RESEÑA

ANTOINE-AUGUSTIN PARMENTIER

Jaime Wisniak.

Department of Chemical Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel 84105. E-mail: wisniak@bgumail.bgu.ac.il

Recibido: 18 de agosto de 2009. Aceptado: 9 de septiembre de 2009.

Palabras clave: papa, cultivo de la papa, pan, ciencia de los alimentos, farmacia hospitalaria, viruela, sangre, leche.
Key words: potato and its cultivation, bread, food science, hospital pharmacy, smallpox, blood, milk.

RESUMEN. A Antoine-Augustin Parmentier (1737-1813), un farmacéutico militar, sin ayuda alguna promovió el cultivo de la papa como fuente alimenticia en Francia. Sus principales actividades fueron en agricultura, nutrición y salud pública. Fue responsable de la primera campaña para la vacunación contra la viruela, pionero de la extracción de azúcar de la betarraga, fundador de la primera escuela gubernamental de panadería en Francia y el estudio de métodos de conservación de alimentos, incluyendo la esterilización térmica y la refrigeración.

ABSTRACT. Antoine-Augustin Parmentier (1737-1813), an Army pharmacist, single-handed promoted the introduction of the potato as a cultivar and food in France. His main activities were in agriculture, nutrition, and public health. He was responsible for the first mandatory smallpox vaccination campaign, pioneering the extraction of sugar from sugar beets, founding the first governmental school of bread making in France, and the study of methods and ways of preserving food, including heat sterilization and refrigeration.

LIFE AND CAREER[1-7]

Antoine-Augustin Parmentier (Fig. 1), the second of the five children of Marie-Euphrosine Millon (1706-1776) and Jean-Baptiste-Augustin Parmentier (1710-1788), a modest draper, was born on 12 August 1737, in Montdidier, department of the Somme, Picardie. Two of his brothers died when he was 11 years old. Parmentier's mother, who had been properly educated, took the responsibility of teaching her children, including giving them rudiments of Latin. The modest means of the family barred the children receiving an academic education and thus, when Antoine-Agustin was thirteen years old, having sufficient knowledge for entry into the pharmaceutical profession, found a position at the pharmacy of Frison at the *Place de la Croix Bleue in Montdidier* (now Place Parmentier), preparing medicines and chemicals. Paul-Felix Lendormy, a far away cousin, was the right-hand of the owner. Parmentier stayed with Frison five years and then, in 1755, at the age of eighteen, moved to Paris to work at the apothecary's shop in Croix-des-Petits-Champs. He lodged in the home of Jean-Antoine Simonnet, a far relative of his, who in his youth had served as *aide apothicaire* at the *Hôtel Royale des Invalides*.

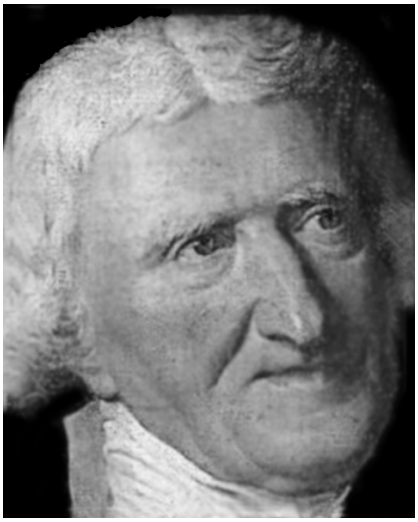

Fig. 1. *Antoine-Agustin Parmentier (1737-1813).*

The war that was to be known as the Seven Year War (1756-1763), involving all the mayor powers of Europe, was already looming in the horizon. Simonnet, recognizing the innate abilities of Parmentier and being aware of the insufficient number of pharmacy personnel in the French Army, recommended the young man to join the armed forces to further his career as a pharmacist. Admittance to the pertinent force required passing an examination, which Parmentier approved without diff iculty on the basis of the experience he had already accumulated. His examiner was the apothecary and

chemist Louis-Claude Cadet de Gassicourt (1731-1799); eventually Gassicourt and Parmentier would become very close friends and collaborators [**Note 1**].

Parmentier was twenty when he joined the army as *apothicaire sous aide* and remained a soldier until the end of his life. An important achievement of Parmentier during the war was stopping an epidemic of dysentery in one of the hospitals he was assigned to Pierre Bayen (1725-1798), the chief pharmacist of the French Army. Bayen favorably impressed by Parmentier's courage and professional abilities, promoted him to pharmacist second class in 1758. In June 1760 Parmentier was promoted to pharmacist first class and Bayen was made *pharmacien aide-major*.

During the Seven Year War Parmentier was wounded in action and captured by the Prussians several times. In the initial two weeks of his fifth term as prisoner of war, Parmentier's daily ration were a few pieces of boiled potatoes, a food which the Germans used only for feeding pork. Eventually conditions improved and he became a prisoner of war with conditional liberty, authorized to work in a pharmacy in Frankfurt am Main, under the condition that he would not try to escape. It was here that he came across Johann Friedrich Meyer (1705-1765), a chemist-pharmacist who researched the chemistry of food and was substantial in advancing Parmentier's education.[5]

The Seven Year War ended on February 10, 1763 by the Treaty of Paris and Parmentier, twenty-six years old, returned safely to Paris with a small sum in his pocket and an uncertain future. To support himself he worked in the apothecary shop of Bernard Lauron, a friend of Guillaume François Rouelle (1703-1770), at the *rue des Petits-Champs*, close to Simonnet, and in his free time attended lectures given by Abbot Jean-Antoine Nollet (1700-1770) on physics, Bernard de Jussieu (1699-1777) on botany, and Rouelle on chemistry.

In October 1766 he competed successfully for the post of *apothicaire gagnant-maîtrise* at the *Hôtel Royal des Invalides,* with an annual salary of 300 livres plus free lodging, a certain amount of wood for heating and candles for lighting. Parmentier stayed six years at the *Invalides*, improving his knowledge and cultivating in the small his garden he had at his disposition, vegetables, which he believed were appropriate for human feeding. At the end of this period, he had been licensed as *maître en pharmacie* (1774) and was thinking about opening his own shop. In order to keep him at the hospital, Joseph Sahuguet d'Armazit, baron d'Espagnac (1713-1783), governor of the *Hôtel des Invalides*, negotiated the creation of the position of *apothicaire-major*, head of the pharmacy at *Invalides*. The pertinent royal decree was issued on July 18, 1772.

Louis XIV (1638-1715), the Sun King, had founded the *Hôtel des Invalides* in 1671 to provide accommodation for disabled and impoverished war veterans. A royal decree, issued on March 7, 1676, assigned responsibility of the infirmaries permanently to the *Compagnie des Filles de la Charité* (Daughters of Charity, founded in 1633 by Vincent de Paul), known as the Grey Sisters on account of their habit. A staff of attendants and servants was appointed to the service of the *Hôtel*. It included a governor, appointed for life by the king, medical personnel (a physician, a surgeon, and a pharmacist), management, bakery, and police. One very important privilege was that the guards were wounded soldiers; no armed troops might even enter it. At the time of Parmentier, the hospital housed about three thousand veterans, served by some five hundred employees. According to the royal contract, the Sisters were wholly responsible for the infirmaries of the hospital and the treatment of the sick soldiers; for the preparation of medicines, drugs, syrups, and sweets, and if they were not familiar or did not how to prepare a particular unguent, they could order it made by the apothecary or the surgeon.[8]

The Gray Sisters, who had the absolute management of the hospital, strongly opposed Parmentier's appointment, refused his entrance to the laboratories, and complained to everyone including the bishop and *Princess Adélaïde de France*, their protector. In 1774 the Council of State ruled in favor of the Sisters and the abolition of Parmentier's position. This opposition led the King, on December 31, 1774, to revoke Parmentier's appointment. Louis XVI compensated Parmentier with an appointment of *pensionnaire du roi*, with an annual pension of 1 200 livres and the right to lodge for life in the hospital [**Note 2**]. This Solomonic decision of the King probably led to the most important contribution of Parmentier to the nutritional habits of the French as well as the establishment of potato as a successful new crop in France. Free of all obligations and having at his disposal all his time, he was now able to use his small garden to pursue his interest on growing plants having nutritional value.[3,8]

On his return from Germany Parmentier was influenced by the repeated years of famine and imposed on himself a humanitarian mission. In his own words: *"Mes recherches n'ont eu d'autre but que les progrès de l'art et le bien général…La nourriture du people est ma sollicitude, mon voeu, c'est d'en améliorer la qualité et d'en diminuer le prix…J'ai écrit pour être utile à tous" (My research has no other goal but the progress of the art and general good. The feeding of the people is my concern and my wish is to improve the quality and reduce the price [of bread]"*.[2,5]

His work led him eventually to consider the potato for this purpose, a vegetable that was despised in France where it was occasionally fed to cattle, but eaten widely in other European countries. It is generally agreed that Parmentier single-handedly popularized the use of the potato in France against very strong opposition and prejudice. Today, any French dish with Parmentier's name attached to it, for example, *potage Parmentier* (potato soup), indicates that the main ingredient is potatoes.[2]

In 1779, he was appointed *censeur royal* (royal censor), for examining and approving all the books that appeared on the subjects of pharmacy and chemistry. He was also charged with traveling around France in-

Note 1. *Gassicourt spent several years with the military, reorganizing the pharmaceutical services of the French armies stationed in Germany in 1761. He his considered the first to have synthesized organometallic compounds.*

Note 2. *In 1792 the National Assembly removed the benefit of free lodgment from all the personnel of the hospital but against this decision, the Conseil de Santé ordered that it be maintained for "le philantrope Parmentier".*

vestigating the reasons for the poor quality of bread. His inquiries demonstrated that the poor quality was due not only to faulty procedures used in its manufacture, but also to the inappropriate methods employed in milling wheat. During his tour of France Parmentier visited his hometown, Montdidier, where he was received as an illustrious son. The authorities took advantage of his visit to ask his help for ways of fighting a plague that was ravaging their wheat crop, the "black disease" (*carie du froment, or blé noir*). Parmentier collected the black seeds, made a series of chemical tests to determine the nature of the pest, and recommended washing the seeds with limewater as a preservative against the plague. He reported his results in a memoir read to the *Société Royale de Médecine*.[9]

One important outcome of his long service as pharmacist of the army was his *Codex, pharmacopée française*[10,11] published by order of the government commission composed of professors of the faculty of medicine and the School of Pharmacy in Paris (1837), with the support of the *Conseil Général d'Administration des Hospices Civils de Paris et de Secours à Domicile*.[2] This Code is a true handbook of the pharmaceutical sciences, devoted to the teaching of the many aspects of the discipline. It is also a critical study of the official and magisterial preparations of its time, as well as of the experience accumulated by the author. The first chapter (Materia Medica) describes the drugs belonging to the vegetable kingdom (245 in total, 100 of them indigenous), the animal kingdom (19 substances), and mineral (36 products), and about 70 synthetic chemicals. The second chapter (Official Medicaments), containing 21 sections, refers to the official medicines, and the third chapter (Prescriptions) describes the preparation of magisterial drugs. There are also chapters about the care of medicines and the management of hospital problems such as air healthiness, disinfection of wards, etc.

Parmentier promoted the improved cultivation of maize and chestnuts[12,13](Parmentier,1780, 1812b), and tried to reform the methods of baking (Parmentier, 1778).[14] During the Revolution he took care of the preparation of salted provisions[15] and manufactured a sea biscuit.[16] He recommended the conservation of the meats by the cold, and also worked on the improvement of the technique of food preserves by boiling, discovered by Nicolas Appert (1749-1841), in 1810. Parmentier did extensive research about wine and the different products from the vineyard, such as raisins. He promptly realized the importance of the latter, as an alternative source of sugar, which was coming into France in large quantities as part of the tribute paid by the colonies. He proclaimed the excellence of raisin syrup, having a larger sweetening power than the solid material and promoted its large-scale production in France. The continental blockade of France, which had resulted among other things, in an exorbitant increase in the price of sugar, led Parmentier, between 1808 and 1813, to work extensively on the manufacture of syrups and preserves based on raisins to replace cane sugar, and to pioneer the extraction of sugar from beets.[17-21] Parmentier also conducted investigations in a wide range of other subjects, for example, preservation of grain and flour,[22] improvements in milling,[23] milk,[24-26] chocolate,[27] and preservation of vinegar, wine, and meat.[28-31] He contributed articles to the twelve-volume *Cours Complet d'Agriculture*, edited by Abbe François Rozier (1734-1793) in 1781;[32] he participated in the writing of the twenty-four-volume *Nouveau Dictionnaire d'Histoire Naturelle* (Paris, 1803-1804); and published his book *Economie Rurale et Domestique*, of which only six volumes of the projected eight appeared before his death.[33]

The *Académie Royale des Sciences*, *Belles-Lettres et Arts de Bordeaux*, aware of the need of interesting farmers in the cultivation of corn, proposed in 1784 a prize on the subject, which was awarded to Parmentier's contribution *Le Maïs ou Blé de Turquie Apprécié sous tous ses Rapports*.[13]

Parmentier also contributed to many aspects of public health, among them, he was responsible for the first mandatory smallpox vaccination campaign (under Napoleon starting in 1805, when he was Inspector-General of the Health Service). He postulated that lack of vaccination, practiced only by the rich, was discriminatory against the poor; he demanded the opening of public centers for free vaccination and the publication of a short and simple document to explain the poor the advantages of the treatment.[34] He studied quality of water from the Seine,[35,36] with Nicolas Deyeux (1745 -1837) he carried on chemical studies of pathological changes in the blood,[37,38] with Louis Guillaume Laborie (?-1800) and Antoine Cadet de Vaux (1743-1828) on sanitation of cesspools,[39] and with them and Hecquet on exhumations.[40] The work with Hecquet and Cadet de Vaux was somewhat unusual. In 1452 the Church of Saint-Eloy, sometime the only parish of Dunkerque, was authorized to bury parishioners inside its building. Inhumations were a good income source to the church but with time they became a health danger to the parishioners. The humidity and saltiness of the ground generated germs and obnoxious odors that carried the risk of epidemics. The need to improve the building led a judge in 1777 to authorize the exhumation and transfer of as many bodies as possible to an outside cemetery. The responsibility of this operation was assigned to Hecquet, Chirurgien-Mayor of the Royal hospitals, with the assistance of Parmentier and Cadet de Vaux. The report they issued recommended that in order to avoid the workers becoming ill they to had to carry a bottle with vinegar and, from time to time, rub their hands and faces with the liquid, and to add, from time to time, potassium nitrate and aromatic substances to braziers with burning coals. Some of exhumed bodies were found to be dry and in a mummified state while others were putrefied. Mummification was assumed to be due to the constitution of the bodies and to the persons having been heavy drinkers (!). Several bodies showed all the signs that the person had been alive at the time of burial, but due to lethargy, assumed to be dead.

The exhumation technique developed by Hecquet, Cadet, and Parmentier would be used afterwards (1786) be used to transfer the mass grave in the *Cimetière des Innocents*.

Parmentier, who never married, passed away on December 17, 1813, at the age of 76, victim of a lung infection. He was interred at Père Lachaise cemetery (division 39, place 56) in Paris. The monument that houses his grave was built with the contribution of the military pharmacists. It is made of stone shaped as a parallelogram (Fig. 2). One of the faces represents a plough located between a wheat bundle and a corn stem; another shows a distillation retort and a basket full of potatoes intertwined with a vine stock, to show his many contributions to humanity. On one side of the tomb it is the written:

ICI REPOSE
ANTOINE AUGUSTIN PARMENTIER
PHARMACIEN
MEMBRE DE L'INSTITUT DE FRANCE,
DU CONSEIL GÉNÉRAL DES HOSPICES CIVILS DE PARIS,
L'UN DES INSPECTEURS GÉNÉRAUX DU SERVICE DE SANTÉ DES ARMÉES,
OFFICIER DE LA LÉGION D'HONNEUR
NÉ A MONTDIDIER EN 1737,
MORT A PARIS 1813.

and on the other side:

MONUMENT
ÉLEVÉE A LA MÉMOIRE
D'ANTOINE AUGUSTIN PARMENTIER
PAR LES PHARMACIENS CIVILS ET MILITAIRES DE FRANCE,
SES ÉLÈVES, SES AMIS, SES COLLÈGUES.

Fig. 2. *Parmentier's grave*

In his testament Parmentier left 600 francs to the *Société de Pharmacie* to establish a fund for an annual prize on a question to be decided by the *Société*. The first subject selected for the 1815 prize was to determine the existence or non existence in vegetables of a substance named generically *extractif*, which was different from the immediate materials known then.

Honors and awards

Parmentier received many awards and honors for his contributions to science, public health, and technology. In 1795 he was elected to the *Académie des Sciences* (*class Economie Rurale*), member of the Institut de France (*class Sciences Physiques et Mathématiques*, 1795). He was honorary, correspondent, member, or associate member of the most important French and European scientific societies, among them the academies of Alexandria, Berne, Brussels, Geneva, Lausanne, Madrid, Milan, Naples, Turin, and Vienna.

Among the many public positions he occupied we can mention his membership in the *Société d'Encouragement à l'Industrie Nationale* (founder, 1801), *Bureau de Consultation des Arts et Métiers, Commission d'Agriculture et des Arts, Conseil Général des Hospices de Paris, Commission des Subsistances et des Approvisionnements* (1805). He was President of the *Conseil de Salubrité de Paris, Inspecteur Général du Service de Santé des Armées* (1803), *Pharmacien Militaire en Chef* (chief pharmacist of the army, 1782), director of the *Société National d'Agriculture*. He founded (and taught at) the *École de Pharmacie de Paris*, he was founder and first president of the *Société de Pharmacie* and of the *Bulletin de Pharmacie*, which became the *Journal de Pharmacie et Chimie*, and later founded a school of baking in which he taught.

Shortly after establishing the *Légion d'Honneur*, Napoléon Bonaparte (1769-1821) decided that ten crosses would be awarded to the civil and military pharmaceutical services. One of them went to Parmentier.

Many public places carry Parmentier's name, for example, in Paris a long avenue in the 10th and 11th boroughs and a subway station on line No. 3, two stops northwest of *Père Lachaise Cemetery*, decorated entirely with a potato theme. The street where he lived (*rue des Amandiers-Popincourt*), and also the nearby boulevard, now carry his name. The city of Montdidier changed the name of the street where Parmentier was born (*rue de la Mercerie*) to *rue Parmentier*; in addition in 1848 a statue was erected in Place Parmentier a statue showing Parmentier distributing of seeds to a grateful peasant. The original statue was destroyed during First World War and replaced by a new one in 1931.

SCIENTIFIC AND INDUSTRIAL CONTRIBUTION

Parmentier was a very prolific writer; he published over 150 memoirs, instruction manuals, books, and critical reviews of papers in the areas of public nutrition, public health, and chemical analysis of foods and physiological fluids. His first book, *Examen Chimique et Physique de la Pomme de Terre*, was published in Paris in 1773,[41] and the last one, *Formulaire Pharmaceutique a l'Usage des Hôpitaux Militaires*, appeared in 1803.[10,11] The most comprehensive of his books was *Economie Rural et Domestique*, published in eight volumes.[33] The *Académie Royale des Sciences, belles-lettres et Arts de Bordeaux*, aware of the need of interesting farmers in the cultivation of corn, proposed in 1784 a prize on the subject, which was awarded to Parmentier's contribution *Le Maïs ou Blé de Turquie Apprécié sous tous ses Rapports*.[13]

Potato as a food crop

According to Stevenson,[42] for more than a century after the South American potato was introduced into Europe, it was grown in the gardens of England and continental Europe as a curiosity rather than as a source of food. It did not adapt to the new environmental conditions and could not compete with the food crops already in use. The Irish were the first to recognize its food value. The climate and soil of Ireland were particularly appropriate for the cultivation of potatoes and they soon became the main food crop of the country. Although potatoes yielded large crops and required little labor and attention, once in a while pests would ruin the crop and result in mass starvation and decimation, as happened during the Irish famine in 1845. Many people began to grow seedling potatoes with the idea of developing more vigorous and productive varieties that would be able to resist disease. In Prussia, king Frederick the Great (1744-1797) promoted the introduction of the potato by distributing free seeds and staplings and compelling the peasants to cultivate them under threat and heavy penalties. The Seven Years War established the potato industry on a firm basis. The spectacular increase of the potato as a food crop may well be considered one of the miracles of agriculture. Today, with the exception of the cereals, it is the most important food crop in the world, being used in the U.S. and England principally for human consumption. In many countries potatoes are important as a food for livestock, as well as for the manufacture of a variety of chemical products such as starch and alcohol.[42]

As will be described below, the introduction of potatoes into France is largely due to Parmentier's relentless efforts who never forgot that while a prisoner in Germany during the Seven Year War, he was daily fed potato soup and learned to like the staple.

The great food shortage of the years 1769-1770 had had a terrible effect upon the population of Burgundy and Franche-Comté, almost leading to a demographic disaster. To try the prevent the repetition of such a calamity the *Académie des Sciences, belles-lettres et arts de Besançon* proposed as theme for their 1772 prize competition the question "*Indiquer les Végétaux qui Pourraient Suppléer en Temps de Disette à Ceux que l'on Employée Communément à la Nourriture des Hommes et quelle en Devrait être la Préparation*" (indicate the vegetables which in time of disaster can be used to supplement the ones normally used for human food, and the ways to prepare them). The subject fitted perfectly with Parmentier's activities during his stay at the Invalides. He had tested different wheat varieties, corn, vegetables, and particularly, potatoes. He collected all his experiences in a memoir entitled "*Végétaux qui pourraient suppléer en temps de disette à ceux que l'on emploie communément à la nourriture des hommes*»,[43] and presented it to the *Académie de Besançon*. Seven memoirs postulated to the prize; the *Académie* selected that of Parmentier.

The Abbé Joseph Marie Terray (1715-1778), the French general comptroller of finances, decided to subject the case of potatoes to the exam by the members of the faculty of medicine of Paris. They concluded that potatoes were apt for human consumption and did no have the negative properties it was accused of. On November 1772 the Faculty of Medicine paid homage to Parmentier by approving his report that confirmed their experiences.

This recognition was not enough for Parmentier; haunted by the spectre of food disaster he wanted to transform potato into bread by manufacturing flour from the dry tubercles. In order to propagate the consumption of potatoes he concocted many dishes based on the product, which he gave to taste to his many friends by inviting them to dine at his home. He also organized a large public demonstration at the bakery of the Invalides, to which he invited the most important public figures. This event was reported in the newspaper *Journal de Paris* of with the remark that Parmentier's bread should be considered "the most important discovery of the century".[5]

Parmentier conducted a large number of experiments with potatoes and published them in 1773 in a memoir entitled *Examen chimique des pommes de terre, dans lequel on traite des parties constituantes du froment et du riz* [**Note 3**].[41] The purpose of this publication was to prove that the tubercle was not dangerous at all. In Parmentier's words: "*C'est le simple examen d'une racine longuement méprisée, su laquelle il reste encore des préjugés que je présente; j'aurai rempli mon but si je puis contribuer à les détruire*" (It is the simple examination of a root long time scorned, about which there are still the prejudices that I describe; I will have achieved my goal

Note 3. *The title of this piece of work is somewhat misleading because there is very little chemistry in it: it is more a physical study of the plant and a description of the many possible ways it can be used in cooking a baking.*

if I can contribute to their refutation). Shortly thereafter he published another work describing the experiments he had done at the Invalides in the presence of Benjamin Franklin (1706-1790) for manufacturing bread from potatoes, without addition of wheat flour,[44] as well as on the economics of growing potatoes.[45]

In one of his publications, Meyer had discussed the two substances that the Italian physician Giacomo Bartolomeo Beccari (1682-1766) had isolated from wheat flour and named animal or glutinous substance and starchy or vegetable substance, respectively. Beccari separated them by grinding wheat flour with water, and filtering the suspension. The solid phase retained by the sieve was the glutinous matter, while the milky water eventually deposited a white sediment, which proved to be a true starch.

Starting from his belief that bread was the basis of human food. Parmentier set out to prove that starch was the most valuable component of vegetables. In his words: "*It is within starch-containing plants that we have to look for the resources which will compensate the scarcity of grains*." Thus, he repeated Beccari's experiments and extended them to other vegetables such as potatoes, chestnuts and acorns, and the roots of iris, bryon (a kind of moss), patience wild, gladiolus, couch-grass, burdock, arum lily, and peony. His results confirmed that the starch they contained were also suitable as food. Parmentier took care to stress that the starch was not part of the poisonous materials that these plants contained. It was insipid, white, and dried in the sun yielded a pulverulent material, which was not affected by cold water and alcoholic solution. It dissolved easily in boiling water yielding an opal-colored gelatinous solution. He believed the starch could be kept for long periods of time, as long as it was stored in a dry place. He also found that the bread prepared from every different starch was equally tasty and nutritious.

Parmentier's work on grain, flour and bread undoubtedly improved the quality of bread in France beyond recognition and it is possible that the reputation that France enjoys today for the quality, consistency and variety of its bread owes much to Parmentier's work two hundred years ago.[2]

In his memoir of the chemical analysis of potatoes,[41] Parmentier reported that the tubercle contains three parts clearly different: (1) water, which was the most abundant component, saline and colored by a mucilaginous extract. Its composition was similar to that in all other vegetables Parmentier had analyzed, and contained a salt in large quantity, which helped this food to be more digestible and nourishing; (2) white and insipid starch, more dense than water and insoluble in it. This was the most interesting component and Parmentier believed that its composition was similar to that of wheat and other farinaceous vegetables, and thus could be used to manufacture valuable nutrients for men and animals; (3) light insipid fibers, insoluble in water and difficult to grind into powder, which were utilized during the germination process (modern chemical analyses indicate that the average tuber contains 75 to 80 % water, 12 to 20 % starch, 1.5 to 2 % proteins, and 2 to 3 % of fiber and ash). Once it had germinated, the potato became hard, acrid, and uneatable. Parmentier tried unsuccessfully to convert it into starch.

In 1786, the King Louis XVI assigned to Parmentier the use of the plain of Sablons, at Neuilly-sur-Seine near Paris, a barren sandy piece of land of about 2 ha, then used as a manoeuvre and parade camp for the royal regiments. The story goes that in order to change his fellow countrymen ideas about potatoes, Parmentier launched in 1776 a Machiavellian operation. He planted the plot with potatoes and invited King Louis XIV and Marie-Antoinette to visit it during the first flowering. Parmentier presented them a bouquet of the flowers, which the King placed in his buttonhole and the Queen on her bosom, an act that was imitated by the court guests immediately. In addition, Parmentier organized a series of dinners for the most important dignitaries, personalities, and scientists during which potato dishes featured prominently. In addition, he launched a fleet of potato soup kitchens in Paris, deploying bowls of rich, steaming potato soup into the hands of the starving masses. The King is supposed to have said to Parmentier: "France will thank you some day for having found bread for the poor".[42]

Another stunt consisted in having the plot heavily guarded by armed royal soldiers during the day; which Parmentier ordered removed at night, in order to satisfy the curiosity of the Parisians, which at night would come and steal the tubercles and eat them unseen. The news spread fast among farmers, who took to cultivating the potato, which became bread for the poor and gave a miraculous solution to the famine problem.[5]

In 1781 Parmentier observed that potato starch mixed with distilled water and cream of tartar (potassium hydrogen tartrate), acquired a sweet taste after several months, which was more pronounced if acetic acid had been added.[46] It is very unfortunate and ironic that Parmentier did not appreciate the scientific and industrial meaning of his finding. Unfortunate, because the understanding of the importance and significance of catalysis was years away[47] and Parmentier's knowledge of chemistry were superficial. Ironic, because Parmentier would invest years of intense research looking for substitutes for cane sugar.[17-21] The reaction with acetic acid was more thoroughly studied by Johann Wolfgang Döbereiner (1780-1849), who found that starch dissolved in water is fermented into alcohol; he assumed that the starch was first converted into sugar.[48] He suspected that the process would occur only very slowly in water alone, and he investigated the effect of acid concentration and temperature. He also discovered the catalytic action of manganese dioxide on the thermal decomposition of potassium chlorate, the basis for the preparation of oxygen.[49]

Parmentier extended his scientific work by publishing his *Traité de la Châtaigne*,[50] describing, among other things, the manufacture of bread based on the flour of chestnuts.

Milk

The *Société Royale de Médicine* requested from Parmentier and Deyeux to carry on a comparative examination of the physical and chemical properties, as well as the nature, of the milk of a woman, cow, goat, ass, ewe, and mare. The two scientists worked more than a year testing milk in different states: crude, boiled, diluted in water, fermented, coagulated, as well as using the method of the Tartars for obtaining alcohol from milk. They used cows of the same age and subjected them to a different feed regimes based on wilted potatoes, corn stalks, sorrel, artichokes, onions, red beets, etc. They also studied butter and cheeses.

Their memoirs on the subject[24-26] discussed their experimental results on: (a) physical and chemical characteristics of milk: properties, volatile and non volatile fractions, cream components, casein material, salts in

serum, and fermentation; (b) medical aspects: influence of food, medicines, mood, and physical feelings, milk and its components as medicines, and milks of different origin, and (c) agricultural economy aspects: dairy, production of butter, cheeses, industrial uses of milk including manufacture of milk alcohol and vinegar.

Blood[37,38]

Parmentier and Deyeux's prize-winning assay on blood was divided into three main chapters.[37] The first one gave a historical review of the chemical information available about blood, the second was a description of the different experiments and measurements they performed, and the third, a description of the alteration of blood produced by inflammatory and putrid febrile sicknesses, and scurvy. Parmentier and Deyeux wrote that according to their experiments, blood was composed of nine principal parts, the odorous part, the fibrous substance, albumen, sulfur, gelatin, the red part, alkali or soda, and water. The neutral salts, which were generally found in blood, seemed to be foreign to it as it was certain that blood could exist without them, and that their presence was due to particular circumstances. The relative proportion of the different components varied largely, according to the age, constitution, and way of life of the person.

The odorous part in a healthy subject was very perceptive, particularly in fresh blood. It gradually grew weaker as the blood changed and disappeared completely once putrefaction took place. In the blood of a sick person, the odorous part was decidedly less observable. Its affinity to the serum appeared to be less than to the coagulum. According to Parmentier and Deyeux, there was a clear analogy between the odorous part of the blood and that of vegetables for both were "soluble in air" (volatile) and in alcoholic solutions. The fibrous substance appeared to exist only in a state of extreme division, if not of solution. Any quick motion given to the blood as it issued from the vessels was sufficient to cause its separation. The fibrous substance undoubtedly contributed to the formation of the coagulum. The red part appeared in a large variety of shades. Parmentier and Deyeux believed that iron was the principal matter concerned with coloring the blood and that its solution in the blood was carried out by means of a fixed alkali analogous to soda. They were surprised that only the red part of blood contained iron and that the muscular substance, which they believed was completely produced by the blood, did not contain the element, even in minute amounts. In blood that remained unaltered, the albumen was always dissolved in the serum, but at soon as blood decomposed, it separated into two parts; one of which united with the serocity and the other mixed with the fibrous substance and the coloring part. Comparison of the albumen of blood with that of the white of an egg indicated that they had the same properties and that also both contained sulfur. Of all the constituents of blood, albumen was the only one that became altered in sick persons. Alkali always accompanied blood in considerable proportion. It seemed that one of its principal roles was to promote the solution of bodies that otherwise would remain insoluble. Blood contains minute amounts of gelatin, which does not appear to be affected by the state of disease. The fluidity of blood depends essentially on the amount of water it contains, which is not always the same.

Parmentier and Deyeux also examined the blood of persons laboring under different diseases, Blood drawn form people laboring under inflammation rapidly became covered by a white crust (the buffy coat), which they found to consist of fibrin. The clotted portion of coagulated blood (cruor), deprived of this substance, was found to be softer than usual and almost totally soluble in water. The albumen of the serum was also altered because it did not coagulate as usual when heated, but became milky when mixed with water. The blood of scurvy patients was not found to differ from that of healthy people, except for a peculiar smell and not coagulating easily. The serum of diabetes patients frequently had the appearance of whey, but did not contain sugar, although the urine was loaded with it.

Parmentier and Deyeux examined repeatedly blood drawn from patients suffering fevers of the worst form. It did not yield volatile alkali by distillation, nor did it become putrid sooner than blood from the healthier person. Yet, in various diseases, the albumen seemed affected; its union with the serum was less complete and its concretion less perfect than in health. By analysis, the buff, when present, was similar to that from inflammatory diseases, and the under laying coagulum was tender: it was soluble in water and the solution was coagulated by heat, alcohol, and concentrated acids, while fixed and volatile alkalis rendered its color more vivid, and prevented the coagulation.

BIBLIOGRAPHIC REFERENCES

1. Balland A. La Chimie Alimentaire dans l'Oeuvre de Parmentier, J.-B. Ballière et Fils, Paris, 1902.
2. Block BP. Antoine-Agustin Parmentier: Pharmacist Extraordinaire, Pharmaceutical Historian. 2008;38:6-14.
3. Cadet de Gassicourt CL. Éloge de A.A. Parmentier, Imprimerie de Fain, Paris, 1814.
4. Cuvier G. Éloge Historique de Parmentier, Éloges Historiques des Membres de l'Académie des Sciences, 1815-1826, Tome 2, Didot, Paris, 1861;p.3-25.
5. Muratori-Philip A. Parmentier, Plon, Paris, 1994.
6. Virey JJ. Nécrologie (A.A. Parmentier), Bull Pharm Fr. 1815;6:46-67.
7. Warolin C. Hommage to Antoine-Augustin Parmentier (1737-1813), first President of the Pharmacy Society of Paris in 1803, Ann Pharm Fr. 2005;63:340-342.
8. Massy R. Le Conflict de 1772 entre l'Administration de l'Hôtel et les Filles de la Charité, Rev Hist Pharm. 1954;11:315-324.
9. Parmentier AA. Analyse de la Carie du Froment, Imprimerie Royale, Paris, 1776.
10. Parmentier AA. Pharmacopée à l'Usage des Hospices Civils, des Secours à Domicile, des Prisons et Dépôts de Mendicité, L'Imprimerie de la République, Paris, 1803.
11. Parmentier AA. Code Pharmaceutique à l'Usage des Hospices Civils, des Secours à Domicile et des Infirmeries des Maisons d'Arrêt, Publié par Ordre du Ministre de l'Intérieur, Méquignon Paris, 1803.
12. Parmentier AA. Méthode Facile de Conserver à Peu de Frais les Grains et les Farines, Barrois, Paris, 1784.
13. Parmentier AA. Le Maïs ou Blé de Turquie Apprécié sous tous ses Rapports, Mémoire Couronné le 25 août 1784 par l'Académie Royale des Sciences, Belles-Lettres et Arts de Bordeaux; nouvelle édition, revue et corrigée, Imprimerie Impériale, Paris, 1812.
14. Parmentier AA. Le Parfait Boulanger, ou, Traité Complet sur la Fabrication & le Commerce du Pain, Imprimerie Royale, Paris, 1778.
15. Parmentier AA. Mémoire sur les Salaisons, Paris, 1793.
16. Parmentier AA. Avis sur la Préparation et la Forme à Donner au Biscuit de Mer, Paris, 1795.
17. Parmentier AA. Sur le Sucre de Betterave, Ann Chim. 1802;42:289-300.
18. Parmentier AA. Des Propriétés Spécifiques des Sirops et Conserves de Raisins, Ann Chim. 1809;70:126-144.

19. Parmentier AA. Traité sur l'Art de Fabriquer les Sirops et les Conserves de Raisins, Destinés à Suppléer le Sucre des Colonies dans les Principaux Usages de l'Économie Domestique, 3é ed., Imprimerie Impériale, Paris, 1810.
20. Parmentier AA. Mémoire sur la Fabrication du Sucre de Betteraves, Ann Chim. 1812;84:211-224.
21. Parmentier AA. Nouvel Aperçu des Résultats Obtenus de la Fabrication de Sirops et Conserves de Raisins dans le Cours de l'Année 1812, avec des Réflexions Générales Concernant les Sirops et les Sucres Extraits des Autres Végétaux Indigènes, Imprimerie Impériale, Paris, 1813.
22. Parmentier AA. Méthode Facile de Conserver à Peu de Frais les Grains et les Farines, Barrois, Paris, 1784.
23. Parmentier AA. Mémoire sur les Avantages que le Royaume peut Retirer des ses Grains, Barrois, Paris, 1789.
24. Parmentier AA. Deyeux, Mémoire qui a Remporté le Premier Prix, le 23 Février 1790, sur la Question Suivante, Proposée par la Société Royale de Médecine: Déterminer, par l'Examen Comparé des Propriétés Physiques et Chimiques, la Nature des Laits de Femme, de Vache, de Chèvre, d'Ânesse, de Brebis et de Jument, Hist Soc Roy Méd. 1790:9.
25. Parmentier AA, Deyeux N. Sur Analyse du Lait, Ann Chim. 1790;6:183-196.
26. Parmentier AA, Deyeux N. Précis d'Expériences et Observations sur les Différentes Espèces de Lait, Considérées dans leurs Rapports avec la Chimie, la Médecine et l'Économie Rurale, Barrois, Paris, 1799.
27. Parmentier AA. Sur la Composition et l'Usage du Chocolat, Ann Chim. 1802;45:139-148.
28. Parmentier AA. Des Différens Moyens de Conserver les Viandes, Bull Pharm. 1809;1:405-410.
29. Parmentier AA. Traité Sur le Vinaigre, Ann Chim. 1800;37:68-73.
30. Parmentier AA. Sur les Vins Médicinaux, Ann Chim. 1800;35:68-73; 1801;39:225-241.
31. Parmentier AA. L'Art de Faire les Eaux de Vie et L'Art de Faire les Vinaigres Simples et Composés, Delalaïn, Paris, 1801.
32. Rozier F. Cours Complet d'Agriculture Théorique, Pratique, Économique et de Médecine Rurale et Vétérinaire, Paris, 1781-1805.
33. Parmentier AA. Économie Rurale et Domestique, Rue et Hôtel Serpente, Paris, 1788-1797, 8 vols (Part of Bibliothèque des Dames).
34. Parmentier AA. Rapport au Ministre de l'Intérieur sur l'Inoculation Gratuite de la Vaccine aux Indigents, Paris, 1800.
35. Parmentier AA. Dissertation Physique Chymique et Économique sur la Nature et la Salubrité des Eaux de la Seine, J. G. Clousier, Paris, 1775.
36. Parmentier AA. Dissertation sur la Nature des Eaux de la Seine, avec Quelques Observations Relatives aux Propriétés Physiques et Économiques de l'Eau en Général, Buisson, Paris, 1787.
37. Déyeux N, Parmentier AA. Mémoire sur le Sang, dans Lequel on Répond à Cette Question: Déterminer, d'Après des Découvertes Modernes Chimiques et par des Expériences Exactes, quelle est la Nature des Altérations que le Sang Éprouve dans les Maladies Inflammatoires, dans les Maladies Fébriles, Putrides et le Scorbut, Imprimerie de Boiste, Paris, 1791.
38. Déyeux N, Parmentier AA. Memoire sur la Sang, J Phys. 1794;44:58.
39. Laborie LG, Cadet de Gassicourt CL, Parmentier AA. Observations sur les Fosses d'Aisances et Moyens de Prévenir les Inconvénients de leur Vuidange, Pierres, Paris, 1778.
40. Hecquet Laborie LG, Parmentier AA, Cadet de Vaux A. Recueil de Pièces Concernant les Exhumations Faites dans l'Enceinte de l'Église de Saint-Éloi de la Ville de Dunkerque, Imprimerie de Monsieur, Paris, 1783.
41. Parmentier AA. Examen Chymique des Pommes de Terre, dans lequel on Traite des Parties Constituantes du Froment et du Riz, Didot, Paris, 1773.
42. Stevenson FJ. The Potato – Its Origin, Cytogenic Relationships, Production, and Uses, and Food Value, Econ Bot. 1951;5:153-171.
43. Parmentier AA. Mémoire qui a Remporté le Prix de l'Académie de Besançon sur cette Question: Indiquer les Végétaux qui Pourraient Suppléer, en Temps de Disette, à ceux qu'on Emploie Communément à la Nourriture des Hommes, et quelle en Devrait être la Préparation, Chez Knapen & Delaguette, Paris, 1772.
44. Parmentier AA. Manière de Faire le Pain de Pommes de Terre, sans Mélange de Farine, Imprimerie Royale, Paris, 1779.
45. Parmentier AA. Ouvrage Économique sur les Pommes de Terre, le Froment, le Riz, etc., Monory, Paris, 1774.
46. Parmentier AA. Expériences et Réflexions Relatives à l'Analyse du Bled et des Farines, Imprimerie Royale, Paris, 1776.
47. Wisniak J. The History of Catalysis – From the Beginning to Nobel Prizes, Educ. Quím. Submitted, 2010.
48. Döbereiner JW. Versuche Über di Gährung, Schweiger J., 1816;20:213-214.
49. Kauffman G. The Origins of Heterogeneous Catalysis by Platinum: Johann Wolfgang Döbereiner's Contribution, Enantiomer. 1999;4:609-619.
50. Parmentier AA. Traité de la Châtaigne. Bastia, Paris, 1780.