REVIEW ARTICLE

Theodore Nicolas Gobley: Animal physiology and plant principles

Theodore Nicolas Gobley: Fisiología animal y principios vegetales.

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ABSTRACT

Theodore Nicolas Gobley (1816-1878), a French pharmacist and chemist, carried on extensive research on the composition of the brain, egg yolk, and eggs and sperm of carp, which culminated in the discovery of lecithin. After some experiments with egg yolk he was able to separate a group of known compounds together with glycerophosphoric acid, an albuminoidal matter (vitelline, similar to the white of the egg), and a nitrogenous substance different from albumin. His results indicated that the viscous matter of egg yolk was identical with the viscous matter present in brain (human, chicken and sheep); it contained the same two fatty material found in the brain, which eventually he identified as lecithin and cerebrine. Gobley also analyzed the fatty material contained in blood and found that it contained olein, margarine, cholesterol, lecithin, and cerebrine. This cholesterol was analogous with that of egg yolk and biliary calculi. He also found that cholesterol and lecithin were the main fatty material present in bile and were almost completely absorbed in the intestine. Similarly, he was able to discover cephalin in the brain. Gobley reported the identification and analysis of a series of plant principles present in faham (Jumellea fragrans), edible champignons, vanilla, and kava (Piper methysticum). The latter was found to be a powerful sudorific, and to exercise an influence in the cure of catarrhal affections and gonorrhea.

Keywords: Bile; blood; brain; egg yolk; kava; lecithin

RESUMEN

Theodore Nicolás Gobley (1816-1878), farmacéutico y químico francés que llevó a cabo una extensa investigación del cerebro, la yema de huevos y los huevos y esperma de la carpa, que culminó con el descubrimiento de la lecitina. Después de algunos experimentos fue capaz de separar un grupo de compuestos conocidos, juntos con el ácido glicero-fosfórico, una substancia albuminosa (la vitelina, similar al blanco del huevo) y un compuesto nitrogenado diferente de la albumina. Sus resultados indicaron que la substancia viscosa de la yema de huevo era idéntica con la substancia viscosa presente en el cerebro (humano, pollo y oveja); ésta contenía los mismos dos materiales grasos del cerebro, que eventualmente identificó como lecitina y cerebrina. Gobley analizó también el material graso contenido en la sangre y encontró que contenía oleína, margarina, colesterol, lecitina y cerebrina. Este colesterol era análogo al de la yema de huevo y de los cálculos biliares. También descubrió que el colesterol y la lecitina eran los principales componentes grasos de la bilis y que ellos eran casi completamente absorbidos en el intestino. Igualmente, descubrió la presencia de cefalina en el cerebro. Gobley reportó la identificación y análisis de una serie de principios vegetales presentes en el faham (Jumellea fragrans), los hongos comestibles, la vainilla y la kava (Piper methysticum). Esta última demostró ser un potente sudorífico y ejercer una influencia en la curra de afecciones catarrales y la gonorrea.

Palabras clave: Bilis; cerebro; kava; lecitina; sangre; yema de huevo

INTRODUCCION

Life and career (Gobley, 1871; Anonymous, 1876; Anonymous, 1903, Wikipedia, 2018)

Theodore Nicolas Gobley (Figure 1) was born in Paris on May 11, 1811, the son of Henry Gobley, a wholesale wine broker, and Sophie Boutron. He started his pharmacy training as an intern in the business of Denis Guerin (1798–1888), his brother-in-law, and in 1833 begun his formal studies after winning the first place in the competition for an internship in the Parisian civil hospitals and hospices. In the same year he received his degree of bachelier és lettres. In 1834 he obtained his diploma of bachelier ès sciences physiques and approved his first exam in medicine, and in the following year he became licencié ès sciences physique. During this stage he also attended the courses given by Pierre Jean Robiquet (1780-1840) and eventually married (1837) Laure Robiquet, one of his daughters. Three daughters were born from this marriage. In 1835 Gobley was awarded the tittle of pharmacist first class by the École Supérieure de Pharmacie de Paris and purchased the pharmacy of Bouriat and Hernandez, which he kept until 1861 (Gobley, 1871; Anonymous, 1876; Anonymous, 1903, Wikipedia, 2018).

Between 1842 and 1847 he served as adjunct professor in the École de Pharmacie. In 1843 he became a member of the Académie Nationale de Pharmacie in 1843, of which he became President in 1861. In 1861 he was elected member of Académie de Médecine (pharmacy section), and was twice its treasurer (1865 and 1870).

In addition to a fruitful research career, Gobley was also very active in professional and scientific societies, as well as in public health and welfare institutions. He was appointed commissary of the Bureau de Bienfaisance (a charity society) of the VIIth administrative district of Paris (1838) and promoted to administrator in 1844 and Vice-President in 1866; member of the Commission des Logements Insalubres of Paris (1852); of the Commission d'Hygiène of the VIIth administrative district of Paris (1860) and promoted to Senior member in 1868; of the commission for revising the French Codex (1861); of the Conseil d'Hygiène Publique (1868), replacing Jean-François Persoz; of the Council of the Société d'Encouragement (1869), etc. He was member of Société de Pharmacie and its President in 1861; member of the Société de Chimie Médicale; Société d'Hydrologie Médicale; Colegio Farmacéutico de Barcelona; Colegio Farmacéutico de Madrid; Académie de Sciences de Rouen, etc. In 1851 he was nominated Chevalier de la Légion de Honneur and promoted to Officier in 1870 (Gobley, 1871; Anonymous, 1876).

Theodore Nicolas Gobley died in Bagnères-de-Luchon on September 1, 1876, as a result of a pleuropulmonary infection, and was buried in the Montparnasse cemetery, after a ceremony at the Saint-Thomas Aquinas church, where Auguste Louis Dominique Delpech, (Académie de Médicine), E. R. Perrin (Secretary of the Commission des Logements Insalubres), Charles Blondeau (Société de Pharmacie), and Adolphe Chatin (President of the Académie de Médicine) pronounced the eulogies. Paul Schützenberger (1829-1897) replaced him at the Conseil d'Hygiène Publique. In his testament Gobley granted a perpetual annual sum of 1,000 francs to the École de Pharmacie for establishing a biannual prize for the best work in pharmacology (Gobley, 1871; Anonymous, 1876; Anonymous, 1903, Wikipedia, 2018).

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Scientific work

Gobley wrote more than 60 papers in the areas of analytical, inorganic, and organic chemistry, physiology, toxicology, and plant principles. He also wrote a short booklet describing his academic activities and his research and results, as customary for candidates to the Académie de Médicine (Gobley, 1860), and collaborated in the writing of the Dictionnaire Encyclopédique des Sciences Médicales, edited by Amédée Dechambre (1812-1896) (Dechambre, 1870). In addition to the subjects discussed below Gobley reported the design of an apparatus (elaidometer) for establishing the purity of vegetable oils, based on the measurement of their density (Gobley, 1843, 1844a), detection of vinegar purity and falsification (Chevallier, Gobley, & Journeil, 1843) preparation of ferric chloride (Gobley, 1844b, 1854), the presence of arsenic in mineral waters (Chevallier & Gobley, 1848), the composition of the snail vine (Gobley, 1858a), amount of iodine in cod liver oil (Chevallier & Gobley, 1851),14 elimination of urea by the kidneys (Poiseuille & Gobley, 1859), etc.

Physiology

Egg yolk

One of the most important research projects of Gobley was the determination of the composition of egg yolk, a task, which eventually led him to discover lecithin (Gobley, 1845ab, 1847, 1850b, 1870,1874a) In his first paper he made a quick review of the little information available and indicated, for example, that Johann Friedrich John (1782-1847) had reported that caviar contained water, albumin, oil, gelatin, iron oxide, calcium phosphate, and sodium chloride and sulfate (John, 1810). William Prout (1785-1850) had made a thorough study of the changes that took place in the egg during incubation and that the yolk contained, by weight, 54% water, 17% albumin, and 29% oil, as well as sulfur, phosphorus, the chlorides and carbonates of potassium and sodium, and calcium and magnesium carbonate (Prout, 1825). Some time later, Louis René Lecanu (1800-1871) had reported the presence of another fatty and crystallizable component, non-saponifiable, which he believed was cholesterol (Lecanu, 1829). After some preliminary experimentation, Gobley was able to separate from the yolk the following substances: water, an albuminoidal matter, which he assumed to be vitelline, olein, margarine, cholesterol, oleic acid, glycerophosphoric acid, lactic acid, osmazone, red and yellow coloring matters, a nitrogenous substance different from albumin, and a number of inorganic salts of sodium, potassium, ammonia, calcium, and magnesium, Gobley believed that the acids oleic, margaric, and glycerophosphoric were combined with ammonia (Gobley, 1845ab).

These first papers contained a detailed description of the procedures for separating each of the components, as well their properties and elemental analysis. Thus, for example, coagulated vitelline constituted 16.557% weight of the egg yolk; it was a colorless, odorless and insipid solid, insoluble in water, alcohol and ether and soluble in aqueous HCl, producing a blue colored solution. In contact with cold aqueous KOH it became a transparent gel, which melted at a higher temperature. An elemental analysis indicated it contained 52.264% carbon, 7.249% hydrogen, 15.061% nitrogen, and 25.426% oxygen, sulfur, and phosphorus. The cholesterol of egg yolk appeared as white pearly leaves, odorless and tasteless, melting at 1450C, non-saponifiable, becoming red in contact with sulfuric acid and transforming into cholesteric acid in contact with nitric acid. An elemental analysis indicated it contained 85.083% carbon, 11.628% hydrogen, and 3.289% oxygen, and that it constituted 0.438% weight if egg yolk. Gobley found the cholesterol egg yolk was identical to the one present in biliary stones; this meant this substance had to play an important role in human physiology because it was present in the principal body fluids, in the brain, lungs, blood, and bile (Gobley, 1845ab).

Gobley extracted dry chicken egg yolk with ether and boiling alcohol and found that after evaporation the extract left a fixed oil and a soft substance, which he named viscous matter. These two components were easily separated by filtration through paper. To him, the viscous matter seemed to be the most interesting component of egg yolk because it contained all the phosphorus present in the starting material. It was semi-transparent, had a yellow orange color, did not react with litmus paper and on heating it swelled but not melted. At high temperatures it decomposed into an acid carbon and ammoniacal vapors. The acidity was shown to be due to phosphoric acid. The viscous matter dissolved in ether without leaving residue and dissolved in cold absolute alcohol leaving a residue of margarine and olein. Further analysis showed it contained oleic and margaric acids and a particular acid comprising phosphoric acid. These three acids combined with ammonia forming a true soap, which seemed to be enclosed within a nitrogenous substance different from vitelline. The behavior with acids was particularly remarkable; it finely divided in diluted organic acids but did not dissolve. It decomposed partially when heated with aqueous HCl (or sulfuric acid) to a temperature below the boiling point and without agitation; the decomposition was almost complete if the process was carried on with agitation and in the presence of ether: the resulting green liquid contained all the phosphorus; nothing of it remained in the fatty material. The result of all these experiments showed it was possible to separate the components of the viscous matter with the help of diluted HCl or KOH, and ether (Gobley, 1845ab).

The fatty acids were found to constitute 7.226% of the weight of egg yolk. Additional experiments were devoted to the separation of the phosphorated acid present in the viscous matter. Gobley found the best procedure to be neutralization of the acid liquor with limewater. The resulting calcium derivative was easily separated by filtration and then decomposed by means of oxalic acid. According to Gobley, the calcium derivative appeared as white blades, odorless and slightly acrid, which decomposed at about 1500C. Elemental analysis indicated it contained 60.66% of 2CaO.PO5, 17.06% of carbon, 3.32% of hydrogen, and 18.95% of oxygen. This composition and properties corresponded unequivocally to those of glycerophosphoric acid (Gobley, 1845ab).

As a result of all his experiments, Gobley reached the following conclusions: (1) egg yolk contained more than 50% of its weight in water; (2) the albuminoidal matter (vitelline) was very similar to the white of the egg, although they differed in their composition; (c) the fatty material of the yolk (egg oil) was composed of a fix fat and an ammoniacal soap (viscous matter); (d) the egg oil was composed of margarine, olein, cholesterol, and a coloring substance, and did not contain sulfur or phosphorus; (e) the yolk cholesterol was identical to the one present in bile; (f) the ammoniacal soap contained oleic, margaric, and glycerophosphoric acids. The combination of these three acids with ammonia was enclosed within a nitrogenous substance different from vitelline (g) the yolk was neutral or slightly acid, probably due to lactic acid; (h) the coloring matter was formed by two substances, one red, containing iron, and similar to the coloring matter of blood, and the other a yellow one, probably similar to the one in bile; and (i) the average composition of the egg yolk was 51.486% water, 15.760% vitelline, 21.304% margarine and olein, 0.438% cholesterol, 7.226% oleic and margaric acids, 1.200% glycerophosphoric acid; and 2.586% of inorganic salts, ammonia, nitrogenous substances, coloring matter, etc. (Gobley, 1845ab).

The following publication reported a comparison between the compositions of egg yolk and brain (human, chicken, and sheep). Gobley found that in every case he had been able to separate a viscous matter having the same properties. Each of these viscous matters treated with hot aqueous HCl separated into two phases: a fatty containing oleic acid, margaric acid, and cholesterol, and a liquid containing glycerophosphoric acid and no phosphoric acid (Gobley, 1847). Gobley had previously reported that the phosphorated substance he had separated consisted of an ammonia soap of oleic, margaric, and glycerophosphoric acids, completely soluble in glacial acetic acid. In addition, vegetable acids released the three acids with great difficulty while inorganic acids did it with great facility, even when added in small amounts. This difference in behavior led Gobley to validate his assumption that the phosphorated substance was really ammonia soap. After numerous experiments he concluded: (a) the fatty material of egg yolk was composed of two different fractions: egg oil and viscous matter, and phosphorus was present only in the second fraction; (b) the oleic, margaric, and glycerophosphoric acids were not the products of an oxidation reaction; (c) the viscous matter was not ammonia soap but a complex substance from which it was possible to separate two different bodies, which he named phosphorated matter and cerebral matter; the latter was the same substance which Edmond Frémy (1814-1894) had named cerebric acid (Frémy, 1840); and (d) egg yolk contained 8.426% of phosphorated matter and 0.300% of cerebric matter (Gobley, 1847).

The next paper extended the investigation to the composition of fish egg, particularly, those of carp (Gobley, 1850b). Previous work by other scientists had reported only general information; fish egg contained albumin, oily matter, an animal substance soluble in alcohol and somewhat related to osmazone, a substance insoluble in alcohol and related to gelatin, phosphorus, calcium and potassium phosphates, a potassium organic salt, and several inorganic salts. According to Gobley, although this information was incomplete, it indicated that eggs of all species had basically the same composition. Gobley performed with fish egg the same experiments he had done with egg yolk and found they contained water, albuminoidal matter (paravitalline), cholesterol, lecithin, cerebrine, olein, margarine, an organic acid (probably lactic acid), coloring matter, odorant matter, sodium and potassium chloride, ammonium chloride, the phosphates of potassium, calcium, and magnesium, and other inorganic salts. Gobley gave a detailed description of the method employed to separate each fraction, and its characteristics. An interesting result was that the elemental composition of the albuminoidal matter of fish eggs was identical to that of egg yolk, for this reason he suggested naming it paravitelline. Not only that, the experiments done with egg yolk and fish eggs showed that these substances contained the same two fatty materials he had previously identified in brain, one of them contained a large proportion of phosphorus, the other of nitrogen. Gobley proposed naming the first lecithin (from the Greek λεχιθοζ = egg yolk), and the second cerebrine (because of its relation to the cerebric acid of Frémy). Gobley remarked the had been unable to obtain pure lecithin, he could only report that lecithin constituted the largest portion of the viscous mater of egg yolk, that it was a soft and viscous body, which emulsified with water, was little soluble in cold alcohol and very soluble in boiling alcohol and in ether and was not affected by air (Gobley, 1850b).

Gobley reached the following conclusions: (1) the chemical composition of the eggs of the carp was very similar to those of the common fowl; (2) they did not seem to possess the alkaline albumen which generally enveloped the yolk; (3) the eggs of carp contained about 50% weight of water; (4) the albuminous body in the eggs of carp, the paravitelline, was very similar to vitelline; (5) the fat of fish eggs was composed of two distinct substances; one oily and the other soft and non fusible (viscous matter); the oily matter was composed of olein and margarine and did not contain sulfur or phosphorus; (6) the viscous matter was a complex body composed of lecithin and cerebrin, the same as egg yolk; (7) lecithin was a phosphorated neutral body, decomposed by mineral alkalis and acids into oleic, margaric, and glycerophosphoric acids; (8) cerebrine was a neutral substance containing nitrogen, which melted at high temperature and swelled like starch in water; and (9) the coloring matter of the eggs of carp consisted of two bodies, a red colorant similar to that of blood and a yellow one similar to that of bile (Gobley, 1850b). Gobley also showed that the sperm of fish contained the same substances as the egg yolk of chicken and the eggs of carp, although in different proportion (Gobley, 1851).

Fatty matter of blood

Knowledge of the composition of blood was considered to be the only serious physiological information for understanding the mode of nutrition of the different animal organs as well as clarifying the mechanism of secretions. A critical unanswered question asked if the substances that provoked these two physiological functions arrived at the organ already synthesized or were prepared within it. Among the constituent elements of the blood, the fatty matters appeared to Gobley to require fresh examination. This was a very difficult project because blood contained a very small amount of fatty matter, about 3 to 4 in 1000 parts, hence the need to procure large amounts of the fluid. Gobley had, consequently, to obtain large quantities of this liquid. The physicians Jean Cruveilhier (1791-1874), Pierre François Olive Rayer (1793- 1867), and Paul Briquet (1796-1881) kindly placed at his disposal all the blood he requested (Gobley, 1852).

The information available in the literature was conflicting. For example, Berzelius had analyzed the blood of ox and found that under the action of alcohol of ether, its fibrin decomposed suddenly forming an adipowax soluble in alcohol and which did not seem to be part of the fibrin (Berzelius, 1813). Michel Eugène Chevreul (1786-1889) rejected this findings claiming that this adipowax was a real component of blood, which did not form under the action of alcohol, ether, nitric acid, HCl, or KOH (Chevreul, 1813). Afterwards, Chevreul proved the fatty matter of fibrin was a crystallizable substance, without acid or basic properties, emulsifying with water, containing phosphorous, and able to form ammonia derivatives (Chevreul, 1823). In 1831 Louis René Lecanu (1800-1871) confirmed that blood contained a phosphorated substance but also a fatty material, which became acid under the influence of KOH (Lecanu, 1831).31 In 1833 Berzelius reported the fatty material contained in fibrin was very soluble, colored red litmus paper, did not contain phosphorus, and was composed of fatty acids (Berzelius, 1833). In the same year Félix Henri Boudet (1806-1878) reported that dry serum blood contained phosphorated crystallizable fat and that blood contained cholesterol, a sodium soap, an a new principle that he named serolin (Boudet, 1833).

Gobley remarked that a fundamental condition for performing appropriate experiments was to operate on perfectly fresh blood, for it is known that this fluid changed rapidly on standing. Thus he collected the blood on leaving the vein of the animal into a flask containing rectified ether, and he added ether until no more fatty matter was separated. The ethereal extract was distilled to eliminate the solvent. The yellow fatty residue of this stage was found to contain combined phosphorus, cholesterol, lecithin, cerebrin, and traces of olein, and margarine 1 The residue of the first extraction yielded upon drying, fibrin and serum. Afterwards, Gobley subjected each fraction to a series of treatments to separate their components, and from the results reached the following conclusions: (1) blood did not contain free or combined fatty acids; (2) Boudet's serolin was a complex body whose existence as a proximate principle could not be admitted; it probably was a mixture of mixture of fat, cholesterol, and albumen (3) the composition of the fatty matter of the blood was simpler than was supposed; it was formed of olein, margarine, cholesterol, lecithin, and cerebrine; (4) cholesterol was the only crystallizable substance of the fat of the blood and its properties and composition were analogous to the cholesterol of the yolk and of biliary calculi; (5) the sulfurized matter or lecithin was not crystallizable and the products of its decomposition were oleic, margaric, and glycerophosphoric acids; (6) the cerebric matter or cerebrine possessed the properties of that found in yolk and in the eggs and soft roe of the carp; and (7) the fatty matter of the blood, when putrefying, gave with the greatest facility oleic and margaric acids. Gobley believed that his results coordinated the many papers published about the composition of blood and explained the reasons for their contradictions (Gobley, 1852).

Bile fatty components

Gobley also studied the nature of the fatty materials present in bile, then assumed to be cholesterol and fatty acids combined with sodium (Gobley, 1856b). For this purpose he conducted five experiments in which he treated fresh bile with ether, lead acetate, barium chloride, several acids (acetic, tartaric, sulfuric, and HCl), and KOH. Extraction of bile with ether and evaporation of the extract left a yellow green solid residue, having a strong odor and composed of cholesterol and small amounts of olein, margarine, and coloring matter. Treatment with lead acetate and barium chloride deposited a precipitate, which did not contain fatty material. Mixing the bile with acetic or tartaric acid did separate fatty matter, even when the liquid was heated to boiling. Addition of ether to the acid solution precipitated the same material as when no acid present. Mixing bile with diluted sulfuric acid produced no effect at room temperature, but on heating the liquor separated into two liquid phases; the lower one yellow brown, the upper one a thick and soft liquid, from which ether extracted all the fatty acids present in bile. A similar experiment with HCl produced a homogenous liquid, from which ether extracted oleic and margaric acids. Treatment with KOH produced the same results as HCl (Gobley, 1856b).

[1] Antoine-François Fourcroy (1750-1809) claimed that the formation of soaps and plasters was due to the oxidation of the oil under the influence of alkalis or metallic oxides and, consequently, had put all the oils and fats in a generic group designated as adipowax (adipocire) to be considered as species of fixed oxidized oil (Fourcroy, 1789).

These results indicated that oleic and margaric acids were not present in a free state but were the product of a decomposition; otherwise they would have been precipitated by lead acetate or barium chloride or separated by the acetic or tartaric acids. These acids probably originated from the decomposition of lecithin, a neutral substance, which Gobley had discovered in the yolk of the egg, under the influence of chemical agents, or of putrefaction (see above). To prove this assertion it was enough to show that glycerophosphoric acid or phosphoric acid were present in the product of the evaporation of bile. The first step was the elimination of all or most of the alkaline and alkaline earth phosphates present in the residue. To do so, Gobley dried bile in a water bath, then treated the residue with absolute alcohol and separated the liquid by filtration. The remaining solid was now decomposed with slightly warm diluted sulfuric acid and the resulting two liquid phases were separated. The lower aqueous phase was evaporated to dryness and treated with several reagents (sodium carbonate, acetic acid, and ferric oxide acetate) to separate the phosphoric acid as ferric sesquioxide acetate. The later represented the amount of phosphoric acid corresponding to that of the fatty acids present in bile (Gobley, 1856b).

An additional proof was the known fact that bile, abandoned to it for some days, begun to give off an unpleasant odor, and exhibited an acid reaction. Treatment of the putrefied matter with ether showed the presence of cholesterol and fatty acids, while fresh bile treated similarly, furnished only cholesterol, fatty matter, and coloring substances (Gobley, 1856b). All these results indicated that bile contained olein, margarine, cholesterol, and lecithin. Gobley also investigated what happened to these substances when the bile entered the intestinal tract. For this purpose he analyzed ox excrement and found that it contained a little amount very fats, lecithin and the products of its decomposition, proving that the fatty components had been speedily absorbed in the tract.

Gobley summarized his findings as follows: (a) oleic and margaric acids did no pre-exist in bile, as previously assumed; thy were the product of the splitting of lecithin by chemical agents or putrefaction; (b) olein, cholesterol, and lecithin were the main fatty matter components of bile and were almost totally absorbed in the intestine; and (c) an animal, deprived of the presence of these fatty substances in the bile required the ingestion of a large proportion of healthy and substantial food to compensate for such deprivation (Gobley, 1856b).

Brain

In a paper published in 1874 Gobley gave an historical review of what was known about the composition of the brain (Gobley, 1874b). For example, Louis Nicolas Vauquelin (1763-1829) had reported the presence of sulfur, water, osmazone, different salts, a red fat soluble in alcohol and a white fat soluble in boiling alcohol, both containing phosphorus (Vauquelin, 1811). Jean Pierre Couerbe (1805-1867) had reported a more detailed analysis: the brain contained (a) a pulverulent yellow fat, stéaroconote; (b) an elastic yellow fat, céranciphalote; (c) a reddish yellow oil, éléancephol, (d) the white fat of Vauquelin, cerebrate, and (e) cholesterin, cholesterote (today, cholesterol) (Couerbe, 1834). Frémy did not consider the substances separated from the brain by Couerbe to be first principles and devoted most of his efforts to analyze the fatty matter, which could be extracted with ether and alcohol (Frémy, 1840, 1841).25He found that the portion soluble in ether was formed chiefly of: (a) The white matter discovered by Vauquelin, having clear acid properties, and which Frémy called cerebric acid; (b) cholesterol, (c) a particular fatty acid, which he named oleophosphoric acid, and (d) traces of oleic, margaric and other fatty acids. Frémy also reported the analysis of cerebric acid, oleophosphoric acid, olein, cholesterol, and the fatty acids present in the brain. In addition he found that cérébrote was actually a mixture of cerebric acid, calcium cerebrate, and cerebral albumin; céphalote was not a pure substance but a mixture of calcium or sodium cerebrate with traces of albumin and oleophosphoric acid; stéaroconote was mixture of cerebral albumin with traces of the sodium or calcium cerebrates and oleophosphates, and finally, éléencéphol was a mixture of olein, oleophosphoric acid, cerebric acid, and cholesterol (Frémy, 1840, 1841) [in 1847 Gobley showed that the fatty matter present in the brain was identical with that of the yolk of the chicken egg (Gobley, 1847)].

In the following section, Gobley reported his findings about the substances he had separated from the brain, e.g. water, albuminoidal matter (albumen and cephalin), fats (cholesterol, cerebrin, and lecithin), olein and margarine, salts and extractive matter, as well as a description of the putrefaction of brain (Gobley, 1874b): (a) The cerebral matter of man contained about 80% weight of water, and two albuminoidal substances, one soluble in water and identical with albumen and the other insoluble in water, which he proposed naming cephalin; (b) the cerebral fatty matter was formed mainly of cholesterol, lecithin, and cerebrin, and traces of olein and margarine; (c) the cerebral fatty matter contained the common salts present in the organism (e.g. sodium and potassium chloride, potassium, calcium and magnesium phosphates), as well as extractive material, some of then soluble in water and alcohol, others only soluble in water; (d) during putrefaction the brain generated acid products containing oleic, margaric, glycerophosphoric, and phosphoric acids; and (e) the brain contained, approximately, by weight, water 80%, albumin 1%, cephalin 7%, cholesterol 1%, cerebrin 3%, lecithin oleic and margaric acids inositol, creatine, xanthine, etc. 5.50%, extractive matter 1.50%, and inorganic salts 1.00% (Gobley, 1874b).

Plant principles

Faham

Faham (Augraecum fragrans or Jumellea fragrans) is a parasitic orchid endemic to Mauritius, which has been valued for a long time on account of the pleasant odor, analogous to the perfume of vanilla, which develops from its leaves during the drying process. According to Gobley, the aromatic principle was easily extracted from the leaves with alcohol or ether. Decoction with boiling water extracted the aroma mixed with another slightly bitter aromatic material and a mucilaginous substance. The water extract was used as a digestive and against affection of the respiratory passages (Gobley, 1850).

Gobley developed the following procedure for separating the aromatic substance: The leaves of faham were reduced to a coarse powder, introduced into a displacement apparatus, and lixiviated with rectified alcohol. The alcoholic extract was distilled and the residue mixed with enough water to give a syrupy consistence, followed by extraction with ether. The ethereal extract was evaporated until it left a greenish and very odorous substance, from which the aromatic principle was extracted by means of boiling water. On cooling, the filtrated liquid deposited crystals, which still possessed a greenish tint. They were purified by repeated extraction with boiling water, followed by bleaching with animal charcoal. The resulting crystals were shaped as small white silky needles, or short prisms terminated with bevels, and had an aromatic odor resembling that of faham and somewhat those of bitter almonds and sweet clover. Gobley found that the crystals melted at about1200C; they were sparsely soluble in cold water and very soluble in boiling water and in ether and alcohol. He believed that the material he had separated was very similar to the coumarin found in Tonka beans (Guibourt, 1820, 1826; Boullay & Boutron Charlard, 1825), in sweet cloves (Guillimette, 1835), and in sweet scented woodruff (Kosmann, 1844). All these principles had very similar properties. The odor of coumarin was very analogous to that of the crystalline matter of the leaves of faham; both substances were sparingly soluble in cold water and dissolved easily in boiling water, from which they separated by cooling as crystalline needles. Both were soluble in all proportions in alcohol and ether but seemed to taste differently: the principle of the leaves of faham was initially bitter and then pungent while that of coumarin was extremely pungent without any slightest bitterness. The point of fusion was also quite different: 500 for coumarin and 120°C for the crystalline material of faham. Gobley decided to investigate this last phenomenon in more detail. For this purpose he isolated and crystallized the coumarin present in sweet cloves using the same procedure he had used for faham. The resulting crystals of both sources were now found to be perfectly similar; they presented a slight bitterness and fused at about 120°C. From this result he concluded that the value reported in the literature was incorrect, and the error most probably originated from the presence of traces of the fatty matter, which existed in large quantity in the Tonka bean. The slight bitterness presented by the crystalline principles of sweet clover and faham was caused by a small quantity of the bitter resinous substance existing in those vegetables (Gobley, 1850).

The last step to prove the identity of the two bodies was the analysis of crystals separated from the leaves of faham. An elemental analysis of the principle of faham indicated it contained, by weight, carbon 76.12%, hydrogen 4.12%, and oxygen, 19.76%, which compared very well with the analysis of coumarin from sweet cloves and Tonka bean reported by Étienne Ossian Henry (1798-1873): carbon 76.30%, hydrogen 3.99%, and oxygen 19.71%. Hence the crystalline proximate principles extracted the Tonka bean, sweet clover, sweet scented woodruff, and faham, were therefore one and the same body (Gobley, 1850).

Edible champignons

In 1856 Gobley reported the analysis of edible mushrooms grown in beds (Gobley, 1856a). In the introduction to his paper he wrote that these mushrooms were very advantageous as food due to their high content of albumin and nitrogenous matters, their sweet matter, fat, and salts, and the delicate tissue of their vegetable fiber. Although the botanical history of the champignon was well known, it was not so with respect to their action on the human body. The same kind of champignon, which was edible in one country, could be poisonous in another climate. Some varieties contained an acrid principle and others a poisonous principle, which was not discovered either by the taste or odor. He mentioned that the purpose of his present work was to try to identify the nature of these potentially dangerous components. Several chemists had already reported the analysis of champignons. For example, in 1811 Henri Braconnot (1780-1855) examined several edible mushrooms and found all of them contained water, fungine (the fibrous part common to all fungi), gelatin (albumin), a large amount of crystallizable sugar, adipowax,2 oil, potassium acetate and phosphate, a vegetable acid combined with potassium, an acrid principle destroyed by heat, and a free acid of the nature of vinegar (Braconnot, 1811ab, 1813). In 1813 Louis Nicolas Vauquelin (1763-1829) showed that the cultivated mushroom contained the same substances found by Braconnot in the other species (Vauquelin, 1813).

Gobley wrote that his investigations added new facts to those, which had already been published and exposed more precisely the nature of some of the bodies reported previously. In his experiments he separated and studied the different components of cultivated champignons. He cut the full mushrooms in pieces and dried them in a stove at 1100 to 1200C until there was no change in weight. The results indicated that the raw material contained 90.50% of water. Pressing the fresh mushrooms released a neutral liquid initially colored rose, which in contact

[2] Palmitic acid, $C_{16}H_{32}O_2$, was discovered in 1813 by Chevreul and named margaric acid because it formed beautiful pearly crystals. Wilhelm Heintz (1817-1880) showed that Chevreul's margaric acid was most likely composed of 10% stearic acid and 90% palmitic acid, having the same melting point, crystalline form, and properties of margaric acid.
In 1857 Heintz synthesized genuine margaric acid ($C_{17}H_{34}O_2$) (Heintz, 1847). Presently, the name margaric acid is assigned to heptadecanoic acid, $C_{17}H_{34}O_2$.

with air promptly turned black. When heated above 700C the liquor precipitated flakes having all the properties of albumin and shown to contain nitrogen and sulfur. He separated the albumin by macerating the pieces with cold water and heating the filtrate. The resulting precipitate was dried and weighted and found to correspond to 0.60% of the original material, According to Gobley this albumin gave the fresh champignon its firm consistency and generated the disagreeable odor they had during their decay. Gobley also found that the material called fungine by Braconnot was not a new principle but cellulose and corresponded to 3.20% of the weight of the fresh champignon. In addition, treatment of the aqueous extract with boiling alcohol followed by filtration and cooling of the filtrate, resulted in the precipitation of crystal shaped as needles and having a sweet taste. These crystals were found to be mannitol (Gobley, 1856a).

Gobley extracted the fatty material of the champignon with ether and dried the ethereal extract. Analysis of the residue indicated it contained oleic and margaric acids as well as an additional component, crystallizing as white scales, melting at 1390C, insoluble in water, sparingly soluble in cold or hot alcohol, completely soluble in ether, and not reacting with alkalis. All these properties indicated that it was a new material, different from adipowax, which Gobley suggested naming agaricine. Further analysis indicated that fresh mushrooms also contained a variety of inorganic salts, such as potassium phosphate and carbonate, calcium carbonate, and sodium and potassium chloride, as well as an extractive matter soluble in water and alcohol, and another soluble only in alcohol (Gobley, 1856a).

Gobley indicated that his results indicated that on the average, edible mushrooms contained, by weight, 90.50% water, 0.60% albumin, 3.20% cellulose, 0.25% olein, margarine, and agaricine, 0.35% mannitol, 3.80% of extractive matter, and 1.30% of inorganic and organic salts (Gobley, 1856a).

Vanilla

In a paper about vanilla Gobley wrote that this substance was the fruit of a climbing and branching plant (Epidendrum vanilla, Lin) of the orchid family, which grew in Mexico, Colombia and Guiana. It was particularly valued for its odorous properties and the useful medicinal action it exerted on the organism as an excitant tonic. About 30 years before, Christian Friedrich Bucholz (1770-1818) and Heinrich August von Vogel (1778-1867) had reported the first chemical examinations of the fruit: Bucholz separated from it fatty oil having a rancid and disagreeable odor, a soft resin, which when heated had a very faint odor of vanilla, a slightly bitter extract, an extractive matter quite similar to tannin, sugar, a starchy substance, and benzoic acid. Vogel thought that the aromatic substance consisted of benzoic or cinnamic acid. Gobley added that since none of the published works described or hinted about the substance(s), which produced the peculiar odor of vanilla, he had decided to try to identify it (Gobley, 1858b).

His experimental procedure was as follows: The vanilla was exhausted with distilled alcohol and the extract concentrated by evaporation. The residue was mixed with sufficient water to give it a syrupy consistence and then agitated with ether. The ethereal solution upon evaporation left a brown substance having a most powerful odor. The aromatic principle was separated with boiling water and the filtered liquid was evaporated and allowed to crystallize. The resulting colored crystals were purified by animal charcoal and successive crystallization. The isolated principle appeared as long colorless needles or four-sided prisms, having an intense aromatic odor, strongly resembling the vanilla, a warm and penetrating taste, and showing no sensible action on litmus. The crystals melted at 76°C and volatilized at 150°C, forming small needle-like white brilliant crystals having all the fragrant odor of vanilla. The principle was sparingly soluble in cold water and much soluble in boiling water. It was very soluble in alcohol, ether, and the fixed and volatile oils and it dissolved in concentrated sulfuric acid producing a yellow color solution. It also dissolved in diluted acids without alteration, and in aqueous KOH (Gobley, 1858b).

Chemical analysis indicated that it contained, by weight, 75.22% carbon, 3.98 hydrogen, and 20.80% oxygen, corresponding to the formula C20H604. According to Gobley, these properties approached those of coumarin, which he had found present in the leaves of Faham. It differed, however, in its odor, its fusing point, and its chemical composition. Hence it constituted an immediate and peculiar principle, which Gobley named vanilline (Gobley, 1858b).

The results of additional experiments led Gobley to the following conclusions: (1) Vanilla contained a crystallizable substance of a particular nature, which could not be considered an acid, and which communicated to it its particular odor; and (2) the substance which crystallizes on the surface of vanilla, known as vanille givrée, was not benzoic acid but vanilline (Gobley, 1858b).

Kava

In 1860 Gobley reported the analysis of the root of a species of pepper (Piper methysticum, Forst.) produced by a vegetable well known in most of the isles of the Southern Ocean under the name of kava, or ava. The roots, fresh or dry, had been long employed by the natives in the preparation of a drink, which before the establishment of close relations between the inhabitants of Oceania and Europe constituted the favorite beverage of these islands. The drink, prepared by simple maceration in water, caused the consumer to fall into a kind of drunkenness or excitement quite peculiar (Gobley, 1860). The crushed root had a slightly aromatic taste and odor and when chewed it was acrid, astringent, and sialagogue (it increased salivation). Heated in a stove at 1100 to 1200C it lost about 15% of its weight. Gobley made a detailed analysis of the drink and found that its approximate composition, by weight, was 15% water, 26% cellulose, 49% starch, 1% methysticin, 2% acrid and aromatic resin, 3% of extractive matter and gum, 1% of potassium chloride, and 3% of magnesia, silica, alumina, and iron oxide. This chemical composition was very similar to that of pepper, although it differed particularly in the nature of the peculiar principle it contained (methysticin). The root had an unequivocal therapeutic action: it was one of the most powerful sudorifics known, and also exercised an influence in the cure of catarrhal affections and gonorrhea (Gobley, 1860).

Figure 1: *Theodore Nicolas Gobley (1816-1878)*

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