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Authors
Hervé This

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Note de recherche

Who discovered the gluten and who discovered its production by lixiviation?

Hervé This[1,2*]

Correspondance :
Hervé This: herve.this@inra.fr
[1] *Inra-AgroParisTech International Centre for Molecular Gastronomy, F-75005, Paris, France*
[2] *UMR GENIAL, AgroParisTech, Inra, Université Paris-Saclay, 91300 Massy, France*

Abstract
The discovery of the preparation of the complex material known today as “gluten” was wrongly described in many important texts in the history of food chemistry, either because the name of the authors was misspelled or because dates were wrong. Historical data show that gluten was discovered by Jacopo Bartolomeo Beccari, in Bologna (Italy) in 1728. However the lixiviation process still used today to get gluten and the chemical characterization of this new material was performed by the physician Johannes Kesselmeyer in Strasbourg (France), in 1759. The discovery of gluten was considered as very important because both scientists thought that they had demonstrated that gluten was of “animal origin”, contrary to starch, which was thought to be of plant origin. Kesselmeyer tried to avoid this paradox of finding animal products in plants.

Keywords
gluten, Beccari, Kesselmeyer, wheat, proteins, starch

Résumé
La découverte de la préparation de la matière chimiquement complexe connue aujourd'hui sous le nom de “gluten” a fait l'objet de nombreuses descriptions erronées, soit avec des noms mal orthographiés, soit avec des dates incorrectes. Les explorations historiques montrent que le gluten fut découvert par Jacopo Bartolomeo Beccari, à Bologna (Italie) en 1728, et le procédé de préparation par lixiviation fut proposé 31 ans plus tard par Johannes Kesselmeyer, à Strasbourg (France), en 1759. Les travaux de ces deux scientifiques furent d'emblée jugés importants, parce qu'ils trouvaient une “origine animale” à cette matière, alors que l'amidon résiduel apparaissait bien d'”origine végétale”. Kesselmeyer essaya d'éviter ce paradoxe d'une matière animale dans un produit végétal.

Mots clés
gluten, Beccari, Kesselmeyer, blé, protéines, amidon

Introduction

Gluten is much discussed today, as this biological material is involved in a food disease ("celiac disease") and said to be responsible for "intolerance" (Dale *et al.*, 2018). It is a classroom experiment to extract it from wheat flour by first making a dough, and then performing lixiviation: a white powder is sedimenting in water ("starch") whereas a viscoelastic material, called gluten, remains (Belitz *et al.*, 2004).

From a chemical point of view, gluten is not a pure compound, and it is not well defined; it is a complex and variable mixture of proteins, including water insoluble glutenins and water soluble gliadins. These proteins have been important in food technology because they have been a contribution to the protein component human diet (Cavoski *et al.*, 2015), and also because they play a key role in determining the unique baking properties of wheat by conferring water absorption capacity, cohesivity, viscosity and elasticity on dough (Shewry *et al.*, 1995; Wieser, 2007).

Gluten was discussed by the French philosopher Denis Diderot (Langres, 1713 - Paris, 1784), well known to be one of the editor of the *Encyclopédie*, along with the French mathematician Jean Le Rond d'Alembert (Paris, 1717 - Paris, 1783) and others (ENCRRE, 2018). Being also a writer, there is no surprise that, because he collected so much scientific, technological and technical materials, he could also produce texts for articles and books outside the main body of the *Encyclopédie*.

In particular, he wrote a text entitled *Elements de physiologie* (Diderot, 2004), that was only published after his death, in which it is explained that the separation of starch and gluten was first performed "*by Jaccopo Beccari in Bologna (Italy) and by Kessel and Meyer, in Strasbourg (France)*[1]

The editor of Diderot's text (Paolo Quintili) added information. First, he recalled that Giacomo Bartolomeo Beccari (Bologna, 1682 - Bologna, 1766) (Figure 1), physician and chemist, was the author of *Prolegomena Institutionum medicarum, Bononiae (Beccari, 1758)* and also of *De quam plurimis phosphoris nunc primum detectis commentarius, Bononiae* (Beccari, 1757). Let us observe that the name "Giacomo", different from "Jacopo", was used as early as 1776 (Pini, 1940). According to him, gluten was discovered in 1742, and exposed in the *Memorie dell'Accademia di Bologna*, but no further reference is given.

About Kessel, it is added that this man was "*the physician Christoph Heinrich Kessel, editor of the book by Kaspar Neumann (1683-1737), professor of chemistry and member of the Academy of sciences and literature of Berlin*", giving the reference *Chymiae medicae dogmatico-experimentalis tomi primi pars prima (tomi quarti pars secunda, etc.)*, published by Dr Christoph Heinrich Kessel, 10 vol, Züllichau, 1749-1755.

About Meyer, the editor of Diderot's text is less "sure", as a footnote is given: "*Diderot is perhaps speaking of Johann Friedrich Meyer (1705-1765), pharmacist in Osnabrück, author of the* Essais de chymie, sur la chaux vive, la matière élastique et électrique, le feu et l'acide universel primitif, avec un supplément sur les éléments*, traduit de l'allemand par M. P. F. Dreux, Paris, 1766 (*Chymische Versuche*, 1ed allemande, Hanover-Leipzig, 1764).*"

These information have to be discussed, because the French chemist Louis Joseph Gay-Lusssac (Saint-Léonard-de-Noblat, 1778-Paris, 1850), in his famous and once widely used textbook of chemistry, gave a different information:

"*Beccaria, Italian chemist, discovered gluten by massaging wheat flour under water: starch flows away with water, and a viscous and elastic substance remains: it is gluten. [...] Alcohol separates it in two parts: it dissolves one, and the other got particular names that were not kept. The matter that alcohol does not dissolve has the same properties as albumin; the matter that is dissolved has the properties of gluten, i.e. viscosity and elasticity*" [1].

1 In all this article, we keep the spelling of the original texts quoted. Moreover, the original texts of all historical exerpts is given in end notes.

"Albumin" is the old name of "proteins", a term that was used for the first time in 1838 (Mulder, 1838).

Another source of confusion is the *Récréations physiques, économiques et chimisques*, by Johann Georg Model (Rothenburg ob der Tauber, 1711 – Saint-Pétersbourg, 1775), translated from German by Antoine Augustin Parmentier (Montdidier, 1737-Paris, 1813) in 1774, because it indicated: [2]

"*The famous Beccari, from the Bologna Institute, investigated the nature and the properties of nourishing matters, and he focused on the most common and ordinary food ingredients used by his people, i.e. wheat. This Physician was the first who observed that the flour of this grain was made of two different parts of which he established the main properties; & as his opinion was adopted by the Chemists of all countries, I think that it is necessary to give detailed historical report of this discovery at the time when it was done, & adding the description of the new ideas added since. M. Beccari, convinced that the knowledge of food ingredients was very useful to physicians, explored as a physicist the flour of wheat, in which he discovered two different materials, that he named animal, or glutinous material, and starchy, or plant material. He communicated immediately his observations & the result of his experiments to the Academy of Bologna, in a long memoir that can be found in the* Commentarium Bononiense*, tom. I, first part, page 122.*

«Here is the method proposed by M. Beccari, in order to separate the two substances. He took a certain quantity of wheat flour poorly ground, & put it in very pure water: water dissolved all the parts that it could dissolve or suspend, then he put the remaining material on a sieve, & what remained after rubbing between the hands made a sticky coherent material, insoluble in water, & that can become a glue that can be used in various uses: the water was first milky, but it became clear, when a white sediment deposited, i.e. a true starch.

"M. Beccari recalled the differences that Chemists admit generally between plant products and animal products, i.e. the first one give acids, and the second give a volatile alkali; this led him to propose that the starchy part has all characters of a plant substance, whereas the glutinous part looks so much like an animal material that if one did not know that it was obtained from wheat, it would be impossible to imagine that it does not come from the animal realm. [...] This discovery by M. Beccari, was very interesting for Physics & Medicine, but it remained forgotten for long; only seventeen years later was it the topic of a Ph. D dissertatio in Strasbourg by M. Kessel-Meyer, under the title: Dissertatio inauguralis

Figure 1: Jacopo Bartolomeo Beccari (Bologna, 1682–Bologna, 1766), as reproduced in the book by Ulysse Roy (Roy, 1862). The books contains historical mistakes.

Medica de quorumdam vegetabilium principio nutriente*."*

About this text, it can be added that Model was a professor of pharmacy and political economy in St. Petersburg, Russia, who published memoirs on borax, common salt, Persian salt (native soda), salt ammoniac, turf, coal, mineral resin, rhubarb, camphor, ergot, brandy, Dippel's oil, etc. His 32 dissertations and letters were translated in French with some changes by Parmentier, who added an introduction and supplemented each dissertation with his own extensive observations and additions. The added material frequently occupies more space than the original article. Anyway in this text, the two different authors Kessel and Meyer proposed by Diderot became a unique "Kessel-Meyer".

Indeed what was the name of the discoverer of gluten: Beccari or Beccaria ? And who introduced lixiviation for producing it: was it Kessel and Meyer, or Kessel-Meyer?

About Beccari, the question is easily solved: the original memoir is in Latin, and the name is "Beccarius". However, for the second question, one does not find any dissertation from any Kessel-Meyer in Strasbourg University, and no scientific publication on gluten by Kessel and Meyer can be found either.

Whereas Thomas Burr Osborne did not quote any contribution by Kessel-Meyer or by Kessel and Meyer in this text on proteins of the wheat kernel (Osborne, 1907), "Kessel-Meyer" is discussed in a later text, published in 1909: "*Kessel-Meyer in 1759 was the next (after Beccari) to call attention to gluten and gave a brief description of its preparation and of experiments to determine the action of various solvents upon it*" and cited the corresponding dissertation (*de quorundam vegebilium principio nutriente*)" (Osborne, 1909). It should be added that there is a spelling mistake about the name of this "Kessel-Meyer" in the references of this 1909 text: the name is written "Kessel-Mkyer".

Because there were so many uncertainties about such an important material, a closer study of historical sources was decided.

Looking for Kesselmeyer

More thorough investigation, using the title of the dissertation given by Model leads indeed to a Ph. D. in Strasbourg University, in April 1759 by a certain Johannes Kesselmayer... or Kesselmeyer. Depending on sources, the defense was the 7th or the 8th of April. Finally, two copies of the dissertation were found in university libraries (Strasbourg University and Paris University of Medicine) with the title given by Model and Parmentier: one was in a book entitled *Viro Illustro*, by Spielmann (Spielmann, 1759), including four dissertations, among which one by "Kesselmayer", the 8th of April 1759, but the real dissertation is a in-4, published the 7th of April 1759, under the name Kesselmeyer (Kesselmeyer, 1759) (Figure 2). We shall now assume that the man who published himself his own work (in Latin) knew better how to spell his name, as well as the date of the publication of his dissertation, i.e. the 7th of April 1759.

Before examining the content of the publications by Beccari and Kesselmeyer, however, it is useful to add that both texts were translated from Latin to French by a French pharmacist Ulysse Roy, in 1862, in a commercial booklet promoting granulated gluten that Roy's company was selling (Poitiers, France) (Figure 3). This translation contains some mistakes, and it does not include any scientific reference. For the 1745 text by Beccari, a better translation was given in 2007 by Borghi *et al.* (Borghi *et al.*, 2007).

In order to understand better the respective contributions of Beccari and Kesselmeyer, let us now consider part of the Beccari memoir, of which is is often said that it was published in 1742, but for which it was shown that it was the text of an adress in 1728 (Borghi *et al.*, 2017): [3]

"*But let's come back to wheat, to which I referred previously. Recently I kneaded wheat flour and I was using a unusual method, albeit easy and known to many; this work led me to observe in flour two different parts, with properties so different that they could appear from entirely heterogeneous bodies, and not from a single*

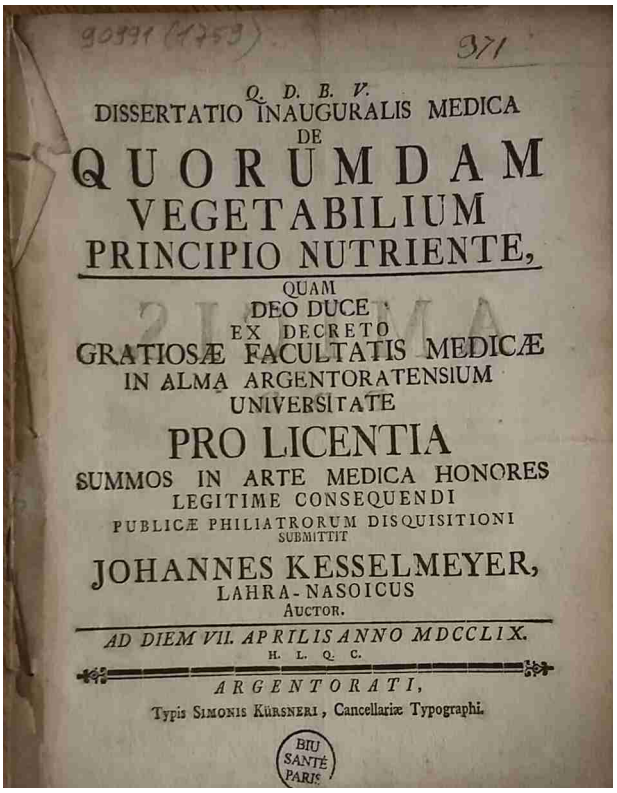
Q. D. B. V.
DISSERTATIO INAUGURALIS MEDICA
DE
QUORUMDAM
VEGETABILIUM
PRINCIPIO NUTRIENTE,
QUAM
DEO DUCE
EX DECRETO
GRATIOSÆ FACULTATIS MEDICÆ
IN ALMA ARGENTORATENSIUM
UNIVERSITATE
PRO LICENTIA
SUMMOS IN ARTE MEDICA HONORES
LEGITIME CONSEQUENDI
PUBLICÆ PHILIATRORUM DISQUISITIONI
SUBMITTIT
JOHANNES KESSELMEYER,
LAHRA-NASOICUS
AUCTOR.
AD DIEM VII. APRILIS ANNO MDCCLIX.
H. L. Q. C.
ARGENTORATI,
Typis SIMONIS KÜRSNERI, Cancellariæ Typographi.

Figure 2: The cover of Kesselmeyer's dissertation (copy in the library of the Faculty of Medicine of Paris).

one, as it seemed at first sight. I don't know any author who discussed about wheat and distinguished these parts. How is it however that, among so many authors, I was the first to make this observation? [...] Let us begin by the separation of these parts present in wheat flour. It does not call for much time or work.

" Wheat has to be of very good quality; one grinds it in a proper manner, so that the sieve separates entirely flour from bran; in this way one cannot suspect later any mixture. After this process is carefully performed, the flour is put in very pure water and kneaded; and then it is washed carefully. During the washing process, water takes out all parts that it can detach, and a material remains. This material is a compact and soft matter of a remarkable consistency, making a glue that could be used for various uses. Let us observe, moreover, that it is not soluble in water.

"The other parts swim for some time in the liquid, giving a milky appearance, but soon they sediment and gather at the bottom of the vessel, without having as coherence as the first matter; they look like a powder always ready to move to the surface; nothing looks more like starch; these parts are even a real starch, as close as vulgar starch as the one that was prepared by a long maceration, and that remains today prepared in this way after long time and work. As it will be needed to designate the two different parts, we shall call them respectively glutinous and amylaceous matters. [...] I observed between these parts such a difference that any one would not know the origin of the matters would attribute one to the animal realm, and the other to the plant realm, which is indeed the real truth. In order to know well the difference between the two realms, one has to consider carefully the decomposition of both.

"This decomposition can be obtained by two kinds of heat, one milder but longer, and the other more intense and as would be needed by distillation; each of the two processes will give very different results. Indeed if heat is mild, animal parts will never enter in a true fermentation but they will instead putrefy. Plant parts, on the contrary, will ferment, and without any other process, they will never spoil."

In this extract, it can be observed that the description of the process for separating gluten and starch is not clear, and this is probably why Kesselmeyer described it in more details: [4]

"*IV. Grains, and in particular wheat, being the most common food that we get from plants, I wanted to begin my researches by them; and as the famous Beccari is reporting about them* (Comm Bonon., *tom 1, par 1, page 122) a remarkable phenomenon, I had, from his instructions, to do my experiments from wheat flour.*

"I took three pounds of wheat flour, called similago, from which I separated carefully all bran; then using water, I made a dough on which I poured again water until it stopped having a white color. In this way flour lost all the parts that water could extract. After this process, I got one

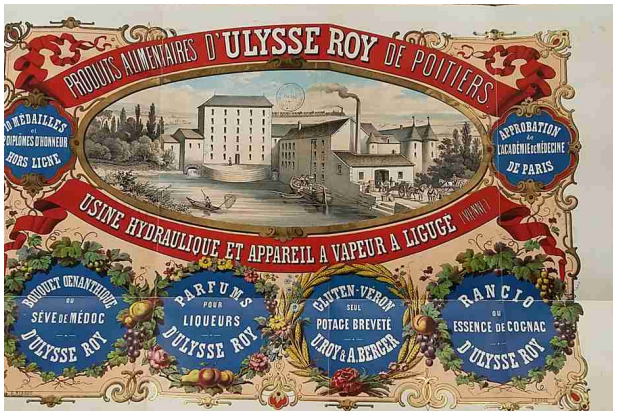

Figure 3: The commercial document published by the pharmacist and gluten maker Ulysse Roy (Poitiers, France, published by the author's company).

pound of a substance very strong, slightly yellow in color, almost odorless and tasteless, not easily destroyed by the teeth, and attaching firmly to hands when they were not wet [note : By repeating my experiments, I discovered that this substance that resists to water remains in constant proportions for various flours of the same quality, and its quantity decreases if the wheat is of lower quality. Wheat flour produced after the rainy weather of the year 1758 produces only on fourth of its weight in glutinous substance...]
"In the water that got the milky color from flour a very white mass deposited after some time, and this mass, as long as it remained under water, could never been reduced into a solid and coherent body; but at the slightest motion it dispersed in the liquid; and by drying using low heat, it gave a true starch.
"V. The famous Beccari was the first to separate from wheat the two substances that I discussed. He exposed his experiment to the Academy of Bologna, that published it in its Commentaries C. I. *This great man adds that the separation of the substances is easy; but I doubt that following the method of the famous author one could easily obtain his results; for me, at least, I confess that before discovering the method that I gave at part IV, I lost much time and flour. The famous Beccari decided to give to the insoluble part the name glutinous material, and amylaceous to the other; we have no reason to stop using such names.*
"VI . I did my best to explain the nature of the two substances that can be separated from wheat, because, at the exception of the famous Beccari, nobody discussed the glutinous substance; many considered the amylaceous substance, but they did not treat it correctly. I shall speak first of the experiments that I did on the amylaceous substance; then I shall give my discoveries on the glutinous substance.

In his dissertation, Kesselmeyer reported a lot of experiments with gluten, including distillation, dissolution with acids (including vinegar, nitric acid, sulfuric acid), alkalis, water, ethanol, oil, egg yolk, grinding with sugar, cream of tartar… Finally, he agreed with Beccari that this material is of "animal" origin, contrary to starch, which is from "plant" origin, because he was using the same kind of chemical characterization as the Italian chemist. In particular, the production of ammonia by fermentation and the change of color of "violet syrups" (at that time used as *pH* indicator), both due to the abundance of nitrogen in proteins, seemed a characteristic reaction of animal tissues, at a time when "plant proteins" were still unknown (Fourcroy, 1792).
This issue of an animal origin of a compound found in plants was so important that the discovery of "plant albumins" was considered later by Fourcroy as an important discovery (Fourcroy, 1795). The two animal and plant realms were considered separate, as were the inanimate and animate kingdoms, which explains why the synthesis of urea by the German chemist Friedrich Wöhler (Eschersheim, 1800 – Göttingen, 1882) was a big scientific event in 1828 (Wöhler, 1828).
This last observation explains why the end of Kesselmeyer's report was probably so important for him:

"After having done these observations on the relationship between the glutinous substance with the various menstrues, I tried new experiments in order to discover how the substance is produced. To this end, I dissolved the substance in vinegar, then I added water in

order to observe a slow thickening of the solution; I obtained a substance very similar to mucilage. By repeating many times the experiments, I observed, depending on the proportions of vinegar, the production of various mucilages. After drying this mucilaginous matter, I realized with as much joy as admiration that it was transformed in this other substance from wheat that we called amylaceous".

Here, demonstrating that finally "animal products" could be transformed into "plant products" was for him, as well as for his readers, of the utmost scientific significance. Anyway the real turmoil appeared later, in 1792, with the discovery of "plant albumins", by the French pharmacist Antoine François de Fourcroy (Paris, 1755-Paris, 1809) (Fourcroy, 1792).

Conclusion

Finally, one can be surprised to observe that the word "gluten" is still used today, in spite of the fact that this material is not well defined chemically: it is made of many different proteins, such as glutenins and gliadins as showed first in 1907 Thomas Burr Osborne (Osborne, 1907) in his work entitled *The proteins of wheat kernel.* The chemical composition of gluten can change depending on the kind of wheat, the year of cultivation and even the milling process. The development of the chemistry of food ingredients makes all the more surprising the sentence at the very beginning of the memoir by Beccari: [5]

"Ancient and modern Physicians published, on all what is used as man's nourishment, texts so smart and so numerous that it seems that no other research is needed".

This had an echo in 1894 when the physicist Albert A. Michelson (Strzelno, 1852 – Pasadena, 1931) stated: "*It seems probable that most of the grand underlying principles have been firmly established*" (Horgan, 1997). Knowing the development of sciences in the 20th and 21srt centuries, such a statement is really strange from someone who was famous for his measurement of the velocity of light and became in 1807 the first American to win a Nobel prize in science. Indeed, sciences of nature have no end, because their goal is to refute theories, not to "demonstrate" insufficient theories that are available at a certain time (Popper, 1994).

Textes originaux :

1. " Beccaria, chimiste italien, a découvert le glu-ten en malaxant sous un filet d'eau de la pâte de farine de froment : l'eau entraîne l'amidon, et il reste une substance visqueuse et élastique : c'est le gluten. [...] L'alcool la sépare en deux parties : il en dissout une, et il en reste une autre, à laquelle on avait donné des noms particuliers qui n'ont pas été adoptés. La matière que l'alcool ne dissout pas a les propriétés de l'albumine ; celle qui s'y dissout se présente avec les propriétés du gluten, c'est-à-dire la viscosité, l'élasticité".

2. "Le célèbre Beccari, de l'Institut de Bologne ayant recherché la nature & les propriétés des matières nourissantes, il s'est exercé particulièrement sur l'aliment le plus commun & le plus ordinaire à ses compatriotes, je veux dire le froment. Ce Médecin fut le premier qui s'aperçut que la farine de ce grain étoit composée de deux parties essentiellement différentes dont il a établi les caractères principaux ; & comme son opinion a été adoptée par les Chimistes de toutes les nations, je crois qu'il est nécessaire de donner un détail historique de cette découverte, en remontant à l'époque où elle a été faite, & en traçant en même temps le tableau des choses nouvelles qu'on y a ajoutées depuis. M. Beccari, persuadé que la connoissance des alimens est extrêmement nécessaire à un Médecin, n'a pas dédaigné d'examiner en Physicien, la farine de froment, dans laquelle il a rencontré deux matières distinctes qu'il a désignées, l'une sous le nom de substance animale ou glutineuse, l'autre amidonnée ou végétale. Il fit part aussitôt de ses observations & de ses expériences à l'Académie de Bologne, dans un Mémoire fort

étendu qu'on trouve dans le Commentarium Bononiense*, tom. I, première partie, page 122. "Voici d'abord la méthode que propose M. Beccari, pour avoir à part, les deux substances. Il a pris une certaine quantité de farine de froment médiocrement moulue, & l'a délayée ensuite dans de l'eau très pure : celle-ci s'est chargée de toutes les parties qu'elle pouvoit dissoudre ou suspendre, puis il la passa à travers un tamis, & ce qui est resté par dessus ayant été frotté entre les mains, présenta une masse colante, tenance, insoluble à l'eau, & qui peut devenir une espèce de colle propre à être employée avec avantage pour différens ouvrages : l'eau qui étoit laiteuse s'est bientôt éclaircie en déposant à la partie inférieure du vaisseau, un sédiment blanc qui est un véritable amidon.*
"M. Beccari après avoir exposé les différences que les Chimistes admettent ordinairement entre les produits des végétaux & des animaux, prouve qu'elles se réduisent à peu près à ce que les premiers fournissent de l'acide, & les seconds de l'alkali volatil ; ce qui le porte à avancer que la partie amidonnée a tous les caractères d'une substance végétale, tandis que la glutineuse au contraire a une analogie si forte avec les matières animales, que si l'on ne savoit pas qu'on la retire du froment, on ne pourroit pas se dispenser de la prendre pour une production du règne animal. [...] Cette découverte de M. Beccari, quoique très intéressante pour la Physique & la Médecine, demeura longtemps dans une sorte d'oubli : puisque ce n'est que dix-sept ans après qu'elle devint l'objet d'une Thèse soutenue à Strasbourg par M. Kessel-Meyer, dont le titre est : Dissertatio inauguralis Medica de quorumdam vegetabilium principio nutriente*."*

3. *"Mais revenons au froment, dont je faisais mention tout à l'heure. Je pétrissais, il n'y a pas longtemps encore, de la farine de froment, et j'employais une méthode inaccoutumée, quoique facile, et connue de beaucoup de personnes ; ce travail me fit découvrir dans la farine deux parties distinctes par leur nature, avec des propriétés si différentes qu'elles eussent paru extraites de corps entièrement hétérogènes et non d'un corps simple et unique, comme il semblait au premier aspect. Je ne connais aucun auteur qui ait parlé de ces parties du froment en détail et en les distinguant. D'où vient cependant que, parmi tant d'écrivains, j'ai abordé le premier cette question ? [...] Commençons par la séparation de ces parties que renferme la farine de froment. Il ne faut pour cela, comme je viens de le dire, ni un temps considérable, ni beaucoup d'artifice ou de travail.*
" Le froment doit être de très-bonne qualité ; on le broie d'une manière convenable, afin que le tamis le dégage entièrement du son : de cette manière on ne pourra soupçonner aucun mélange. Cette opération faite avec soin, on mêle la farine dans une eau très-pure et on la pétrit ; il ne reste plus alors qu'à laver soigneusement. Dans ce lavage, l'eau enlève toutes les parties qu'elle peut détacher, les entraîne avec elle et laisse les autres intactes. Celles-ci forment peu à peu une masse compacte, molle sans doute, mais d'une consistance remarquable, et qui fournit une colle très-propre à différents usages. Remarquons en outre qu'il ne serait plus possible de la dissoudre dans l'eau.
"Quant aux autres parties, elles nagent quelque temps confondues avec le liquide, qui ressemble alors à du lait, mais bientôt elles descendent et se rassemblent au fond du vase, sans avoir toutefois la même force de cohésion que les premières ; elles ressemblent à une poudre toujours prête à s'élever confusément à la surface de l'eau : rien n'a plus d'affinité avec l'amidon ; ces parties sont même un véritable amidon qui ne le cède point à l'amidon vulgaire, celui que les anciens préparaient par une si longue macération, et qui de nos jours ne coûte guère moins de temps et de travail. Comme il sera besoin, dans la suite, de désigner ces parties distinctes, nous donnerons aux premières pour plus de clarté, le nom de glutineuses, et aux autres celui d'amylacées. [...] J'ai remarqué, entre ces parties, une telle différence, que quiconque n'en connaîtra point l'origine attribuera certainement les unes au genre animal et les autres au genre végétal, ce qui est, en effet, l'exacte vérité. Pour bien connaître la différence qui existe entre les deux

genres, il faut se rendre bien compte de la décomposition de chacun d'eux.
"Cette décomposition peut s'obtenir par deux sortes de chaleur, l'une plus douce, mais prolongée plus longtemps, l'autre plus intense et telle que l'exige la distillation : chacun de ces deux procédés donnera des résultats bien différents. En effet, si la chaleur est douce, les parties animales ne seront jamais amenées à une fermentation véritable et proprement dite, mais tomberont toujours en putréfaction. Les parties végétales, au contraire, prendront d'elles-mêmes un mouvement de fermentation, de sorte que sans un procédé particulier, elles ne seront jamais réduites en pourriture."

4. *"IV. Les céréales et en particulier le froment, étant la nourriture la plus habituelle que nous fournissent les végétaux, j'ai voulu commencer par elles mes recherches ; et comme le célèbre Beccari rapporte à ce sujet (*Comm Bonon.*, tom 1, par 1, page 122) un phénomène remarquable j'ai dû, d'après ses instructions, faire mes expériences sur la farine de froment.*
" Je pris trois livres de farine de froment, appelée similago, dont je fis disparaître soigneusement tout le son ; puis avec de l'eau, j'en fis une pâte sur laquelle j'en versai encore à diverses reprises, jusqu'à ce que cette eau cessat de prendre une teinte blanchâtre. La farine perdit ainsi toutes les parties que l'eau put enlever. Après cette opération, il resta une livre d'une substance extrêmement tenace, de couleur un peu jaunâtre, presque sans odeur ni saveur, insoluble dans la bouche, peu soluble aux dents, et s'attachant fortement aux mains, lorsqu'elles n'étaient point humides [note : En réitérant mes expériences, j'ai découvert que cette substance inaltérable à l'eau demeure dans une proportion constante pour les farines de même qualité, et qu'elle diminue si le froment est de qualité inférieure. La farine du froment qui eut à subir les temps pluvieux de l'année 1758, ne fournit en substance glutineuse que le quart de son poids...]
"L'eau qui avait reçu de la farine une couleur de lait, déposa quelque temps après au fond du vase une masse très-blanche qui, tant qu'elle demeura sous l'eau, ne put jamais être réduite en un corps solide et consistant ; mais à la plus légère agitation, elle se dispersa dans le liquide; et, en la desséchant au moyen d'une chaleur douce, elle donna un véritable amidon.
" V. Le premier, l'illustre Beccari, sépara du froment les deux substances dont j'ai parlé. Il exposa son expérience devant l'Académie de Bologne, qui l'inséra dans ses Commentaires C. I. *Ce grand homme ajoute que la séparation de ces substances exige peu de travail ; mais je doute qu'en suivant simplement la méthode de l'illustre observateur on arrive facilement à son but ; pour moi, du moins, j'avoue sincèrement qu'avant d'avoir découvert la méthode que j'ai exposée au par. IV, j'ai perdu beaucoup de temps et de farine. [Il plut au célèbre Beccari de donner à la substance qui n'est point soluble dans l'eau le nom de glutineuse, et à l'autre celui d'amylacée ; nous n'avons aucun motif de nous écarter de ces dénominations."*

5. "Les Médecins, anciens et modernes ont laissé, sur tout ce qui sert à la nourriture de l'homme, des ouvrages si judicieux, et en si grand nombre, qu'il semble n'y avoir plus lieu à faire de nouvelles recherches."

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Edité par
Françoise Corbineau, Membre de l'Académie d'agriculture de France, Professeur à Sorbonne Université, Université Pierre et Marie Curie-Paris 6, UMR7622 CNRS-UPMC Biologie du Développement, Equipe Biologie des semences.

Rapporteurs
Jean-Claude Pernollet, membre de l'Académie d'agriculture de France, directeur de recherches honoraires à l'Inra.

Didier Marion, directeur de recherches à l'Inra, Unité Biopolymères Interactions Assemblages, INRA Nantes.

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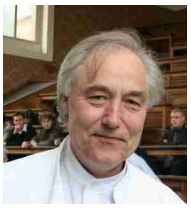

Hervé This, physico-chimiste dans le Groupe Inra de gastronomie moléculaire, à AgroParisTech. Il est membre de l'Académie d'agriculture de France.