosophical ideas, which were condemned in public instruction" (a first expression of Cadet's future attitude).

During his youth Cadet met, heard, and talked with many distinguished scientists who visited the his father's home, among them Benjamin Franklin (1706-1790), Jérôme Lefrançois de Lalande (1732-1807), Jean Le Rond D'Alembert (1717-1783), Marie Jean Antoine Nicolas Condorcet (1743-1794), Antoine-François Fourcroy (1750-1809), Jean Sylvain Bailly (1736-1793), Denis Diderot (1713-1784), George-Louis Leclerc Buffon (1707-1788), and Félix Vicq D'Azyr (1748-1794). From these prominent figures he got the liberal ideas, which later would characterize his social and political activities.

Cadet graduated from Mazarin at the age of sixteen. His father wanted him to study pharmacy and continue the prosperous business he had built but the young man had become so much influenced by the intellectuals he had met at his father home that he wanted to dedicate himself totally to writing and literature. Reluctantly he studied law and became a lawyer.

Cadet entered the *Faculté de Droit* in Paris in 1784. Flahaut gives a fascinating description of the French law studies and regulations at the end of the $18^{th}$ century.[7] To enter the *Faculté* the candidate had to be at least 16 years old, although exceptions were granted. After three years of study he obtained the *license en droit*. To become a lawyer, the young graduate had to take the oath in front of the Parlament of Paris, thus becoming avocat *en* Parlement, but without becoming a member of the *Ordre des Avocats*. This basic rank was chosen by those who did not want to pursue the legal profession *per se*, but wanted to serve in different functions associated with the tribunals. To practice the profession, the young graduate had then to serve a four-year stage under the responsibility of a deputy of the *Ordre*, who really taught him the profession within the surroundings of a well-disciplined structure. At the end of his stage he became avocat *au* Parlement at the age of 23 or more. Flahaut describes as follows the difference between *avocat en Parlement* and *avocat au Parlement*: The first one had the degree but did not practice the profession; the second was the one, Ordre accepted by the within its cadres and could then carry on pleas. Charles Louis took the oath in the Parlament on November 1787 but was unable to do his stage because of the violent conflicts between the King Louis XVI and the Parlament, which took place during 1788. The next year, the King put the Parlament in indefinite vacation and the *Ordre des Avocats* was abolished in 1790.[7] Thus Charles Louis could not become *avocat au Parlement* but fortunately for him, the crisis of institutions, changes of rules, and vacuum that accompanied the French Revolution, allowed him to take place in legal procedures.

Although Cadet had a good oratorical skill and pleaded with eloquence and success, he engaged in the practice of law only for a short time. In 1781, he retired from the profession after having defended with much success the poor and the persecuted. In 1788 Armand-Joseph de Béthune (1728-1800), Duc de Charost, and André-Jean Boucher d'Argis (1750-1794) created the *Société de Bienfaisance Judiciaire* dedicated to the defense of the poor and, particularly, to provide indemnity to those who after being accused of criminal acts, had been absolved. This society may be considered the ancestor of the modern institutions providing free legal assistance. Cadet promptly joined the Society and participated vigorously in its activities.

In 1789, he married Madeleine-Félicité Baudet (?-1830), the daughter of Guillaume Baudet and Marie-Félicité Germain. They had two children: Charles Louis Félix (1789-1881) and Louis Hercules (1794-1879). Cadet and Madeleine Baudet were divorced in 1798.[7]

Cadet's personal fortune (his father assigned him an income of 8000 francs per year) and that of his wife allowed him not to exercise the career of his choice but to pursue the worthy ones that interested his generous heart.[2] Since an early age he had shown a strong interest in literature, so he devoted himself to write poems, light comedies, theater scripts, political reports, etc. He enjoyed theater and wrote many works that were put on stage. Some of these works are *Les Voyages de la Liberté* (1789, *Le Souper de Molière* (1795), *Voyage ou Lettres sur la ci-devant Province de Normandie* (1798-1799) (which includes much information about his sentimental life, his anti religious attitude, and his passion for history), *La Tombeau de Jacques Molai* (1798), *La Visite de Racan* (1799), and *Les Initiés Anciens et Modernes* (1799). According to Flahaut[7] since 1793, when he entered the political life, he called himself homme de lettres (man of letters), as seen in the birth certificate of his second son; he used this description until 1800 when he switched his identification to pharmacy.

Cadet let himself get involved deeply in French politics. Being a member of the *Garde Nationale*, he fought against the mob that pillaged the Saint-Lazare convent. Elected President of the Mont-Blanc section, on October 1795, during the insurrection of 13 Vendémiaire, year IV (5 October 1795) he pronounced himself so strongly against the Convention that he was condemned to death and executed in effigy at *The Place de Grève*. He escaped under a false name to an ironwork factory in Berry were he devoted his time to improve the lot of the workmen and improve the methods of production. After 13 months of exile he was granted absolution. In spite of all the serious ups and downs of his fortune, and the dangers that menaced him, he declared himself publicly against secret societies; he published a book entitled *Le Tombeau de Jacques Molay* in which he traced the origin of the French Revolution back to the Knights Templar. He described in detail how the Templar's last master, Jacques de Molay (?-1314) planned revenge against the French monarchy in his prison cell in the Bastille and how the current revolutionaries were carrying out his will. The Templars, according to Cadet, did not die out but went underground and reappeared in the guise of Freemasons.[2] In 1799, his comedy *Voyage en Normandie* ended with the poem *Le Poète et le Pharmacien, ou mes Adieux aux Littérateurs* (The Poet and the Pharmacist, or my Farewell to the Literary Hacks).

Upon the death of his stepfather in 1799, Charles-Louis decided to abandon the profession of law for that of pharmacy and in 1800 he qualified as a pharmacist. Again Flahaut gives an interesting description of this profession at the end of the 18$^{th}$ century:[7] The *Université Impériale de France*, created in 1806 by Fourcroy, *Directeur de l'Instruction Publique*, was composed initially of four faculties: Theology, Law, Medicine, and Arts. The Faculty of Sciences, together with a *Doctorat ès Sciences*, was added in 1808, an important event because it represented the first time that science was officially taught in France. In June 1812, Silvestre-François Lacroix (1765-1843), the Dean of the Faculty of Sciences, informed the *Comité de Rédaction* of the *Bulletin de Pharmacie* that they were allowed to present the two theses required by the bylaws and be admitted as *Docteur és Sciences*. The Faculty Professors which devoted themselves to Physics and Chemistry, would examine these theses. Their approval allowed the candidates to register in the Faculty.

Cadet reacted immediately and presented his first thesis in August 1812, which was totally dedicated to chemistry.[9] A month later, he presented a second thesis to the Faculty of Sciences, which according to the regulations had to be associated to a much wider field, showing the extent of the knowledge of the candidate. Cadet's thesis had as a subject *De l'Etude Simultanée des Sciences*[10] and was dedicated to his friend, Eusèbe Salverte (1771-1839). In this work Cadet developed his thoughts about the relation between man and sciences. Thirteen years before (1799) he had published a work entitled *Le Poète et le Savant*[11] showing the need for men of letters to study the theory of sciences (which he had called the philosophy of sciences). Afterwards, in 1803, in the introduction to his *Dictionnaire de Chimie*, he had studied the relations existing between the sciences, within the purpose of allowing a more efficient approach to them. After discussing the relations between chemistry and arts, that is to say, the techniques of manufacturing and the transformation of chemical products, he analyzed the relations between chemistry and the other sciences, such as medicine, meteorology, physics, and geology. According to Cadet, these sciences were inseparable: "*In order to fruitfully study chemical theory it is possible to settle on the rigor of knowing the generalities of natural history and physics, but not to flatter too much on the progress of science, if you are not familiar with vegetable and animal physiology and the elementary operations of algebra and geometry*".

In this thesis Cadet refined more his position. The opening statement was that natural sciences are unlimited; their division is conventional, arbitrary, and hypothetical. Nature has not created methods, systems, and theories. It produces the phenomenon according to its general rules, gives men the necessary organs to observe them, and makes fun of classifications that it imagines very weak. Cadet distinguished in the physical and natural sciences the general theory or philosophy of science, its practice and its application. He defined the philosophy of science as the series of principles, which could be deduced from well-observed facts, from phenomena that reproduced themselves constantly and identically under the same circumstances. One could not dream of developing a general theory before accumulating a large amount of data corresponding to a phenomenon in a given science. The human spirit had done a large conquest on creating the analytical methods of universal application. Through it, we separated the facts upon which the elementary principles which constituted the basis of each science. Yet, it was not possible to know and perfect a science without knowledge of the philosophy of the rest. Those who kept themselves within the domain of a given science were bound to err and became incapable of making it progress. What was the meaning of observation? It was the art of acquiring clear and exact ideas about the objects that stroke our senses, to investigate in facts all they contained, and to combine and change them is such way to produce new knowledge. Cadet made then a statement that he considered essential: "*N'est ce pas abuser des termes que de donner le nom de science à la botanique, à la minéralogie, à l'anatomie…? Ce ne sont que des branches inféconde*s, *mais nécessaires, de sciences véritables»* (Isn't it an abuse of terms to give the name of science to botany, mineralogy, anatomy...? These are not more that sterile branches, although necessary, of the true sciences). In a way, Cadet was already speaking of the problem of the two-cultures that Charles Percy Snow (1905-1980) would champion in 1959: The breakdown of communication between the «two cultures» of modern society, the sciences and the humanities, is a major hindrance to solve the world's problems.

Thanks to his brilliant activities Cadet soon evolved as one of the most important leaders in pharmaceutical circles and was one of the founders, in 1809, of the influential *Bulletin de Pharmacie* (which would afterwards become the *Journal de Pharmacie et Accessoires*). He was a member of the *Société de Pharmacie* after its creation in 1813 and President of the same in 1818. In 1946 the Société de Pharmacie became the *Académie de Pharmacie*. In 1821, Cadet was admitted to the *Académie de Médicine* and nominated as its Secretary.[7]

Appointed *Pharmacien Ordinaire de sa Majesté Napoléon I^er^, Empereur et Roy*, he was present at the battle of Wagram in 1809 and shortly after was awarded the order of *Chevalier* of the Empire. In 1814 he was appointed member of the *Legion d'Honneur*. Napoléon provided Cadet with lodging at the Tuileries and each of his residences.

Another idea that Cadet nourished for a long time, and became truth in 1820, was the creation of an *Institut Nomade* (Nomad Institute), a kind of scientific corporation, half civil and half military, managed by a supreme council, located in Paris under the vigilance of the ministers, which would travel around France, scrutinizing all the sources of richness of the nation, all the industrial branches, and, in coordination with the local authorities, would lay out plans of reform and improvement, fighting all the mistakes, the prejudices, faulty methods, preparing new exploitations, getting familiar with the "beast and the plough", and the hands that had only carried a double edge sword and had only shed the blood of men.[12]

Cadet's most important work was his four-volume *Dictionnaire de Chimie* published in 1803 and dedicated to Fourcroy.[13] This dictionary was intended to replace the one of Pierre-Joseph Macquer (1718-1784) that had become obsolete due to the fast changes in scientific knowledge that were taking place at that time. It also became rapidly obsolete and Cadet was preparing a second edition when he succumbed to cancer. The main interest of the dictionary was in the introduction, which he included under the title *Ordre de Lecture*. This order of lecture could well be looked upon as a true elementary course on chemistry. It presented the history of chemistry, the facts that served as its basis, the procedures it employed and their results, the operating ways and their improvement, the logic of the new nomenclature with their exact principles, and the possible consequences that the future would prove right or wrong. His philosophy was so audacious that the book was put in the Index in Vienna and Madrid.

Another important activity of Cadet was in the field of public health. According to Flahaut,[7] before the Revolution the French administrative and judiciary policy was distributed among many authorities: the Minister of Paris, the Police Lieutenant, and the Provost Marshal of the Merchants. Each had, within their attributions, an ill-defined responsibility of the surveillance that demanded the maintenance and development of the public health of the capital. During the reign of Louis XVI the two pharmacists Philippe-Nicolas Pia (1721-1799) and Antoine Alexis-François Cadet de Vaux (1743-1828), were charged with certain aspects of public health. The many activities of Charles Louis Cadet had put him in contact with the many problems that emerged when trying to solve the problems of the citizens of the capital. For this reason, he submitted to the Comte Louis Nicolas Pierre Joseph Dubois (1758-1847), Prefect of Police of Paris a proposal for of creating a *Conseil de Salubrité* (health council), which would engage in the solution of the problems. The idea was promptly accepted and the committee established in 1802. The members of the first committee were Charles Louis Felix Cadet de Gassicourt (1789-1861), Nicolas Déyeux (1744-1837), Antoine Augustin Parmentier (1737-1813), and Jean-Baptiste Huzard (1755-1838). During the following years the council dealt with a great number of health problems: regime of prisons, illumination of the city, flood assistance, asphyxia during the cleaning of the sewage, elimination of the graveyards located in the center of the city, medical charlatanism, venereal diseases, etc.[7]

Cadet passed away on November 22, 1821, probably of intestinal cancer. He was buried in the Père-Lachaise cemetery.

Cadet was a corresponding member of the Royal Academies of Madrid and Turin, of the *Société Économique de France*, of the *Société de Médecine*, de *Chirurgie et de Pharmacie de Bruxelles*, of the two *Sociétés des Sciences Physiques et d'Émulation de Liége*, and of the *Société Savantes de Bavière*. He belonged to the *Société Savantes d'Orléans*, of Lyon, of Autun, Strasbourg, to the *Société Philotechnique*, and the *Société libre de Pharmacie de Paris*. He was one of the founders of the *Lycée de Paris* (afterwards named *Athénée Royale* of Paris).

Although science had made tremendous advances in his time and when full papers were read, the Introduction to his *Dictionnaire de Chimie* (164 pages) was particularly remarkable for the extension of the views he presented and their philosophical spirit; these were the reasons why this work was introduced in the Index of Madrid and Vienna. Some of his expressions are: "*Empiricism was the first guide, credibility the first judge, and in this blind experience, the observer initially got lost by superstitious ideas that attributed most of the illnesses to the malign influence of the stars or to the divinities…in the beginning the art of curing was in the hands of priests, the poets and the charlatans…The administration of medicines was always accompanied by ceremonies, exorcises and deprecations…In medicine like* *in politics, all revolutions must take place very slowly, to avoid being ill-fated…human weakness is so strong that a physician feels that he has to acquiesce with…the superstitions of most impatient sick persons…Prejudice and superstition, the children of ignorance, disappear in front of the torch that physics and chemistry exhibit to the man that searches truth in good faith; friend of tolerance, respectful of all opinions, it does not examine if a certain book, dictated by the divinity to the zealots of her ministers, has truly a celestial origin; it does not contest the possibility of miracles but does not accept as such any phenomenon that seem to contradict the ordinary laws of nature…*" Cadet then listed a series of facts presented as divine manifestation, which he believed could be attributed to a natural origin (the deluge, meteors, the parting of the Red sea, etc.)

In 1812 appeared the *Formulaire Magistral*, appendixed with a *Mémorial Pharmaceutique*, enriched by remarks from the physician Etienne Pariset (1770-1847).[14] This formulary contained a multitude of formulas for balsams, elixirs, liquors, opiates, pomades, pills, powders, syrups and other remedies. It was written at a time when simple medicines were in fashion and when an intrigue was raised against the *polypharmaques* (drugs composed of many active substances). According to Cadet, instead of attacking simple or compound medicines, efforts should be made to improve both. In an bold manner, he wrote that nothing in nature could be considered simple, everything tended to become complete, including moral order, physical order, and of course, medicine. Medicines should be considered by the strength of their action and the power of their virtues and not by their composition, because the effect of a compound was substantially different from that of each of its components. There were substitute truths, the same as in rhetoric; it was not convenient to take the synonym of a word by the word itself. The ensemble of the substances had to be more active.[7]

**SCIENTIFIC CONTRIBUTION**

After several years of practice, Charles-Louis saw the need to renew the pharmaceutical catalog published by his father,[15] adapting it to the needs of his time. Two editions were published of the new version.[16,17] The first edition was very similar to that of his father. The medicines were classified in the same manner, but were more numerous. A new chapter was added about the treatment of people poisoned or asphyxiated. In the second edition Charles-Louis modified substantially the contents and presentation, showing a strong care for the needy.[17] The first part was an *Instruction Sommaire pour les Secours d'Urgence*, which illustrated his worries for the poor, largely put into action in the *Comité de Salubrité* and the *Comité d'Hygiène Publique*. Here, he described the steps to follow during the most common emergency situations such as drowning, poisoning, burning, bites or stings from animals, etc. Other chapters were devoted to plants useful to cultivate at home and plants useful for general knowledge of medical use, without cultivating them. The most important chapter was devoted to Simple and Compound Medicines.[7]

In 1802, Cadet reported his findings about candleberry (*Myrica pennsylvanica*), a plant or a small tree originated in America[18], and called to the attention of horticulturists and industrialists on the possibility of developing its culture in France as a potential source of wax. The waxy gray fruit of the North American wild or cultivated bayberry shrubs were (and are) mainly used to make fragrant bayberry candles, scented soap, and sealing wax. The wax covering the berries was found to be of a quality superior to that of bees and used for manufacturing candles, a basic instrument for the illumination of premises at that time. In his memoir Cadet described the different experiences for analyzing the composition of the wax and to produce it highly pure. In addition, the berries were found to contain a highly colored astringent principle of possible industrial use.[7]

In another work about coffee, published in 1806, [19,20] Cadet remarked that this commodity should be investigated in detail because of the large tribute that France collected from it and the large consumption of sugar it represented, which enriched foreign countries. He first prepared an infusion from dry green grains of coffee (commercial coffee) from three varieties, Moka, Martinique, and Bourbon, and treated it with potassium hydroxide, ammonia, limewater, iron sulfate, alcohol, aluminum sulfate, hydrogen chloride, and a solution of gelatin. He also separated the fractions obtained by distillation. From the results of these experiments he concluded that this type of coffee contained an aromatic principle soluble in water, a small amount of essential oil, abundant mucilage, a lot of gallic acid, a resin, vegetable albumin, and traces of tannin. There was no difference between the Martinique and Bourbon varieties; the Moka one contained less resin, less gallic acid, more resin and more aromatic principle. He repeated these experiments using roasted coffee and found that the process developed in the grain a pleasant fragrance and formation of tannin soluble only in cold water. He analyzed the ashes of coffee and found them to contain calcium, potassium, iron, and carbon. He ends his memoir describing the ways of obtaining a beverage having an agreeable aroma, a taste slightly strong, a nice color, and a certain density.

In another memoir about tea[21] Cadet wrote that tea had been introduced in France in 1634, although the British used it way before as a common drink. He was surprised that an infusion prepared from a foreign plant had become the preferred drink for a civilized nation and the reason for the independence of United States. After describing ten classes of tea originated in China, Cadet described the methods of preparing the infusion and the physical properties of the material, and then his experiments to determine the principal components. The infusion did not change the color of litmus paper; mineral acids enhanced its color but destroyed it when concentrated. Alkalis turned it brown, solutions of iron sulfate produced a black precipitate, and a water solution of gelatin caused coagulation. After many experiments of this kind Cadet concluded that tea contained gallic acid, tannin, resin, mucilage, and extractive. The first two components explained the febrifuge properties of the infusion. Analysis of the cinders indicated the presence of carbon, iron, aluminum muriate (chloride) and traces of potassium. He concluded that the most astringent teas, which are richer in the first three components, were those that have gone through a controlled roasting and prepared with the utmost care. The last part of the memoir was dedicated to a discussion of some hygienic aspects of tea. Tea advocates claimed the tea purified the blood, prevented gout and kidney stones, facilitated digestion, and was helpful to the heart, brain and lungs. Against these claims Cadet quoted the testimony of many famous physicians who attributed to tea multiple harmful actions over the nervous system. As a consequence, Cadet believed that tea was helpful to people like the Arabs, the Tartars and the British (!), who ate much food poorly cooked, and should be quite fatal to sedentary and delicate people. His well-known dislike for the English was shown by his comment: "At the time when a ridiculous Anglophilia had taken possession of all French heads, it had made tea fashionable, not because of its taste but because of mania. (Fortunately) the Revolution changed the (French) habits and made tea unfashionable". Cadet advocated that instead of tea French people should drink an infusion prepared from European herbs such as mint, sage, veronica, Artemisia, salvia, etc., which provided a healthy and tasty beverage. In particular, he recommended the use of *précieuse aya pana* (*Eupatorium ayapana*, a plant used in South America as tea and having the advantage of not containing caffeine), which was cultivated without problem in Ille de France. Cadet believed that this infusion was more valuable than all the teas of the world, having a sweet aroma and rare agreeable properties.

In 1816, Cadet used a report written by a French businessman[22] to describe the different teas exported by the Chinese, their botanical origin, their substitutes, and the treatments they were subject to, their qualities, and their different applications,

The production of quicklime (lime, calcium oxide) from limestone (calcium carbonate) in limekilns was an old and important industrial process. The material was used in the manufacture of cement and in the production of other alkalis, which in turn had important industrial uses such as the manufacture of soap. It was well known that lime spontaneously fixed carbon dioxide of water vapor to form calcium carbonate or calcium hydroxide. Inversely, these two substances, heated at the proper temperature, lost water or carbon dioxide and brought back lime.

At the end of the 18th century, Joseph Black (1728-1799) performed some basic experiments on these phenomena and brought to light the existence of carbon dioxide.[23] He heated limestone (and magnesium carbonate) and found that it decomposed yielding a gas and leaving behind lime; exactly the same weight was lost when magnesium carbonate (magnesia alba) was heated and then treated with acid, as was lost when the magnesia alba was treated with acid directly. Recalling Stephen Hales's (1677-1761) experiments, Black concluded that the loss of weight in both cases was caused by air that had been fixed in the magnesia alba leaving the reaction. In one case it was driven off by heat, in the other case by the action of acid. Black concluded that all the mild alkalis (carbonates) like magnesia alba, contained fixed air, whereas the caustic alkalis (hydroxides) did not: "*It is sufficiently clear, that the calcareous earths in their native state, and that the alkalis and magnesia in their ordinary condition, contain a large quantity of fixed air, and this air certainly adheres to them with considerable force, since a strong fire is necessary to separate it from magnesia, and the strongest is not sufficient to expel it entirely from fixed alkalis, or take away their power of effervescing with acid salts… Quick-lime therefore does not attract air when in its most ordinary form, but is capable of being joined to one particular species only, which is dispersed through the atmosphere, either in the shape of an exceedingly subtle powder, or more probably in that of an [ether]. To this I have given the name of fixed air…I thought it better to use a word already familiar in philosophy than to invent a new name, before we be more fully acquainted with the nature and properties of this substance…*"

Black also showed that when calcium oxide was allowed to stand in air, it converted slowly to calcium carbonate, from where he deduced that there were small quantities of carbon dioxide in the atmosphere. Air was then a mixture of at least two distinct substances, ordinary air and carbon dioxide.

Cadet's first thesis, entitled *De l'Extinction de la Chaux*[9] was dedicated to "Monsieur Thenard, Member of the Institute, my mentor and friend". In his *Dictionnaire de Chimie* (1803) Cadet devoted three pages to describe the properties and preparation of lime, without adding new notions to its composition. An important feature was the avidity of lime for water and carbonic gas ($CO_2$); this fact was the reason behind the surnames *chaux vive* (quicklime) and *chaux éteinte* (slaked lime).

In his 20-page long thesis Cadet presented the results of his experiences on the amount of water necessary for quenching a given amount of quicklime, the proportion of water that fixed on quicklime turned it into slaked lime, the amount of water vaporized during the slaking process, the amount of heat released and the temperature achieved, (which was relatively high during certain conditions, up to 300 °C), the slowing down of the process produced by addition of certain substances (such as alcohol) to the water, the increase in volume of the chalk during the quenching process, and other secondary effects that took place during the reaction.[7]

Given the significant amount of heat released during the extinction with water, it was possible to add a flammable mixture (sulfur, camphor, sawdust, etc.), which could catch fire. The addition of water in a measured amount delayed the inflammation of the mixture by half-an-hour. Finally, Cadet suggested replacing the combustible mixture by an explosive one and thus preparing a landmine or an artillery wick (*lances à feu, mèches à cordes*), where the lighting could be retarded in an agreed manner. In 1805, he described his artillery baguette, which could be used as a cheaper and more efficient alternative to the traditional means of lighting a gun. The baguettes were square cylinders, 50 cm long, and 14 mm thick, made of lime wood impregnated with turpentine and lead nitrate, which could replace the wicks used to light the gunpowder inside the weapon. These baguettes had the property of burning very slowly and totally, were not put out by rain; they did not spark, stayed lit for a long time, were less fragile, easier to transport, and cheaper that the standard material.[7]

Another memoir was related to geoponics.[24] Physicist and chemists had long been looking for ways to examine soils in order to appreciate their fertility. The book of the soil scientist Olivier de Serres's (1539-1619), *Théâtre d'Agriculture,* [25] was the textbook of French agriculture in the 17th century. In it, he already advocated crop rotation to maintain the fertility of the soil. Fertility or non-fertility of the soil was due to the ratio between sand and clay it contained. A correct ratio made work easier because the soil maintained the amount of humidity proper for vegetation. If the composition of the soil at several feet depth was the same as at the surface, this was a better index than its color to judge fertility. In their book *Cours Complet d'Agriculture Pratique*[26] the abbé François Rozier (1734-1793) and Jean-Antoine Chaptal (1756-1832) described a procedure based on pouring a certain amount of soil in water, separating the silica that separated almost immediately, followed by dissolution with acid of the calcareous earth suspended together with alumina, depositing the latter, drying and weighing each portion, and determining the calcareous earth by difference. The results allowed classifying the soils into twelve different groups, among them silico alumina, silica calcareous, and silico alumina calcareous. The procedure was very approximate and required expensive materials and the help of a trained chemist. These facts led Cadet to develop a much simpler method of analysis, which could be used by every farmer. First of all, he proved that physical properties of the soil, such as color, odor, taste, density, and the force of aggregation, were inappropriate *indices* for determining the fertility of the soil.[24] The procedure he recommended consisted on putting on the paper of a glass filter (weighed previously) an determine known of soil, and pouring over it a determine amount of water. The time of filtration was recorded and the filter was weighed to determine the amount of water that had been absorbed by the soil. This operation was repeated ten times under fixed conditions. The different types of soils (clay, calcareous, sandy, etc,) required different amounts of water. The amount of water absorbed and the time it took for being absorbed expressed the nature of the soil. Cadet determined that the affinity of water for clay was 84 %, for sand 22 %, and for calcareous earth 27 %. These values allowed him to prepare a table containing 10 divisions, where the smallest amount of water absorbed corresponded to sand almost pure and the largest to soil appropriate for gardening. Thus the farmer had a very simple practical procedure for determining the soil appropriate for cereals, for potatoes, for artificial prairies, and for vines, and also for the improvements to do on the soil.

Together with I. Deslauriers, Cadet published an extended study of pharmaceutical tinctures (extracts).[27] The day-to-day advances in the knowledge of physiology and the analysis of plants, clarified to the pharmacist the nature, formation and modification of the immediate and far principles of vegetables. They also obliged him to suggest to physicians the changes in the trade preparations, to make them more rational, more consistent, and more appropriate to the goals the physician wanted to fulfill. Although alcoholic tinctures were the most simple pharmaceuticals preparations, each pharmacy had its own rules for preparing them. They used alcohol of different concentrations, they developed the preparation at different temperature, and the active substance was of different purity. Hence there was no reason why the product sold by the different pharmacies would be the same and have the same efficacy, making it very difficult to judge its effects. The purpose of the memoir was to determine the conditions to prepare the tinctures in a constant and regular way by macerating the vegetable substance in a proper time and in an alcoholic solution of appropriate concentration. The conditions would be different for each substance, it required using alcohol of the proper concentration and knowing the solubility of the active ingredient(s). Under this situation, the physicians would have no doubt regarding the doses they prescribed for the treatment of diseases. The paper describes the preparation details of 55 tinctures mostly used by pharmacists, among them aloe, absinthe, chamomile, curcuma, citron, ginger, gentian, myrrh, saffron, and vanilla.

In another publication, Cadet discussed the manufacture and uses of animal carbon.[28] It was not many years that the physical and chemical properties of animal carbon were known. Bone and ivory were burned in closed vessels to obtain a beautiful black appropriate for paints. After discovery the properties of carbon as a filtering and bleaching medium, it became a much sought after product in refineries, confectioneries, chemical laboratories, and distillation facilities. Many factories produced the material in Paris using very simple procedures. Crushed bones were put in earthen or cast iron pots and heated using wood or coal. At a high enough temperature, when the heat decomposed the gelatin and the fat of the bones, the mouth of the pots was opened to let escape the methane generated, which was lit by air entering at different heights. The combustion process of the bones was considered finished when the flaming of the gas ended. The shape of the reaction vessel was not important; the important thing was to use the minimum possible of fuel and the maximum temperature. The gas released was used in Paris for illumination, or for heating the reacting mixture.

Cadet remarked that the properties of the animal carbon thus produced varied according to the type of bone and the age of the animal. The experimental information indicated that large round bones, such as femurs and tibia of steer, furnished more carbon that those originating from veal of the same species and weight. Bones of young animals provided about 5 % weight of carbon against about 40 % from older animals. This fact explained why carbon from ivory was blacker than the carbon obtained from any other animal.

Animal carbon was a mixture of calcium phosphate, calcium carbonate, a small amount of calcium oxide, and carbon. The bleaching property was a result of the mixture of these substances; each one separate had a much smaller bleaching power. Consequently, manufacturers that were used to judge the raw material employed, used to add soft animal parts, such as blood, intestines, membranes, etc., to raw material that seemed to contain too much gelatin. A practical consequence of these observations was that the best animal carbon for decolorizing purposes was the one containing the most carbon. This was not enough, prior to use it was recommended that the mixture be well pulverized. The proportion of carbon in the black was easily determined by treating the material with HCl, which dissolved the calcareous salts and calcium carbonate. The washed residue was basically pure carbon.

Many refiners believed that the animal carbon could be used several times. Thus, when used as a clarifying filter, it was afterwards washed with a lot of water and then calcined again, adding or not a supplement of animal matter. In general, the recycled carbon was usually of a better quality than the original batch.

Additional information was that animal carbon was a better material for clarifying than vegetable carbon, and that the former could also be used to remove noxious odors, if well pulverized.

Cadet published many papers on the subject of natural products, their properties, extraction, and uses as drug. Thus he reported on the liquid resin obtained from cashew nuts.[29] After discussing the structural characteristics of the nut, Cadet indicated that the cotyledons contained a sweet tasty fixed oil. Mechanical pressure of the almond exacted a very small amount of oil, because its viscosity made it very difficult to separate from the parenchyma. Similar results were obtained by heating the pericarp with water for 24 h. The oil could be extracted easily with the help of cold ether, yielding about 25 g of oil per 100 g of almonds. Similar results were obtained with lukewarm alcohol; concentration of the solution deposited a large amount of gallic acid.

Cadet investigated the properties of cashew nut oil and among them he found that with most metal salts it yielded insoluble compounds which were decomposed by sulfuric acid, weak nitric acid did not attack it but concentrated it converted it into a yellow solid material, soluble in alcohol and insoluble in water. The solid material seemed to be resin, which could be precipitated by water from its alcoholic solution. According to the properties of the oil indicated it should be classified as a liquid resin and not as an oil. This resin formed soluble soaps with alkali, which frothed with water like ordinary soap but left the skin sticky, the same as soap originating from resins.

The irritating and strongly astringent flavor of the oils suggested that it should have a purgative and vomitive action on the stomach and the intestine. Treated with minium and spread over wood it dried promptly leaving a brilliant surface as that obtained with common varnishes, signaling a potential use in the arts.

According to Cadet, the medicine practiced by primitive people was only an empiricism changed by superstition and prejudices.[30] Nevertheless, it had furnished medicine, after enlightened by observation, a set of most powerful and active substances, which could be used confidently. Hence it was of interest to study this crude therapeutics and develop a missing method to help in the selection and classification of medical substances. The settlers of French Guyana had reported the existence of very large number of plants used by the natives, which they had acclimated as possible source of medicines. Cadet reported that more than 200 plants originating from Guyana could be used for such purposes and proceeded to describe the 157 of them he felt were the most remarkable, which he classified in the categories of (1) purgatives and emetics, (2) antipyretics and astringents, (3), sudorifics, (4) tonics, stomatics and emmenagues (provoke menstruation), (5) vermifuges, (6) anti venereal, (7) sternutative (provoke sneezing), (8) emulsifiers, and (9) sialalogues (stimulate secretion of saliva) and masticatory.

On the plants studied in particular was a new species of quinine.[31] Cadet studied the properties of the bark and concluded that it should be considered a variety of cinchona. He then proceeded to study a large number of plants known to have astringent properties. The astringent property was present in the branches, roots, leaves, and many times in the flower fruit and the fruit. It manifested itself through an acid, a resin or a styptic extractive principle. Some of them produced a back precipitate with iron dissolutions and other coagulated gelatin.

Cadet studied the bark and skin of a large number of plants and trees to determine the most appropriate for tanning leather.[32] Using a standard procedure based on the weight of gelatin precipitated, he classified the vegetables in the following four categories: (a) Vegetables, slightly astringent, having little action on iron salts, and slightly blurring a gelatin solution (elm tree, acacia, carob tree, box-thorn, ash tree, etc.), (b) astringent vegetables that blacken iron dissolutions and cloud gelatin solutions, without forming a precipitate (different varieties of maple, young fustic, lemongrass, privet, liriodendron, etc.), (c) highly astringent vegetables, producing substantial precipitation of iron salts, and slightly clouding gelatin solutions without formation of a precipitate (different varieties of walnuts), (d) Highly astringent vegetables producing a tannin precipitate of glycerin (gall nuts, dogwood, alder, cherry tree, horse chestnut, sumac, etc.).

Regarding the tanning of leather, Cadet concluded as follows: (a) the sharp styptic and astringent flavor was not a sufficient index to determine the tanning power, it was actually a misleading property, (b) tannins are present rather abundantly in the roots or barks of different families of vegetables, and (c) the oak, almost exclusively used in France for tanning purposes, could be advantageously replaced by the cherry tree, apricot tree, the alder, the dogwood, and the tormentil.

Another one studied in particular was the crab tree (andiroba) and the oil (crab oil) extracted from its seeds.[33] First, Cadet gave a description of the tree, as reported by travelers and settlers. The most important product of the tree was its brown, woody, four-cornered nut that resembled a chestnut. It contains several oil-rich kernels or seeds that average about 63 % of pale yellow oil; a single tree producing about 200 kg of nuts annually, while 6 kg of nuts were required to produce 1 kg (about a liter) of oil. The wood was used in Guyana to build furniture and vases and the oil was mainly used for illumination because it was not possible to remove its extreme bitterness. The latter property made it useful for polishing furniture in order to prevent attack by wood-chewing insects. Native hunters rubbed it on their bodies and hair to avoid insect biting. The separation procedure was as follows: The nut was boiled without previous separation of the hull in a large pot of water and the resulting paste kneaded many times and then exposed to the sun until it had rotted and then squeezed to extract the extremely bitter oil tasting like nux vomica (today this bitterness is attributed to a group of terpene chemicals called *meliacins*). The remaining paste was heated and expressed further and then used to harden the boats. One consequence of this extraction method was that crude andiroba oil was frequently associated with a red coloring that originated from the skin of the seeds. According to Cadet, at 4 °C the oil was solid and melted on heating to 10 °C; at about 18 °C it separated into a solid part shaped like globules, which Cadet believed to be stearin, and a liquid, which he tried to separate into its components without much success. Since the oil was slightly soluble in water and alcohol, and totally soluble in ether Cadet tried to react it with different substances, in particular NaOH, KOH, PbO, and acetic acid. The alkalis produced soap, soft with KOH and hard with NaOH, both slightly smelling and colored like the oil. From his results Cadet inferred that the oil, in addition to stearic acid, also contained oleic and margaric (heptadecanoic) acids.

In 1819, Cadet reported his results on the examination of a moss collected in Tenerife that the inhabitants used for dyeing rose different textiles.[34] Cadet recognized it as the same lichen growing in Europe in ash and other trees (lichen fraxineous). He treated the lichen with ether, alcohol, and ether. A long maceration with ether gave pale yellow liquor, which after evaporation turned into a green mass of moss smell. The material was not soluble in alcohol but a solution of bicarbonate made it soluble in water, turning it brown. Maceration with alcohol produced a yellow solution, which treated with water separated a whitish matter that clouded the solution immediately and then floated on it. The alcoholic solution, evaporated to dryness, yielded a residue soluble in ether and insoluble in water.

As a result of his experiments, Cadet concluded that the lichen was composed of a yellow red coloring material soluble in water, a fatty material soluble in ether and insoluble in alcohol, which the alkalis changed its color by combining with it and making it soluble in water, a resinous material soluble alcohol water and precipitated by water, of a calcium salt, and an extractive matter. The lichen did not seem to be of particular use for the French dyers, which obtained similar but more beautiful tones using native species.

In 1819, Cadet reviewed the processes for preparing starch.[35] The insolubility of starch in cold water allowed its easy separation from the vegetable that contained it. The resulting starch was naturally pulverulent and easy to separate from the fibrous tissue that contained it. The art of extracting starch from potatoes, cassava roots, etc. consisted on such an easy manipulation that it could be applied to large masses, without the need of mechanical forces. The smallness of cereals, their hardness, the association of wheat flour with gluten, did not allow the use of simple division. Grain passed through the mill and the sieve gave flour that required conversion into a paste, kneading, and blending immediately under water in order to remove the starch and leave the gluten. This was a lengthy operation that could only be performed on small masses. Afterwards, the gluten was destroyed by fermentation. The resulting product was initially sweet, then acid, and finally putrid. Applied to large masses of grains it constituted the so-called starching operation. The process yielded to such poisonous emanations that the authorities prohibited the starchers to exercise their profession within a city. Since this ordinance had led to an increase in the price of starch there had been a search for methods to replace fermentation by a procedure similar to the one practiced in laboratories, and which could be applied to a large mass of grains. According to Cadet, Mr. Guin, a Marseille starcher, had developed a procedure that was tested and approved by a committee of three pharmacists appointed by the mayor of Marseille. In this process the grains were first soaked in lukewarm water to soften them. In order to prevent fermentation, the water was replaced frequently. The operation lasted between four and six weeks. During this time the grain swelled and crushed under finger pressure. The resulting mass was taken to the mills where the grains were mechanically crushed and torn, turning the accompanying water milky. The liquid was now discharged into a trough where the starch precipitated while the gluten and the hulls remained in the mill. The starch was washed several times with water and left to dry in the air. No noxious fumes were evolved during the whole process. Although the commissaries of Marseille had found Guin's starch totally comparable to the best starch produced by other procedures, Cadet believed that there must be a difference between both products. The starch obtained by simple washing was less divided and less holding that the one coming from the old procedure. Fermentation, without decomposing starch, acted over it and gave it a different aspect. Microscopic examination of both products showed that one of them was white matte and formed by grainy particles, while the other was somewhat laminar and brilliant. They had the same nature but they were not equally suitable for the same uses, and perhaps Guin's starch was not better that potato starch for making powdering powder. This was a very small inconvenience that could be easily remediated.

Cadet published a short notice about a pharmacist that was selling eye drops supposedly made from a cadmium salt, when it was actually only composed by zinc sulfate. Some readers had concluded that Cadet was not aware of the existence of cadmium and its salts. For this reason, Cadet found appropriate to publish a note disproving these notions and describing the many properties known about the metal and its salts.[36]

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