Parma State Archives
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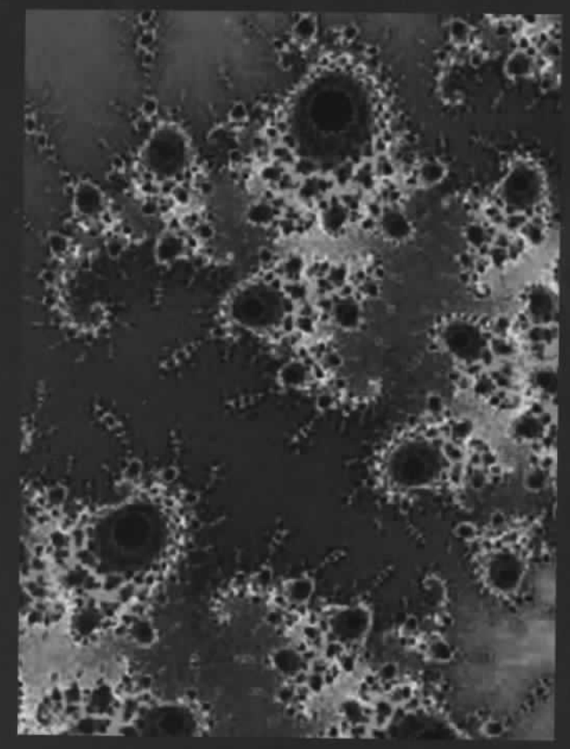

ARCHIVAL PASTA

The Science and History of the Oldest Sample of Pasta (1837-1838)

PARMA STATE ARCHIVES
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The Science and History of the Oldest Sample of Pasta (1837-1838)

PARMA 2000

UNIVERSITÀ DEGLI STUDI
DI PARMA

The work documented in this volume was authorized by the Ministry of Culture Patrimony and Cultural Activities, Central Office, Archival Patrimony, div. II, with no impediments for the use of the pasta sample for analyses on 11 March 98, prot. 2.2262.

Cover: a mathematical fractal which simulates the internal structure of pasta.

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PREMISE

The Barilla Group is the biggest user of Durum wheat in the world. It's our primary material par excellence: each week, we need it to supply 25 million boxes of pasta to Italian families, to allow the entire world's consumers to cook 7 billion plates a year. For us, the planning for quality can't but start in the wheat field.

The food industry, however, has evolved, and if it wishes to accept the consumer challenge, it can no longer resort exclusively to production aspects. There must be a close relationship between the worlds of production and science. There needs to be a bridge between industry and scientific research, in itself becoming ever more interdisciplinary. Science is convinced of the need for an integrated approach to the phenomena.

Today, it is of utmost importance that the food technologist is flanked by physicists, chemists, biologists, and historians; their interaction must work ever more toward the advantage for the consumer. This is why, when the Parma State Archives informed us of the discovery of a pasta sample that was so old - the oldest, as far as we can determine, we immediately thought that this would be a good forum to put this interaction to the test.

What did we discover? Nothing that we didn't already know: pasta today is made as it was 150, or even 1,000 years ago - even if there are a few small variations. Aside from the results of the research, and aside from the meaning that this finding has for the history of archive-keeping and food technology, what really matters is the method. It was a pretext for testing our most modern research instruments, for getting academics of diverse backgrounds to work with one another.

Researchers who contributed to this research are from Barilla in Parma, the Foggia Food Research Consortium and Historic Archives, the University and State Archives of Parma, and the Rome Experimental Institute for Cereal Agriculture. We would like to offer special thanks to Marzio Dall'Acqua, Director of the State Archives, who allowed us to work on the pasta samples; Marco Fontana, Director of the Department of Physics and amongst the top academics in "Gastronomic Physics"; Norberto Pogna, Acting Director of the Experimental Institute for Cereal Agriculture, who made his experience available regarding methods in molecular biology.

To impose oneself on the world with product quality, the best primary materials are not enough. One must have cutting edge production systems, invest in innovation, and - above all - always keep the culture of the product alive. This short book is the fruit of the most modern technology, but sustained by a passion for history and culture.

Guido Barilla

The following essay was written by Marzio Dall'Acqua, director of the Parma State Archives regarding aspects of archive-keeping doctrines; by Mario Palazzino, author of the section on «The Pasta Sample», and the rest of the work was done by Antonella Barazzoni, both of whom work for the Parma State Archives. The photographs in the text were taken by Giovanni Amoretti, Parma.

«...they will bear neither unpleasant odor nor taste». THE PASTA SAMPLES FROM 1837 AND 1838 FOUND IN THE PARMA STATE ARCHIVES

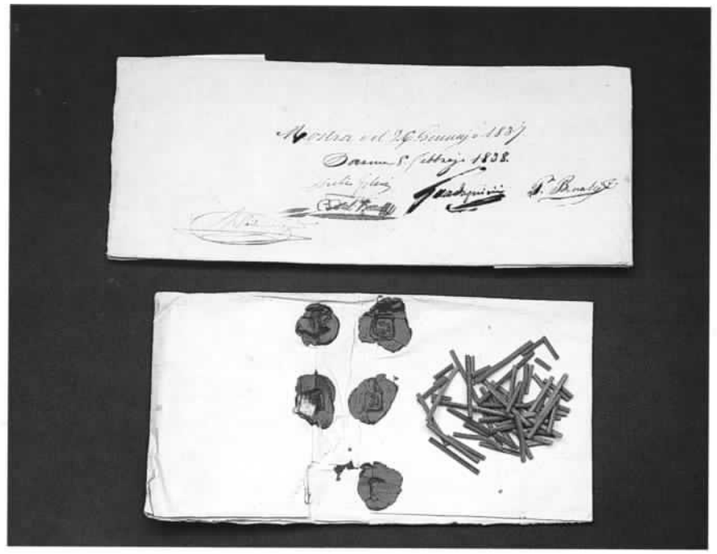
Marzio Dall'Acqua, Mario Palazzino, Antonella Barazzoni
Parma State Archives

«Despite what is sometimes believed - writes Marc Bloch - beginnings, documents, don't just show up out of nowhere because of who knows what impenetrable desire of the gods. Their presence, or their absence, in archives, a library, or in the land are due to human causes which in no way escape examination. The problems they pose in their transmission are not only an exercise for the experts, but also intimate contact with life in the past, because what is found and enters into play is none less than the passage of memory through successive generations»[1].

Still, as in this case, the intrinsic legibility of processes of learning and preservation, even centuries old, can in a heartbeat be thwarted by chance, by the imponderable, for which a fragment, a document, a scrap from the past emerges with its own force, with a peremptoriness such that it demands to be read, considered, studied to become a pointer to a path not taken before. This is what happened for these two samples of dry pasta. The older sample, from 1837, was divided into two rough paper bags typically used by grocers, and the more recent one is from the following year. Their physical evidence is accompanied by an imposing mass of paper documentation. An anomaly, and yet it both confirms and reaffirms the value of written documents.

The discovery was made during an examination and reorganization of the *Presidency* then *Department of Finances* archive section when envelope 1295 was opened. The old inventory system of these papers categorized it as *General Secretary. House of Forced Labor 1838*[2]. Amongst other files there was one relative to the *General Business for the State Prisons and the Poorhouse*, owned by Vincenzo Marinelli. Inside, there were manila envelopes that still bore the signs of red sealing wax. The envelopes contained the pasta samples, dried up over time, moving in their fragility and weightlessness. In the thin green patina, oxidation of the more than 150 years that separate them from us, there was the concrete ineludible evidence of an historic dailiness. One of Michel Foucault's students, Arlette Farge, wrote of archives as an irruption, that is, as «an attack, an incursion, a violent and unexpected invasion, entrance» of the past on our temporal dimension. It is what really «emerges, overflows, exceeds. It is a whim, a sally, a tragedy. It doesn't corroborate, doesn't summarize, doesn't smooth out anything, especially when it is about conflicts and tensions; it makes the real prickly with its inopportune jumps, from which the historian must sometimes weave a meaning, a reason, and the relationships of power»[3]. These samples of pasta burst upon us, on our present, with extreme force. Only a coincidence that the samples should have been found here where the food industry is the economic leader? Here in Parma, the place where the international imagination links us to food, a land with an industry like Barilla which summarizes and represents today an age-old tradition of pasta making. A distant event allowed these paper bags to be placed amongst other papers. They lay hidden, and now reemerge within the context of a fabric that is representative of the most important reality in

Sample of pasta presented by the supplier Vincenzo Marinelli on 30 January 1838, and not retained conformist to the public contract (Parma State Archives).



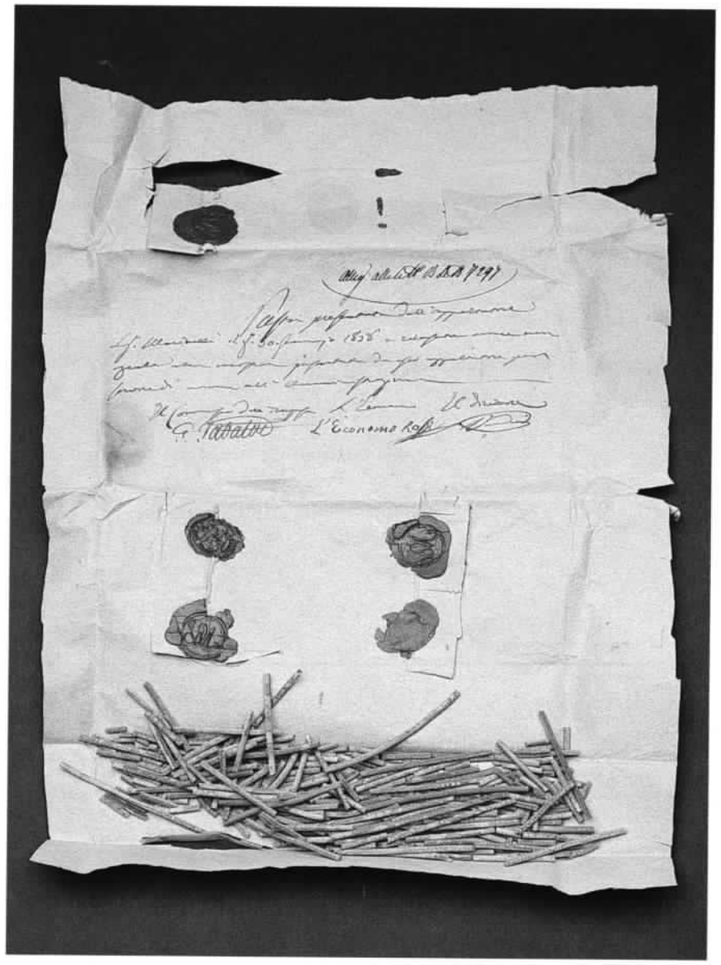
Sample from 30 January 1838 (Parma State Archives).

the food sector for Italy, once again contradicting, even if as an exception, Bloch's idea. Furthermore, these little bundles violently recall one's attention to places of punishment; prisons; sweatshops and forced labor camps; vagrant beggars who are followed, captured, and segregated; health and sickness; normality and deviation. These are themes that we still obsess about today, that have been ignored by Parmesan historiography and studies on Restoration Parma. And one can't not reponder Michel Foucault's warning about places of emargination: «A document is not the happy instrument of a history that is in of itself and in its full right memory: history is a certain way that a society has to give legal status and elaboration to a mass of documentation from which it can't separate itself»[4].

Archives, whether specific or general like the State Archives, are a place for sedimentation. It is a process that happens within a single archive, in the dailiness of the administrative action and juridical testimony emitted by an office that produces documents, but also happens in relation to an aggregate that is the social accumulation of memory itself which Foucault writes about - it is not only preservation but also concealment. Filippo Valenti was the first to underscore this aspect of sedimentation, comparable with archeological stratification, in which this historicization is determined by complex situations of use/non-use/reuse, preservation/destruction or dispersion, original order/reordering/upsetting of order. Each of these situations is significant, and is fundamental because it inserts itself in a mesh, a grid that corresponds to the precise desire of the producing entity to intervene on the construction of its own memory - self-documentation producing broken links, blackouts, discontinuities or restorations that hide concealments and oversights, crises and nuances[5]. This is the context in which objects or allusions are found in archives. They go beyond the classic concept of archive as universitas rerum as a togetherness of written memory on behalf of a producing entity for practical, administrative, or juridical purposes linked to an obligation that is called archive-keeping or historical. With time, losing its original scope, archival documentation takes on cultural tones, and becomes the base and stock of history. From one person's distraction one can thus find in archives forgotten objects amongst the papers, but also, as in this case, evidence that can have juridical value, historic crimes. All this is without even considering cultural material that often emerges when archivists do preservation of a work: strings; bindings of registers, indices, ledgers; bookmarks; or containers for documents that are unusual, precious, or in some way unique and creative despite impoverished means or materials. It is a seemingly marginal aspect of archive-keeping that is fascinating, and for the most part, still to be discovered. In some cases, such as the for Hebrew Scrolls, or the fragments of codices that are liturgical or juridical that were reused in later bindings for documents that needed to be protected, but not particularly elegantly, this type of research and recovery process has already begun[6]. A new interest has come into being for these little signs, for the survival of these clues, which extends from scribbles, to handwriting, to preservation work done privately, occasionally, or poorly[7].

The function of archives emerges as soon as one begins to reconstruct the episodes that brought someone to save the pasta samples amongst other papers and one begins to link the subtle plot of

Sample of pasta presented by the supplier Vincenzo Marinelli on 30 January 1838, and not retained conformist to the public contract (Parma State Archives).



relationships and rapports that show the history of institutions involved, and the people and their affairs. All this work is typical for the archivist and the researcher, for people who check and organize papers, and who consult them.

Thus archives regain the nature of their necessity, their meta-linguistic value, born to express operationality, and become the source for reconstructing the past for which there are traces, but that are marginal and symbolic, conditioned by writing.

This fortuitous case presented itself, thanks to available road companions such as the Parma University's Physics Department and Barilla. It went beyond the point of making the pasta samples undergo analyses with the most sophisticated and cutting edge technologies. In reality, the questions a historian poses have only multiplied, then turned back upon themselves again to other research on the documents. Thus giving a meaning to our work as archivists.

The Pasta Sample

It was the morning of Tuesday, 30 January 1838, when the delivery boy for the Vincenzo Marinelli company, like every other day, was delivering a load of pasta to the penitentiary institute's larder. On that day, though, the Treasurer and the Prison Director refused to accept the consignment because they claimed that the quality of the pasta that was supposed to be served to the «healthy» inmates didn't correspond to what was described in the accords that regulated the consignment contract. That same day, the Director, Giulio Cesare Verdelli, sent note of the happening to the president of the *Forced Labor and Corrections Institution Oversight Council*, Giulio Zileri. In the note, he attached «a sample of the pasta» that Marinelli had delivered on 25 January of the previous year «to serve as the administrative sample for the quality of that which was to be fed to the healthy inmates,» and «a display of the refused pasta»[8]. The director was following the directive of Article 7 in the *Conditions Log* relative to nutrition at the State Prison and the Poorhouse. It required him to fill out «a report of the refusal, and this and the objects refused will be subjected to consideration by the Oversight Deliberation Council»[9]. The same contract clearly specified what the quality of the pasta consigned had to be in the chapter relating to «Specific Conditions». «Article 28: Pasta for the healthy will be made from wheat flour, called Mezzana, without any mixing in of chaff, fine bran, or bran. Article 29: Pasta for the sick will be of pure wheat flour, with no straw, fine bran, or bran. Article 30: Whether for the healthy or the sick, the pasta will have neither smell nor taste unpleasant, and it will always be completely dry»[10]. The following day, the businessman, Marinelli, addressed the Oversight Council to give his version of the facts. After having sustained the good quality of the product, he invited the Council to judge, with the help of «various and technical experts» only whether the pasta conformed to the clauses in the contract, and not, as expected Verdelli, if the pasta was «similar to a sample that was sealed and sent to the director on the occasion of the contract made with the pasta maker, Casalini. To not have problems, I agreed with Casalini that his sample was of a quality superior to what was my obligation - even if sometimes Casalini supplied pasta that was inferior to the sealed sample»[11]. After only a very short period of time, Saturday, 3 February, the Oversight Council, composed of the Parma Podestà, Giulio Zileri (president); the

Ducal Attorney, Giuseppe Guadagnini; Senesio Del Bono; Pietro Benassi; and Giuseppe Didier; met to take the case under consideration and deliberated whether to consult three technical experts of the field and to adjourn for Monday the 5th to make a decision «in full knowledge of the case»[12]. In the following sitting, the experts' report was examined. All three experts were pasta makers and sellers[13]. The report determined: 1) The sample delivered in January 1837 conformed to article 28 in the contract «both for what regards the quality of the flour, and the way in which it was worked»; 2) the pasta sample refused the previous week was «of flour a bit inferior than the former as a result of the milling»? and that furthermore it hadn't been «well worked. It was made with insufficient heat when it was in the press, and thus the product was coarse. In cooking it, it dissolves more easily, and results as less pleasing to the palate»[14]. Following these declarations, the Council deliberated to approve the act taken by Director Verdelli and demanded that Marinelli supply the Prison with pasta of the same quality as that which was deposited as a sample in January 1837. The Council further ordered that the parcel of pasta be rebundled and sent along with the deliberative act to the Presidency of Finances. It was punctually done on 12 February[15].
Thus, as a result of the refused consignment and the administrative proceeding that followed, these pasta samples came down to us.

The Prison and the Poorhouse

During the years of the Restoration in the Parma Duchy, the penitentiary system was directly linked to the poorhouse and the workhouses. These institutions were organized as a result of laws and structures that were put in place during the French period. In 1810, Parma was the administrative seat of the Taro Department. Parma's prisons were spread around the city at various points: There was a House of Arrest in the Piazza, along with the Police Prisons; the criminal prisons were located at the Rocchetta and Rosario; the penal settlement was at Mulini Bassi, beyond the St. Barnaba Gate, where there was a cloth factory that used forced labor; and there was the Confinement Prison at San Francesco, where the following year a military prison was also established.
In the new reorganization of the Duchy, Mistrali was particularly tormented by financial problems and suggested that the penal settlement and the Detention Center be united. The regulation was approved 4 November 1814, but wasn't published in the *General Collection of Laws*, and still today can't be found in the archives. He further proposed that the towns be burdened with the prison expenses. The unification of the penitentiary system became effective in 1815.
The Regulation Regarding the Administrative Police Number 80, Article 23, dated 14 August 1815,[16] determined that the control of the prisons were the responsibility of the Police. On 30 June 1817, the Central Detention Center was placed under the Interior Ministry. The decree of 20 April 1821 more precisely established that the Prison Police and the custody of the prisoners were the competence of the Interior Ministry, whereas the economic administration was done by the Finances Ministry. With the decree of 8 January 1831, the Prison Police were placed under the Director of Justice, and the economic administration under the Interior. On 9 June of the same year, the situation according the regulations of the 1821 decree was reinstated. Decree Number 329 of 5 December 1846 substitutes the two ministries of Interior and Finances with three separate and distinct Departments: Grace, Justice, and Good Government; Interior; and Finances. The prisons became the responsibility of the first. Article 2, Paragraph 7 states «the Police for the prisons, the custody centers, the Forced Labor and Corrections Institution, and the Poorhouse». The economic administration was kept by the new Department of Finances.
The «fees for board, whether for the healthy or for the sick, and the wood and candles for the different locations and the hospitals» were set by the Director, Ferdinando Dupré, on 26 October 1816, and were approved in the «Reorganization of the Central Detention Center» on 12 October 1818. For the kitchen, the decree foresaw a daily supply of 98.4 kilos (12 pesi) of wood from 11 March to 15 November, and 123 kilos (15 pesi) from 16 November to 10 March. Six bundles and three bunches of matches were allowed daily.
As far as board was concerned, the daily food portions for the detainees was the same as for those in the Poorhouse: for the healthy, 650 grams (2 libras) of wheat bread, 136 grams (5 ounces) of pasta or rice, 11 grams of lard - ox head or hoof could be a substitution, whatever happened to be cheaper, 11 grams of salt (10 denari), and lastly 9 grams of oil (8 denari). For the sick, the amount foreseen was analogous to what the hospitalized at the Poorhouse received: 410 grams of bread, 136 grams of pasta or rice, 191 grams of raw meat (7 ounces), 11 grams of salt, and a liter of wine. For detainees under 6 years of age, and for those who were between 6 and 12, the quantity of bread, pasta and rice were reduced. Evidently, children too were closed up in the Parma prisons. The regulations foresaw a very detailed case situation for the sick: «To the ordinary people 4 broths will be given in which each will have an ounce of grated bread. The wine as for the severe diet. All other levels of diet will have an entire portion of broth 4, 3, or 2 times daily: the fourth will not contain meat». In the diets, the meat could be substituted with 2 eggs. Lastly, doctors could prescribe a lesser amount of food, but never more than what was established in the regulations[17].
The convicts who were allowed to work, thus not forced labor, had the possibility to improve their board with the earnings from their work[18].
Control over the prisons was held by the Oversight Council, an entity that was born out of laws enacted at the end of the 18th Century, which were adhered to in the French period and the Restoration Period as well[19].
The Oversight Council, which existed in the lesser prisons but with a lower number of members, was presided over by the podestà and was composed of the Ducal Attorney, by three members which then became five, and a secretary. The Oversight Council had to check on the condition of the locations, the registers, the legality of the detentions and the releases, the number of convicts, the board, the room, the discipline, the behavior of the personnel, the safety and security of the prisons, the complaints lodged by the prisoners, and then make relative changes. The Oversight Council also had to convene to establish the penalty for convicts guilty of attempted escapes, violent acts, or other crimes committed within the prison. It had to deliberate with a majority vote on the punishment to be inflicted as recommended by the Institute's Director. The members were nominated by Ducal Decrees and were chosen from a list of three as proposed by the appropriate office. The requirements were: reputation for morality, social extraction, status of

family, age, and above all, income. In fact, it was indispensable that the candidate not have problems of a financial nature in that checks on the running of the prison had to be carried out every day. The nominees were usually noblemen, professionals, or clerics. They often showed scarce availability, presence, or assiduity; the quorum was often not met during meetings.

Problems regarding the institutes for the poor and the indigent were directly linked to the those of the penal institutions. Ever since the era of Napoleonic domination, indigency had been considered a social plague, such that in 1809 a Poorhouse was created on Borgo San Donnino, now called Fidenza, on lands that belonged to the Jesuits and the Ursulines which were then enlarged with adjacent lands. The Poorhouse was directed by Stefano Sanvitale with the goal of employing the lazy and the unemployed in artisanal work linked to the production of goods of broad consumption. Suppressed with the Restoration, it was reopened in 1816[20].

The costs for reopening amounted to 165,000 Francs. The costs were divided up in the following manner: the arrears owed to the religious corporations for the old Poorhouse which amounted to 357,335.62 Francs were reduced to only 60,000 but had to be paid immediately; the cities of Parma and Piacenza each contributed 20,000 Francs; there was a credit balance of 4,298.84 Francs; 20,000 Francs came from charity; and finally, the Treasury contributed 20,701.16.

The decree established the prohibition of begging - the new penal code of 1820 punished the crime with three months of incarceration - and the requirement for the mendicants to present themselves for a job. Otherwise, after the arrest they would be transferred to the work halls. If they then didn't fulfill this obligation, they would be closed up in the Poorhouse which thus took on an incarcerary character. Aside from beggars, people who could also be put in the Poorhouse were children and young people who had been abandoned or who belonged to families that couldn't take care of them. The family had to pay an agreed upon sum if it wasn't completely indigent - complete indigency had to be proven. Lastly, there were the handicapped and the elderly who had no savings. As with the prisons, the Poorhouse used the healthy for artisanal work which then gave them better treatment. As with the prisons, there were strict regulations with prohibitions and heavy fines for transgressors. There were, however, differences. Whomever could prove that he had found permanent work or could be supported by relatives could be released. Beginning in 1819, there was a department that gave the detainees a rudimentary education[21]. As with the prisons, there was a unpaid Oversight Council that had to check up on the management of the institute and that the norms were respected correctly. It was composed of a magistrate and three other members; later the number increased to five. At the head of the institute for mendicants there was a director and administrator who earned 3,000 Francs a year - thus at the same level as the Directors of Police and the Prison.

Article 4 of the instituting decree established that «the product of the work done by mendicants will be given to them by two thirds, of which one third can be used if they want to improve their daily diets, and one third to create a savings which will be given to them when they leave the Poorhouse. The other third will go to the institution to reduce expenses and help maintain it». Differently from the incarcerated, the mendicant's savings went to the state and not to heirs if they died.

Though the regulations minutely describe work hours within the institution, they said nothing about eating hours whose composition was, on the other hand, well regulated by the «fee for board». The detainee's diet foresaw bread (entirely of wheat), pasta or rice, lard (or ox head or hoof), salt, and oil in the same quantities as the incarcerated. In addition, the detainees were given a quarter flask of wine. For those that worked, and for the handicapped on holidays, 136 grams (5 ounces) of raw meat were allowed,,or two eggs. The value was to be deducted from their expected earnings for work done in the plant or mill. As far as the ill were concerned, the base diet was the same as that of the incarcerated.

As far as the responsibilities of the authorities of the Poorhouse were concerned, it would be a good idea to mention some of the most important deliberations. The Poorhouse was placed under to the Interior Ministry on 30 June 1817; the economic administration remained under the responsibilities of the Finances Ministry. Registers and receipts were exempt from stamp taxes, and the locations and their attached gardens weren't subject to land taxes. From 1830 on, the Poorhouse was permanently maintained by the Treasury. The earnings of the workers were judged by the Earnings section of the State Council. Lastly, from 1837 on, the Poorhouse Fund was held by the Borgo San Donnino Tax Collector's Office. Contracts for the provision of various materials had to be assigned as a result of a public auction[22].

The general Internal Police was first entrusted to the Director of Police, then from 28 January 1831 to the Justice Department, and finally, in 1846, to the Grace, Justice, and Good Government Department. Trials for attempted escape were the competence of the civil and criminal courts in the jurisdiction in which the mendicants were arrested[23]

Vincenzo Marinelli, the pasta supplier

The Marinelli family was a family with a strong vocation for entrepreneurship in the commercial sector. The head of the dynasty was Antonio, «Fishmonger», who in 1765 at 50 years of age lived on Borgo Montassù in a house that he owned with his wife, Anna, 46; and their children Agostino, 21; Elisabetta, 17; Giuseppe, 15; and Marianna, 10[24].

Proof of the existence of his business is in a deed that was written up by the Notary, Borelli, on 11 May 1764 for the renting of a space for Fish called «Della Botte e Bresciana in Guastalla».[25]

In 1770 it was listed amongst the suppliers of fish for the College of Nobles[26].

His sons, Agostino and Giuseppe, followed in his footsteps. In 1802, it is documented that they were fish suppliers for the «His Royal Highness' Kitchen, The Infante», don Ferdinando di Borbone[27].

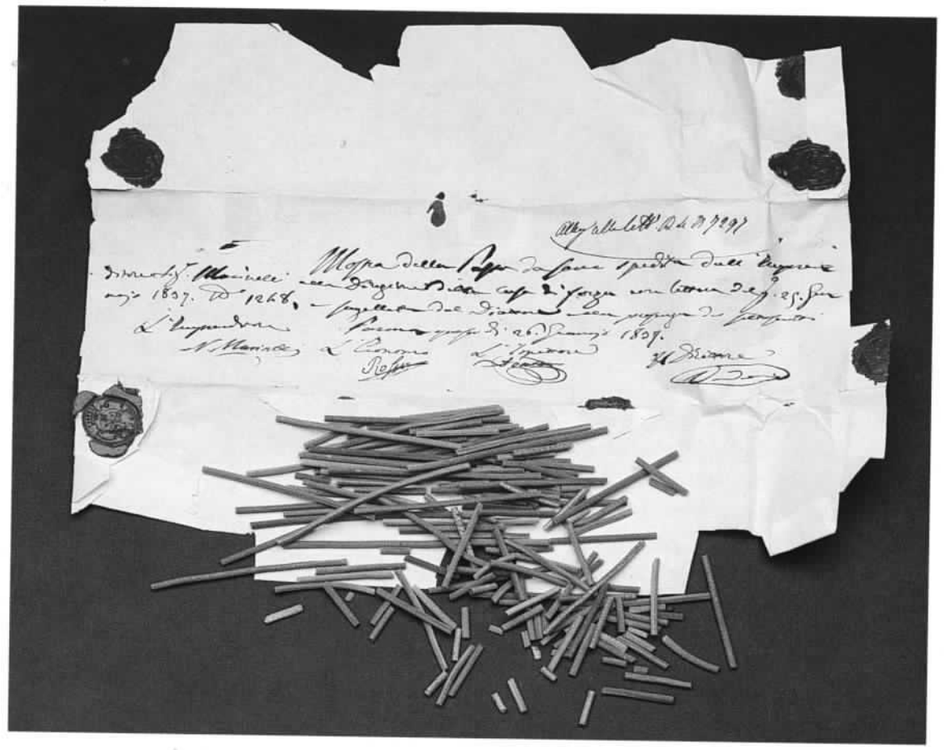
Giuseppe, who died in Casalbaroncolo on 13 October 1804, and his wife Antonia bore a son, Vincenzo Francesco Luigi Marinelli in Parma on 21 June 1782, in the family home at 16 Borgo Montassù. On October 1811, he married Maddalena Marianna Clotilde Rugarli. She was born in Parma on 18 April 1790, at 155 Strada Santa Croce to Domenico di Pietro and Luisa Montagna.

Filippo Melley, a land owner and supplier of bread for the Central Detention Center; Giacomo Gozzi; Alessandro Speciotti, a musician; and Domenico Rangoni, a shopkeeper; acted as witnesses to the marriage in 1816. Giovan Battista Bodoni signed the marriage document as the Civil State Deputy.

The couple had no children.

Maddalena Rugarli died in their house on Borgo Montassù on 16 July 1846, and Vicenzo Marinelli died at 174 Strada San Michele on 8 September 1858. The lawyer Pietro Pelleri and

Pasta samples sent to the Forced Labor and Corrections Institute by Vincenzo Marinelli on 25 January 1837(Parma State Archives)



the «cousin», Emilio Marinelli, made out the obituary[28]. Emilio was the son of the cousin Francesco Marinelli, who was the son of Agostino, brother to the father Giuseppe[29].
During the French Period, consignments to the Central Detention Center were made by several different businesses. From 1812-1813, food supplies were consigned by Angelo Fioroni and Vincenzo Cattanti[30]. When the provisional government of Magawly took power, the food supplies for the penal institution were assigned to several different businesses. From 1814 to the end of 1816 the supply contracts lasted for and were extendable for periods of six months. Pompeo Moraschi was the supplier for «Pasta for the Healthy, Pasta for the Sick, Beans, and Rice»; Filippo Melley for bread; Antonio Mori for lard, olive oil, and candles; and Pietro Bichieri for wine[31].
After a normal public bidding contract in 1817, a contract for the supplying of items necessary for the running of the Central Detention Center and the reinstituted Poorhouse including furnishings was given to the Gabriele Ravà company, in Parma at 13 Borgo della Macina; to Luigi Pellegrinelli in Parma at 18 Piazza Grande; and to Angelo Bertolini in Parma at 95 Strada San Michele[32]. Attached to the contract was the «Index for the responsibilities for the use of judging the general supplying of beds, boarding, clothing, candles, and fire to be done at the Poorhouse and the Central Detention Center». Article 8 determined that «the food will be, if necessary, examined at the moment of distribution by the directors, or by the respective members of the Administration Councils of the two centers. If they are found to be of poor quality, or poorly prepared such that they could be bad for the health of the detainees and incarcerated, they could, after deliberation by the Council, be refused. If that happened, the Supplier was required to supply more, and if this requirement was not met, then it would be up to the director to provide for the needs of that day at the expense of the Supplier»[33]. The contract was supposed to last until December 1826.

With the contract by the Notary Nicola Pellegrini on 26 April 1817, Angelo Bertolini ceded control to Vincenzo Marinelli, «shopkeeper with residence in Parma, present at this signing, who accepts for all causes and effects, the contract assigned to the Bertolini business in relation to the Judgement that was made by the Government of these Duchies to Messieurs Gabriele Ravà, Luigi Pellegrinelli, and Angelo Bertolini, who were accepted for the supplying of Furnishings, Goods, and Foodstuffs for the Poorhouse at Borgo San Donnino and the Central Detention Center in Parma....»[34].
In the first semester of 1819, however, it went out of business[35].
There is no documentation for the years 1820-1821. One can conclude that the supplies were furnished by Marinelli, because on 30 January 1822, he signed a new nine-year contract. There is indirect documentation of the contract in a document from 28 August 1829 in which new prices were set for bread and pasta as was done every year «in proportion to the grain prices derived from the market reports from the first fortnight of the month of August...»[36].
After the first contract expired, others were stipulated every nine years with small modifications compared to the first. The last one, which lasted from 1 January 1852 to 31 December 1860, was brought to term by Marinelli's heir, but who, for now, still hasn't been identified[37]. In March 1856, he is listed amongst those convened «for the purchase of shares for the Establishment of a Bank in the Parma States in conformity with a project published in a Parma Gazzette supplement on 29 August 1854 which was promoted by Her Royal Highness, The Reigning Duchess...»[38]. This continuity of business with the government is also reflected in the name Marinelli gave to his business: «General Business for the State Prisons and the Poorhouse».

1 - M. BLOCH, *Apologia della storia*, Einaudi, Torino 1976, VI edition, p. 74.

2 - This archive section contains the documentation relative to the Finances Ministry from the Restoration Period, that of the government of Maria Luigia and the Bourbons. The old inventory is the one indicated by the official numbering of the Parma State Archives Indices, number 30. See: A. BARAZZONI - P. FELICIATI, *Synopsis ad invenienda. L'Archivio di Stato di Parma attraverso gli strumenti della ricerca (1500-1993)*, Archivio di Stato di Parma - P.P.S. Editrice, Parma 1994, pp. 273-280.

3 - A. FARGE, *L'archivio e la storia del sociale*, in P. A. ROVATTI (edited by), *Effetto Foucault*, Feltrinelli, Milano 1986, p. 165.

4 - M. FOUCAULT, *Archeologia del sapere*, Rizzoli, Milano 1971, p. 13.

5 - F. VALENTI, *Riflessioni sulla natura e struttura degli archivi*, in «Rassegna degli Archivi di Stato», XLI (1981), pp. 9-37; I. ZANNI ROSIELLO, *Archivi e memoria storica*, Il Mulino, Bologna 1987. Isabella Zanni Rosiello is the one who speaks of archives - self documentation.

6 - The Parma State Archives have taken special note of these aspects for some time now as well: AA.VV., *Memento mei dal restauro manuale al restauro virtuale*, Archivio di Stato di Parma e Fotoscientifica, Parma 1997; P. RINOLDI, *Frammenti di codici romanzi nell'Archivio di Stato di Parma*, Scuola di Archivistica, Paleografia e Diplomatica, Parma 1998. More generally: G. B. BAROFFIO, *I frammenti liturgici*, in «Rassegna degli Archivi di Stato», LV, (1995), pp. 334-344; M. PERANI, *I frammenti ebraici negli archivi italiani: censimento e bibliografia al 1998*, in «Rassegna degli Archivi di Stato», LVIII, (1998), pp. 56-74.

7 - G. ZEVOLA, *Piaceri di noia. Quattro secoli di scarabocchi nell'Archivio Storico del Banco di Napoli*, introduction by E. H. GOMBRICH, Leonardo, Milano 1993.

8 - Parma State Archives, from now on referred to as ASPR (Parma State Archives), *Presidenza poi Dipartimento delle Finanze*, b.1295, note of 30 January 1838, sent by the Director of the Forced Labor and Corrections Institution to the President of the Oversight Council for the same institute.

9 - Copy of the contract and the relative *Quaderno delle condizioni* accepted by Vincenzo Marinelli on 20 April 1821 and valid for nine years, thus also for the period taken under consideration here is listed in: ASPR, *Presidenza poi Dipartimento delle Finanze*, b.864.

10 - *Ibidem*.

11 - ASPR, *Presidenza poi Dipartimento delle Finanze*, b.1295, note n.1615 of 31 January 1838, sent by Vincenzo Marinelli to the Oversight Council for the Parma Forced Labor and Corrections Institute.

12 - ASPR, *Presidenza poi Dipartimento delle Finanze*, b.1295, act n. 811 of 3 February 1838 by the Oversight Council for the Parma Forced Labor and Corrections Institute.

13 - The three experts were: Biagio Alfieri, 60 years old, resident at piazzale delle Erbe n.15; Giovanni Terile, 47, resident at strada S. Barnaba n.70; Antonio Carani, 36, resident at strada S. Lucia n.60.

14 - ASPR, *Presidenza poi Dipartimento delle Finanze*, b.1295, atto n.814 del 5 February 1838 by Vincenzo Marinelli to the Oversight Council for the Parma Forced Labor and Corrections Institute.

15 - See: ASPR, *Presidenza poi Dipartimento delle Finanze*, b.1295, note n.923 of 12 February 1838 sent by the Oversight Council for the Parma Forced Labor and Corrections Institute to the Finances President.

16 - Published in: *Raccolta generali delle Leggi per gli Stati di Parma, Piacenza e Guastalla*, ad indicem, from now on RGLS.

17 - *RGLS, Tariffe del vitto, tanto pei sani che pei malati, e della legna e dei lumi pei diversi quartieri e per gli ospedali*: this table is attached to the Riordinamento della Casa Centrale di Ditenzione, n. 77, 12 October 1818.

18 - See the sovereign resolution, in *RGLS* n. 58 del 28 April 1820: «The sum agreed upon as listed above will serve to compensate for the running of the Institute or other damages or fraud committed deliberately by the detainees»; in fact, the incarcerated were given, as retribution for work done, half of the sum taken in by the Treasury from the sale of manufactured goods - for immediate needs and - upon exiting the prison. That is, the prison administration retained the part that the incarcerated expected and deposited the balance in the Treasury weekly. Those who wish to have better food could obtain it through payment to the Institute administrators. On 16 September 1834, it was established that if a prisoner died while serving for his crime and something was owed to him this would go to his heirs.

19 - Article 5 of the 1814 regulations speak of the «oversight of the Council which is free and charitable, of the prisons, that already exists».

20 - The sovereign decree n. 109 of 12 September 1816, in RGLS, which includes 23 articles, establishes the reopening of the Poorhouse at Borgo San Donnino, as a result of the «excessive number of vagrant poor and beggars». To attest to the heavy aspect of the problem is the data found in a statistical study entitled «Specchio per la distribuzione di 15.000 franchi per le 27 preture del governo dei ducati di Parma e Guastalla», in ASPR, *Presidenza poi Dipartimento dell'Interno*, b. 437, elaborated a few months after the fall of Minister Magawly. Out of a population of 217,692 inhabitants in the courts (preture) mentioned above, there were 3,495 mendicants.

21 - The sovereign order, in RGLS, n. 50 of 30 July 1819 gives life to a school defined as of «mutual teaching». A teacher was named - a priest who had to «choose amongst the detainees who he thought susceptible to being taught» and had to teach with the new method to read, write, and do arithmetic.

22 - RGLS, decrees and orders 30 June 1817; 15 October 1818; 20 November 1820; 30 April 1821; 30 January 1822; 17 February 1822; 30 April 1830; 2 October 1831; 2 March 1837.

23 - RGLS, decrees 3 January 1822; 9 November 1818; 5 December 1846.

24 - This news is deduced from «*Descrizione di Tutta la Popolazione della Città di Parma Seguita l'Anno 1765. Parte Seconda*» pg. 444, conservato in ASPR. on pg. 444, preserved in ASPR. Essentially, it is the census ordered by the Minister Du Tillot.

25 - ASPR, *Notai Camerali di Parma*, Borelli, reg. 516.

26 - ASPR, *Tesoreria e Computisteria farnesiana e borbonica*, <Computisteria borbonica di Parma>, reg. 43 on pg. 424: 1770 May 9 «To the accountant sig. Ortencio Arcari £ 19.900 current moneys are expressly to be valued for the payment for the two Fishermen Bacchi e Marinelli for the Pesce consigned by the same in Service of this Royal College of Nobles...» Bacchi is the Guastalla partner of Marinelli's and his guarantor in the contact spoken about.

27 - ASPR, *Tesoreria e Computisteria farnesiana e borbonica*, <Fili correnti>, b. 772-773.

28 - All data derived from: ASPR, *Stato Civile*, <Parma, Matrimoni, 1811>, busta 270; *Stato Civile*, <Parma, Allegati, 1811>, busta 273bis; *Stato Civile*, <Parma, Morti, 1846>, busta 1936; *Stato Civile*, <Parma, Morti, 1858>, busta 2700.

29 - ASPR, *Stato Civile*, <Parma 1824>, bb. 805 e 807; *Stato Civile*, <Parma 1828>, b. 1008.

30 - ASPR, *Governatore '800*, b. 626: «Receipt demonstrative of The Consignments made by Messieurs Angelo Fioroni, and Vincenzo Cattanti to the Central Detention Center in 1812, and 1813...» The numbering and the naming of the archive, given the complex reorganization in progress, can't be other than temporary.

31 - ASPR, *Governatore '800*, b. 626.

32 - The «Processo Verbale d'aggiudicazione... per le Somministrazioni diarie al Deposito di Mendicità e Casa Centrale di Detenzione...», written up by the notary, is dated 18 November 1816, and is preserved in ASPR, *Governatore '800*, b. 550.

33 - ASPR, *Governatore '800*, b. 550.

34 - ASPR, *Governatore '800*, b. 550.

35 - There is news of the bankruptcy of the firm in question from sentence n. 494 of June 1819 of the Government Council executed after a query raised by the Accounts Committee regarding the contract, in ASPR, Consiglio di Stato ordinario e straordinario, reg. 4.

36 - ASPR, *Presidenza poi Dipartimento delle Finanze*, b. 770.

37 - For the 1831 contract, see ASPR, *Presidenza poi Dipartimento delle Finanze*, b. 864; the following one was not found amongst the papers of the Finances Ministry; of the 1848 contract there is a trace only in the inventory of the archive section, cited as: b. 1937 entitled «1848. Contratto Marinelli»; the last one, valid from 1852 to 1860, is in busta BT.

38 - The document cited is preserved in ASPR, *Presidenza poi Dipartimento delle Finanze*, b. 2854. Actually, he only bought one of the first 500 shares put up to the market by the newborn credit institute (cfr. ASPR, *Presidenza poi Dipartimento delle Finanze*, b. 2919).

THE HISTORY AND TECHNOLOGY OF PASTA

Giancarlo Gonizzi
Barilla Historic Archives

Introduction

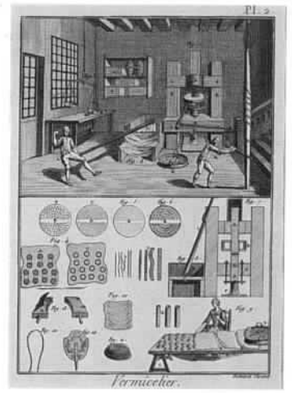
Pasta has, over the centuries, been the work of housewives and cooks: until the 14th Century, the production of pasta was limited to the home. No one really knows with any certainty when the production made the transformation from home to industry. We do know, however, that this date hovers around the middle of the 14th Century. As consumption of pasta increased so did the number of master pasta makers who came together to form corporations for the protection of the interests of those in the field.

Simple machines are designed to make the production smoother and more profitable. From the Statute of the Corporation of Rome, which had its start at the end of the 1500s, we learn that the pasta shops were divided into two categories: those with a press and those without.


Vermicelier.

Therefore the introduction of the screw press which, though it has been falsely argued by some to have had its beginning in the last century, the use of this machine was already quite widespread in the 16th and 17th Centuries.

The screw press, initially made of wood, undergoes a slow transformation that centuries later will see it made entirely of metal.


Vermicelier.

Technological advancement in pasta production has been slow over the centuries, and builds momentum first with the introduction of the steam powered machine, and then with the introduction of electric motors. In addition, with the introduction of artificial drying processes, the pasta industry spreads to all of Italy's regions, even in those areas that were not conducive to the natural drying processes practiced in Naples, Genoa, and Palermo.

The decisive push in the technological evolution of the pasta industry came with the introduction of the continuous press in 1933 thanks to the Braibanti & Sons Company. It is exactly at that time that pasta production leaves the artisanal arena to become a veritable industry.

The dough

The production processes that took place in pasta factories, or pastifici, were carried out in four phases: mixing, kneading, molding, and drying, each executed by a different machine.

Before any of these stages took place, however, it

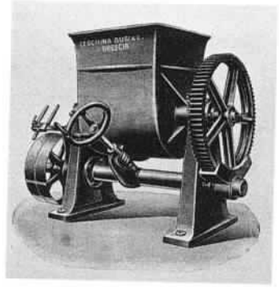
was necessary to see to the cleaning of the raw materials which, delivered in a normal impure state had to be filtered either by hand or by means of mechanical sieves.

The dough mixing operation consists in combining a given quantity of semolina with water and gently blending them in such a way as to form a homogenous mixture. This operation was initially carried out manually with the help of feet and later with the help of a mixer similar to those used in making bread, but constructed in such a way as to reduce the dough's aeration to a minimum in order to make cleaning easier.

Dough could be made with cold water chilled to 15-25 degrees Celsius or hot water heated to 40-100 degrees Celsius, and the choice of either method depended on the quality of the flour and the probability that the dough would embark upon a process of fermentation.

Cold processes were used in Sicily, Liguria, and Abruzzi, while the hot method was typical in Naples. The dough mixing lasted from 5 to 20 minutes, according to whether the pasta was soft or hard or cold or hot; if it took longer the pasta tended to break easily and this defect had no remedy. At the beginning of the 20th Century and beyond, dough mixing was carried out by one of the following machines:

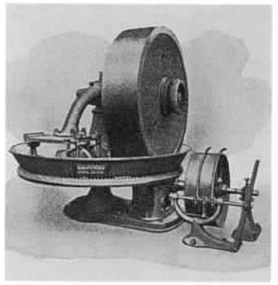
- Manual mixer: used in smaller pastifici that had to rely on human hands. The manual mixer was completely constructed of metal and held from 5 to 30 kilos. The drum in which the dough was mixed could be turned upside down so that the contents, at the end of the mixing operation, could fall into the special trough in order to be passed on to the subsequent kneading process in the shortest amount of time.



- Motor-driven mixer: a very important machine because perfect results depended mainly on the quality of the dough, its transparence and resistance, and was produced at a maximum of 250-300 Kilos at a time.
- «Cam» mixer: several companies equipped their mixers with special «cams» attached to the shaft in order to keep the drum perfectly clean at the end of every batch. It was nonetheless necessary to assure that even the slightest amount of dough from the preceding batch was removed from the drum, where it could have given rise to harmful fermentation in subsequent batches.

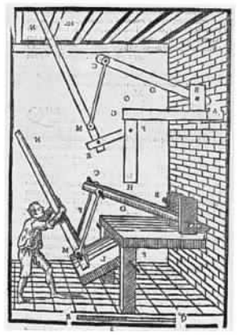
For decades mixers have been the foundation of the pasta industry.

In the old pastifici the position of the mixer was above the kneading machine, in a higher position so that the dough could be poured directly onto a plate



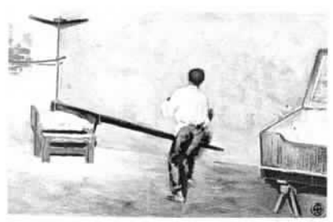
or kneading tub. This placement was called «cascade style». The mixer was filled with bags of semolina or semolina and granular flour or the raw material was delivered directly from the flour vendor in tubs or canvas bags that were handled by the same operator who oversaw the mixing. It should also be noted that the mixing had to be done in conjunction with kneading in order to avoid that the dough rest for too long, something that was potentially conducive to fermentation or hardening of the surface of the dough.

The kneading



The duty of kneading is to completely mix the dough, making it compact and homogenous without making it crumble, while safeguarding the firmness and resistance of the dough and the uniformity of color.

Kneading must not cause the formation of a crust on the surface that would be quite harmful to the product's quality. For this reason the kneading movement must concurrently be deep, gently, and quick, so as to avoid potential crumbling and whitening of the dough.



The history of kneading begins with a device formed by a polished piece of wood on which the dough was placed, and which was subsequently pressed over the pasta dough, flipping repeatedly; the device was ideal for soft dough and required considerable manpower.

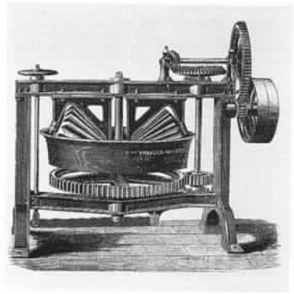
A comparable system was utilized in Liguria with a mill system equipped with a marble or stone wheel similar to those used in crushers. It was made up of a tub and a cylindrical mill that exerted pressure on the dough; this method differed from the others because the dough underwent continuous pressure since the mill was ungrooved. In addition, due to the friction of the tub with the mill, the pasta became white and cooked quickly. To fix this inconvenience kneading machines were improved with the addition of blades and grooves.

The bladed kneading machine more easily reproduced the results of the wall-mounted device. It was composed of a circular wooden table that pivoted, and by wooden blades situated according to one of the diameters that lowered and raised, pressing the dough on the table. While the blades were raised, the table turned at a certain angle and stayed put when the blades were lowered; every so often the outer edge of the dough had to be lifted and turned back towards the center of the table until it was well mixed at all points.

A kneading machine with grooved rollers was also created with its wooden or metal table onto which the dough was positioned and which moved in alternating directions while the grooved blade above and to the side provided intermittent pressure similar to that of the wall mounted device.

Finally the kneading machine with conical rollers showed itself to be effective and gentle on the dough, reducing crumbling to a minimum and ideal for all qualities of dough: soft/hard and hot/cold.

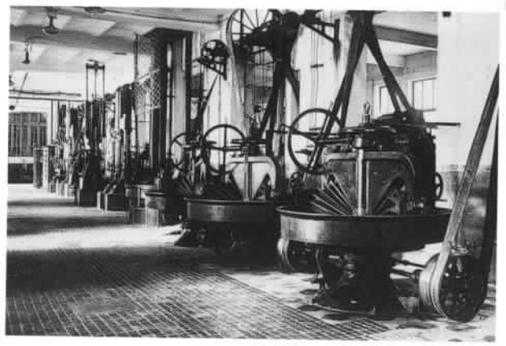
The kneading machine with grooved rollers had a circular tub that continuously turned around



itself and by two grooved conical rollers which turned around on fixed supports on the assembly, and which, by means of ropes, could be lifted or lowered. As the kneading progressed, the rollers were lowered onto the pasta dough, until it was reduced to a flat disc; then it was cut into sections and the center area was moved to the outer area. Many machines did this action automatically by means of a «dough turner».

The most popular kneading device was that which used rollers. The bladed mixer was used in the Naples area with excellent results for hot dough. The mill system was used in Liguria and in other areas near Venice; the kneading process using a moving counter was only used for smaller quantities.

The kneading devices were constructed in varying sizes and every device was designed to work with minimum and maximum quantities according to whether the dough at hand was hard or soft. The kneading time depended on

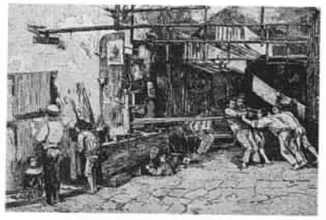


the quality of the raw materials, the machine's characteristics, the movement of the grooved rollers and the pasta turner, which were so important to the production of homogenous dough of just the right shade, without the formation of a crust.

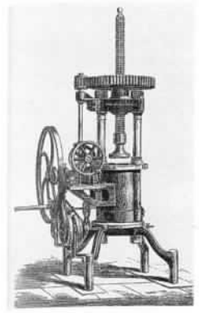
Refinement and molding

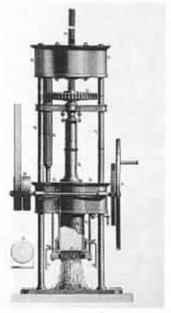
This operation (which was normally not carried out in normal pasta production) consisted in «laminating» the dough which, after the kneading process, was fed through rollers so as to make it more homogenous in order to obtain a very smooth-surfaced final product. The machine used for this operation was called a refiner or laminator, and was mainly used to extrude thin sheets of special pasta, egg pasta, or hand-formed shapes.

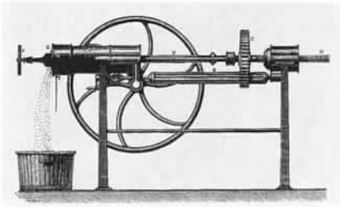
Pasta was originally entirely produced using the lamination process, i.e. pressure between a roller and a flat surface or between two rollers. In the passage from the artisanal phase to the industrial phase the use of extrusion was developed, in which dough was forced to through a die so as to obtain hollow tubes, tubes, ribbons and strands which were then cut. Today extruded pasta has totally replaced «laminated» products in the pasta industry.



Initially, in this phase of production, screw presses with a bell-shaped holding tank were used, in which a plate or board equipped with a rubber seal pushed the dough through the press. The presses were either vertical or horizontal, and these last were equipped with a rotating blade featuring two or three cutting edges that sliced the pasta as it left the extruder. The blade's rotation was continuous for short pasta shapes and intermittent for others; still others, such as maltagliati and penne, were cut at an angle with special machines called *tagliapenne*.



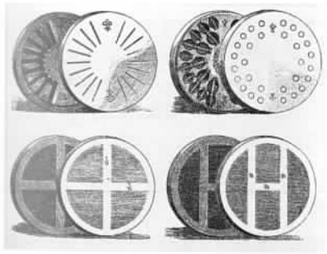




The hydraulic press, a piston connected to a pump, gradually replaced the manual process. The process became increasingly popular and over time replaced the screw press since it was useful in the production of large quantities.

Though more expensive, the hydraulic press was mechanically less complex and as such was less prone to breaking down. The Pattison Company made the first hydraulic presses around 1870 in Naples.

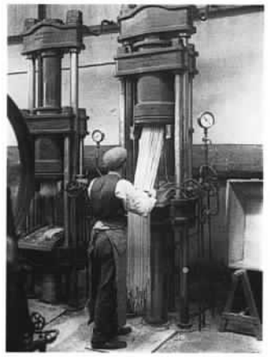
Presses were generally attached to the tanks, or were mounted above a transom attached to a frame, onto which the tanks were loaded after being filled. The earliest use of the word «trafila» (press) as a term is from 1630 in Giambattista Basile's *Cunto de li Cunti*. Its holes of various shapes and sizes determined the variety of pasta shapes.



The dies were made of materials that were resistant to acids that formed during the pasta's fermentation such as copper and bronze. The die holes for hollow pasta had a core insert; for long and thin shapes a thin die was used with a steel backing. Dies were also made with short tube-shaped holes that opened towards the tank's chambers. The die holes were 10% larger than the finished dried product to compensate for shrinkage.

The hydraulic press allowed for all kinds of dough to be utilized (soft, hot, hard), but the best method was the use of soft, hard dough. The pressure exerted ranged from 150 kilos per cm2, but pressure of even 200 atmospheres could be reached.

Hydraulic pumps assisted hydraulic presses with "single" lines; i.e. each press had its own pump or with centralized equipment. In this case hydraulic accumulators of adequate capacities were necessary.



As it exits the die, long pasta is laid out manually on mats. In order to avoid disfigurement and the sticking together of shorter pasta shapes, a shaking device, the trabatto, is used. A simple device, it aerates pasta as it leaves the extruder, thus avoided deformation and stickiness. After the trabatto, the pasta is laid out on screens for the traditional drying phase of aeration and tempering either open-air or in rooms equipped with braziers.

For more than four centuries, from the 16th to the 20th Century, the pasta industry utilized the above-mentioned equipment: mixers, kneaders, presses and various accessories that were developed and gradually improved with experience.

Drying

At the beginning of artisanal production, pasta was almost always sold fresh, in the same shop in which it was produced; the increase in consumption and the shift towards industrial production led to problems relating to conservation and transport.

In fact, fresh pasta - whether extruded, long or short, laminated or sliced - is soft, can be crushed, and is subject to alteration due to fermentation. In addition, the moist surface to the pasta is particularly favorable for the production of mold.

Since the beginning of artisanal production it had be noted that pasta, along with other foods, if deprived of a elevated percentage of the water it contains after being extruded, can be conserved for long periods without altering itself.

Based on this experience, an empirical search began to find a condition that allowed for the most accurate and least costly drying method.

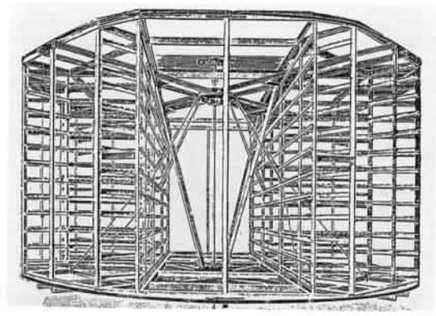
Climates with constant and favorable breezes for drying pasta led to the increase in production in Genoa, Sicily, and in Naples, where the industry took on imposing proportions.

By the end of the 1800's a notable increase in exportation of the product had taken place. More than a phase in the production of pasta, drying was, especially near Naples, a «rite» in which everyone participated. The official «rite» of the pasta maker, a true wizard and as such obeyed, was to make a forecast, understand the weather, and be able to know by touching if the pasta had reached the correct degree of dryness in order to make sure that necessary subsequent operations could help to avoid that the product so fastidiously produced could either ferment or dry too quickly.

Drying could go on for two to three days and the pasta maker had to see the process through to its end without damaging the product, that is, without «caniare» the pasta, but also avoiding phenomena of acidity, fermentation, or growth of mold. The danger of acidity then was as big as «*caniatura*» or burning the product. And on humid days windows and doors would be opened and the short pasta would be set out on screens, while for long pasta the poles would be spaced further apart.

Out of these «rites» the figure of the professional «head pasta maker» was born: he had to know the weather, winds, and seasons; he could feel changes at a moment's notice, could interpret them and each time «invent» just the right method for drying the pasta.

He invented - above all - that which today is the most important phase of pasta's drying cycle. He invented wrapping, thus the tempering, or rest,



ventilation, and these operations were alternated and varied the duration and number according to the shape, season, weather, and the situation of the drying room.

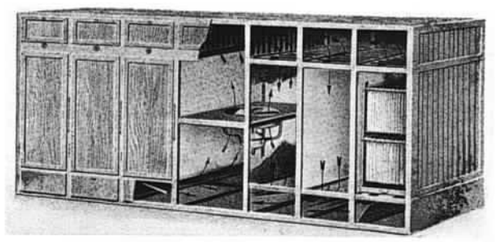
The classic Neapolitan drying process consisted in the following steps:

- *Incartamento* («paper wrapping»), was carried out preferable in the sun, in courtyards or balconies protected from winds; the name derives from the fact that at the end of this initial drying phase, the external surface of the pasta appeared rather hard due to the intense evaporation which protected the pasta from subsequent fermentation processes.
- *Tempering* in moist, cool cellars; this phase served to redistribute residual humidity throughout the pasta in a uniform way, so as to keep the pasta pliable, and to be able to finalize the drying stage.
- *Definitive drying*. This stage took place in large rooms that were oriented in the direction of the winds and that were equipped with adequate windows to allow for the pasta to be adequately ventilated.

The carrying out of natural drying processes required multiple and complex observation of an empirical nature and for this reason was considered to be a veritable «art».

In order to steer clear of inconstant climates and to be able to work in the winter, especially in the northern regions that were less ideal in terms of climate, facilities for «artificial» or «thermomechanical» drying were built, featuring closed rooms equipped with fans and radiators for the production of hot air currents which ventilated the pasta.

The oldest machine for artificial drying, the, *giostra* (roundabout), dates back to 1875. It featured a polygonal cage in wood or steel rotating on its axis and onto which the poles or screens full of pasta were arranged. With the rotating action of this machine the pasta was dried but in an imperfect way since the pasta at the outside edge dried first. But nothing better was available, and it was necessary to wait many years, to 1898, when the first *system invented by Tommasini* was presented. This system reproduced the traditional natural drying process but accelerated the first and last phase via the use of agitating the air with fans. With this system incartamento, was carried out at a temperature of 30-35° Celsius in caissons in which long pasta was kept for a time varying from 30 minutes to an hour according to the shape of the pasta and the ambient humidity; after this (only for long pasta) the product was taken to a tempering



room for one night and then to definitive drying, where ventilation was regulated so that every 4-6 hours alternating phases of moderate incartamento and tempering were carried out.

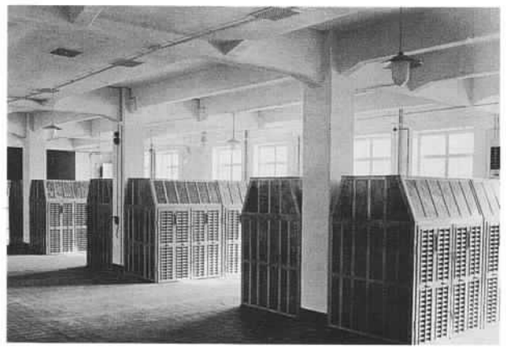
Definitive drying of long pasta required 3-6 days, while short shapes only need 24 hours. The Tommasini system allowed for savings in terms of time and space but not labor since it was still necessary to carry the pasta from the incartamento caissons to the rooms (or caissons) for definitive drying.

With the objective of eliminating this transport, R. Rovetta, in 1903, and G. Falchi, in 1907 and

1912, patented methods which had the common goal of carrying out the various drying phases in a closed environment, in which air conditions were conveniently and gradually modified as the drying process progressed.

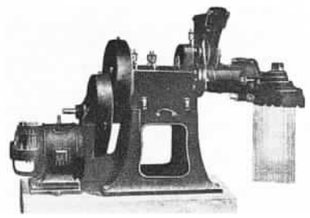
The Marelli automatic drying system was intended for short pasta shapes and was a machine with continuous screens where fresh pasta was loaded from above by means of a hopper and, carried down on screens, was rotated while 35°Celsius air currents circulated in the opposite direction.It was especially suited for large-scale production.

The «Ceschina» complete drying system for pasta was a large storage container with independent sections, so that each section could be adapted to regulate or stop the ventilation process. In such a way the same storage container could hold all of the various phases which must be carried out during the incartamento, tempering, and definitive drying stages, with alternating phases of ventilation and necessary rest in order to assure the correct drying of an excellent product.



The continuous press

For quite some time the dream of both pasta-makers and makers of pasta machinery was a press which operated continuously. Numerous attempts brought nothing concrete or satisfactory until the dream was realized with the help of a common workman from Provence. Féreol Sandragné had worked for many years in the Mécanique Méridionale in Toulouse, a factory which, in addition to producing common pasta machines, had also built coiling machines.



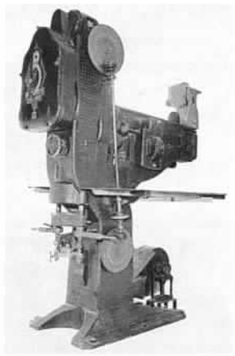
These machines had replaced the quick, able hand of the worker with an intelligent play of levels that bent to receive the pasta, moving laterally and turning completely over.

Sandragné, forced into retirement, found other employment as a porter in a brick factory. What a marvel! The soft clay was taken in by two rotating screws and pushed through a die, and bricks with holes came out to a metal cord that automatically stacked the succession of bricks.

Having studied the necessary changes, Sandragné prepared various wooden models by hand, ordered them to be cast, and invited his supervisors to see how he produced pasta in a continuos line in his attic.

Due to the rubbing together of the screws that worked the dough, the machine quickly heated and the pasta stopping flowing through the machine. But one only had to put a wet cloth (precursor to the cooling room) on the body of the blades to keep them functioning.

Sandragné's ex-supervisors convinced him to release the patent (registered on October 6, 1917) and for every machine produced they gave him a percentage. News of the continuous press spread immediately. From 1929 to 1939 the Mécanique Méridionale produced an average one every day and exported them to far-away countries.



In 1933 the first Italian continuous press, designed by the engineers Giuseppe and Mario Braibanti of Parma, led to the modern automated pasta processes.

Continuous lines

After the Second World War, with the overwhelming success of the continuous press, continuity for drying processes became a practical necessity and a goal to reach.

For short pasta shapes it was simpler: two transport machines were used instead of the screens - the system with rotating devices and that with conveyor belts in metal or nylon.

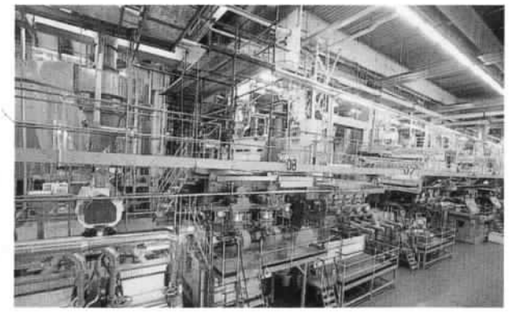
More complex, however, was the development of continuous lines for long pasta on poles. Carts, chains, shelves, oval-shaped poles, with Z-shaped extremities or various models were used, arriving at the current system of mechanical support with poles that led to two: racks and chains.

For special pasta (matasse and nidi in particular), two systems of transport are used: the most common is the first, with screens, and the other with belts very similar to those used for short pasta and which, obviously, called for effective incartamento which was carried out on special belts with plastic containers that could assure that the pasta kept its shape and the overall effectiveness of the processes.

Having discovered the mechanism for transporting the pasta, development of continuous lines for drying followed closely behind automatic presses which, over the years with technological advancement and productivity required by the demands of the market, initiated the race for the biggest capacity, from 100 kilos per hours of the *Micro*, to 2,000-3,000 kilos per hour for the largest presses and therefore to today's production lines which can arrive at 6,000 kilos per hour.

But the true result of this development isn't so much the growth, though surprising, in productivity of these plants as much as it is the definitive affirmation of continuous production lines as «producing units».

For example, one no longer speaks about single machines such as mixers, kneading machines, presses, incartamento machines, or drying racks, but of «lines»; lines made up of a series of complimentary machines that come together to create a complete production cycle from raw materials to the final product which is packaged, ready to be shipped, and guaranteed for its absolute quality to the consumer.



BIBLIOGRAPHY

Pasta - History

- PORTESI Giulio
L'industria della pasta alimentare - Roma, Molini d'Italia, 1957.
- FIRPO Luigi
Gastronomia del Rinascimento - Torino, UTET, 1964.
- ALBERINI Massimo
Storia del pranzo all'italiana - Milano, 1966.
- AGNESI Vincenzo
a c. di *Alcune notizie sugli spaghetti* - 1975.
- CUNSOLO F.
Il libro dei maccheroni - Milano, Mondadori, 1979.
- MONTANARI Massimo
L'alimentazione contadina nell'alto Medioevo - Napoli, 1979.
- FACCIOLI E.
Le fonti letterarie della storia dell'alimentazione nel basso Medioevo, in «*Archeologia medievale*», VII, 1981.
- SADA Luigi
Spaghetti e compagni - Bari, Ed. Centro Librario, 1982.
- BOLOGNA Giulia,
a c. di *La regina delle mense* - Milano, Comune di Milano, 1989.
- FUSCO Roberto
Pagine di storia viste dalla parte degli sconfitti: ovvero la pasta, evoluzione di una lotta. Massalubrense, Sorriso di Erasmo, 1989.
- MEDAGLIANI Eugenio - GOSETTI Fernanda
Pastario, ovvero Atlante delle Paste Alimentari Italiane - Milano, Alessi, 1989.
- MORELLI Alfredo
In principio era la sfoglia. Storia della pasta - Pinerolo, Chiriotti, 1991.
- AGNESI Vincenzo
È tempo di pasta - Roma, Gangemi, 1992.
- ALBERINI Massimo
Storia della cucina italiana - Casale Monferrato, Piemme, 1993.
- ALBERINI Massimo
Maccheroni e spaghetti. Storia, letteratura, aneddoti - Casale Monferrato, Piemme, 1994.
- *BARILLA. Cento anni di pubblicità e comunicazione*, a cura di Albino Ivardi Ganapini e Giancarlo Gonizzi - Milano, Pizzi, 1994.
- AGNESI Eva
È tempo di pasta - Roma, Museo delle Paste Alimentari, 1998.

Pasta - Technology - Sources

- BIANCHI, Isidoro
Lettera del Signor Isidoro Bianchi... sopra una Macchina di nuova invenzione per fabbricare con maggior facilità... ogni sorta di Vermicelli - Lettera tratta da: *Opuscoli Scelti sulle Scienze e sulle Arti*. Parte IV, Tomo VIII
- PIGONATI, Andrea
Dei molini a mano per macinare il frumento in propria casa - S.l., (I), s.d. [inizio '800]
- BARACCO, Michele
Descrizione di due macchine per la pasta immaginate da Michele Baracco Vermicellaio, presentate alla Società Patriottica di Milano e dalla medesima premiate - S. n. t. [Milano, 18..]
- ALBANESE, Angelo
Macchina per la panificazione o nuova gramola di Angelo Albanese dell'Istituto di Scienze, Lettere ed Arti nel concorso d'industria - Venezia (I), Francesco Andreola, 1825
- SPADACCINI, Cesare
Novello e grande stabilimento di paste coll'uomo di bronzo per togliere l'uso abominevole di impastare coi piedi - Napoli (I), Stabilimento Tipografico dell'Aquila, 1833
- CAGNASSI, A.
Il Tesoro della Sanità, ovvero il Panattiere istruito, operetta *necessaria ai padroni e garzoni panattieri, ai vermicellai, ai particolari, agenti di campagna e utile ad ogni sorta di persone. Coll'aggiunta in fine del modo di fare le paste sfogliate* - Torino (I), Tipografia Speirani, 1840
- FIGUIER, Louis
Le meraviglie dell'industria. Il pane, le farine, le paste, le conserve, ecc. - Milano (I), Treves, 1881 - Text also in French version
- SPADACCINI, Cesare
Catalogo della V Esposizione della Società Patria - Genova (I), 1883 - Esposizione macchine per molini e per pastifici.
- *Conferenze tenute all'Esposizione internazionale di apparecchi di macinazione e panificazione*. Milano (I), Tipografia Bernardoni, 1888
- BURDESE, A.
Il progresso nell'industria dei molini. Succinta relazione pratica sulla produzione del frumento e del riso. Norme del pastificio e panificio col ragguaglio del prezzo dei grani dal 1877 al 1895 - Bologna (I), Tipografia Azzoguidi, 1896
- CESCHINA BUSI & C.
Nuova serie di macchine perfezionate per pastifici - Brescia-Napoli (I), Ceschina Busi & C., 1904 - La più rinomata fabbrica di macchine da pastificio. Interessanti articoli dedicati alle diverse macchine. Catalogo aziendale.
- CESCHINA, Giovanni
Primo contributo allo studio della essiccazione delle paste alimentari - S. Giovanni in Conca (I), Tipografia degli Ingegneri, 1907
- ROVETTA, Renato
Industria del Pastificio - Milano (I), Hoepli, 1908. Prima edizione - Edizioni successive 1921-1929. Ristampa 1951
- *The Atlantic Macaroni C. Millers and Manufacturers of Macaroni Fancy Paste and Egg Noodles* - Long Island City, New York (USA), 1915 - Trattato sui maccheroni. Illustrazione degli impianti del pastificio e catalogo formati.
- OFFICINE RIUNITE ITALIANE
Macchine per pastifici. Officine Riunite Italiane, continuazione delle antiche ditte Ceschina, Busi, Ing. Conti - Brescia (I), 1923 - Illustrazione di circa 90 formati di pasta ottenibili con le diverse trafile. Catalogo Aziendale.
- ROVETTA, Renato
Industria del pastificio o dei maccheroni. Storia, fabbricazione, impastamento, gramolazione, raffinamento, torchiatura, tranciatura, essiccazione, conservazione, imballaggio, esportazione, riscaldamento, progetti, assicurazione - Milano (I), Hoepli, 1929 - Terza edizione ampliata. Edizioni precedenti 1908-1921. Ristampa 1951
- *L'Esposizione internazionale di macchinari ed accessori per panificazione, pastificazione e la Mostra del pane italiano* - Bologna (I), Catalogo della mostra, 15 giugno-15 luglio 1932
- ROVETTA, A.
Esposizioni di essiccatoi per paste alimentari - Roma (I), 1933 - Estratto da Industrie dei Cereali, n. 9, 10, 11. Roma, 1933
- MARTINEZ, G.
Rivoluzione nell'industria delle paste alimentari, l'automatica Braibanti e gli attuali sistemi di lavorazione - Roma (I), Arti Grafiche Trinacria, 1935
- *Trasportatori pneumatici Bühler* - Milano (I), Tipografia Bulluman, s.d. [195.]
- CAMPANELLO, Felice
I Re Soli, personaggi di una civiltà alimentare - Collecchio, Parma (I), Parmalat, 1984
- ODDI, Renzo
L'industria della pastificazione - Parma (I), Barilla, 1989
- GELOSI, Attilio - SUSS, Luciano
Un pastificio sano per un prodotto di qualità - Bologna (I), Avenue Media, 1995

Pasta - Technology - Studies

- ZIINO, N.
Memoria intorno alla macinazione del grano ed alla pastificazione: osservazioni e proposte - Estratto degli atti del Collegio degli Ingegneri ed Architetti di Palermo, 1888 - Palermo (I), Tipografia Editrice Tempo, 1888
- FIGUIER, Louis
Les merveilles de l'industrie ou description des principales industries modernes - Parigi (F), Jouvet et C.ie, 189. Text also in Italian version
- ROVETTA, Renato
Industria del Pastificio - Milano (I), Hoepli, 1908 - Prima edizione. Edizioni successive 1921-1929. Ristampa 1951
- BATTARRA, Alberto
I pastifici e i panifici - Torino (I), Utet, 1921
- ROVETTA, Renato
Industria del pastificio - Milano (I), Hoepli, 1921 - Altre edizioni 1908-1929. Ristampa 1951
- ROVETTA, Renato
Industria del pastificio o dei maccheroni. Storia, fabbricazione, impastamento, gramolazione, raffinamento, torchiatura, tranciatura, essiccazione, conservazione, imballaggio, esportazione, riscaldamento, progetti, assicurazione - Milano (I), Hoepli, 1929 - Terza edizione ampliata. Edizioni precedenti 1908-1921. Ristampa 1951
- GARUFFA, E.
La macinazione dei cereali. La panificazione ed i panifici. I pastifici. - Torino (I), Utet, 1930 - In «*Le conquiste dell'industria*». Enciclopedia industriale redatta a cura di numerosi specialisti sotto la direzione del prof. E. Garuffa. Dispensa 49 (volume XI: *Le industrie alimentari ed igieniche*) - Cenno sulla costruzione dei grandi magazzini da grano o silos. La lavorazione dei grani senza macinazione e per scortecciatura. La panificazione ed i panifici. I Pastifici.
- MARUCCO, G.
Dell'essiccazione della pasta. - Roma (I), 1934 - Estratto da *Le Industrie dei Cereali*, n. 7. Roma, 1934 - L'A. riferisce sui tre stadi essiccativi della pasta alimentare: incartamento, rinvenimento, essiccazione definitiva.
- MARUCCO, G.
Appunti delle lezioni di pastificio - (*R. Scuola per l'Arte Bianca e per le Industrie Dolciarie* - Torino) - Torino (I), Litografia F. Gili, 1935
- AGNESI, Vincenzo
Un pastificio di cent'anni fa. - Roma (I), Edizioni Le Industrie dei Cereali, 1940

- BORASIO, L.
Le ricerche scientifiche nel quadro dell'evoluzione tecnica nell'industria delle paste alimentari - Vercelli (I), Tipografia Gallardi, 1940 - Estratto da Risicoltura n. 7. Vercelli, 1940
- BERLINER and staff
Formulary and latest developments in the manifacture of alimentary pastes. - New York (USA), 1940
- CASALINI, M.
L'agricoltura e le industrie legate all'agricoltura. - Roma (I), Editrice I.E.M.I.A., 1940 - L'agricoltura: demografia, produzione e commercio. Le coltivazioni agricole principali. Gli elementi fondamentali del progresso agrario. Le industrie alimentari. Le industrie tessili. Le industrie di distillazione ed estrazione. Le industrie del legno, del sughero e della carta. Le industrie delle pelli.
- CIANCIMINO, M.
Enciclopedia delle piccole e medie industrie. - Milano (I), Ciancimino, 1941 Due volumi.
- RENAUDIN, Charles N.
La fabrication industrielle des pâtes alimentaires. - Paris (F), Edition Dunond, 1946
- HUMMEL, Charles
Macaroni products. Manufacture, processing and packing. - London (GB), Food Trade Press Ltd., 1950
- ROVETTA, Renato
Industria del pastificio o dei maccheroni. - Milano (I), Hoepli, 1951 - Ristampa. Edizioni precedenti 1908 - 1921 - 1929
- TRAGLIA, Gustavo
Il lunario della pasta asciutta. - Milano (I), Ceschina, 1956 - Contiene un capitolo sull'evoluzione delle tecnologie del pastificio
- BARONI, D.
L'importanza della pressa sulla qualità delle paste alimentari. - Paris (F), Institut Technologique des Ceréales, 197.
- DALBON, G. - BARONI, D.
Nuova tecnologia nella produzione delle paste alimentari. - Milano (I), Braibanti, 1979
- LIRICI, Luciano
Manuale del capo pastaio. - Controlli di fabbricazione, analisi, legislazione, pastificazione, ieri ed oggi - Pinerolo (I), Chiriotti, 1983
- CANTARELLI, Corrado - MERCIER, Chrisiane
Pasta and extrusion cooked foods. Some technological and nutritional aspects. - New York (I), Elsevier Applied Science, 1986
- CANTARELLI, Corrado
MERCIER, Christiane - *Pasta e prodotti estrusi.* - Milano (I), Tecniche Nuove, 1987
- GUARNIERI, Roberto
Industria della pasta: problematiche e innovazione. - Parma (I), Barilla Spa, 1987
- UFFICIO STAMPA E RELAZIONI PUBBLICHE ENEL
Manuale per l'uso razionale dell'energia nel settore della pasta alimentare. - Roma (I), Enel, 1988
- BOLOGNA, Giulia
La regina delle mense. Storia, geografia, gastronomia, produzione industriale della pasta alimentare. - Milano (I), Comune e Biblioteca Trivulziana, 1989
- MILATOVIC, Ljubomir - MONDELLI, Gianni
La tecnologia della pasta alimentare. - Pinerolo (I), Chiriotti, 1990
- MILATOVIC, Ljubomir - MONDELLI, Gianni
Pasta technology today. - Pinerolo, Torino (I), Chiriotti, 1991
- *Quale futuro per la pasta fresca italiana? Normativa, qualità, tecnologia.* - Padova (I), Nuova Editrice, 1993 ca.
- *Influenza del trattamento termico sulla sicurezza e sul valore nutrizionale delle paste alimentari - Studio Policentrico Sperimentale.* - Roma (I), Società Editrice Alimenti, 1994 - Supplemento al n. 4, ottobre-dicembre 1994 de *«La rivista della Società di Scienza dell'alimentazione»*
- *Evaluation of the drying process on the safety and nutritional value of pasta - An experimental collaborative study.* - Roma (I), Società Editrice Alimenti, 1994 - Supplemento al n. 4, ottobre-dicembre 1994 de *«La rivista della Società di Scienza dell'alimentazione»*
- KRUGER, James - MATSUO, Robert - DICK, Joel
Pasta and noodle technology. - Minnesota (USA), American Association of Central Chemists, 1996

PASTA AS A COMPLEX SYSTEM: THE PHYSICS OF GASTRONOMY

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Introduction

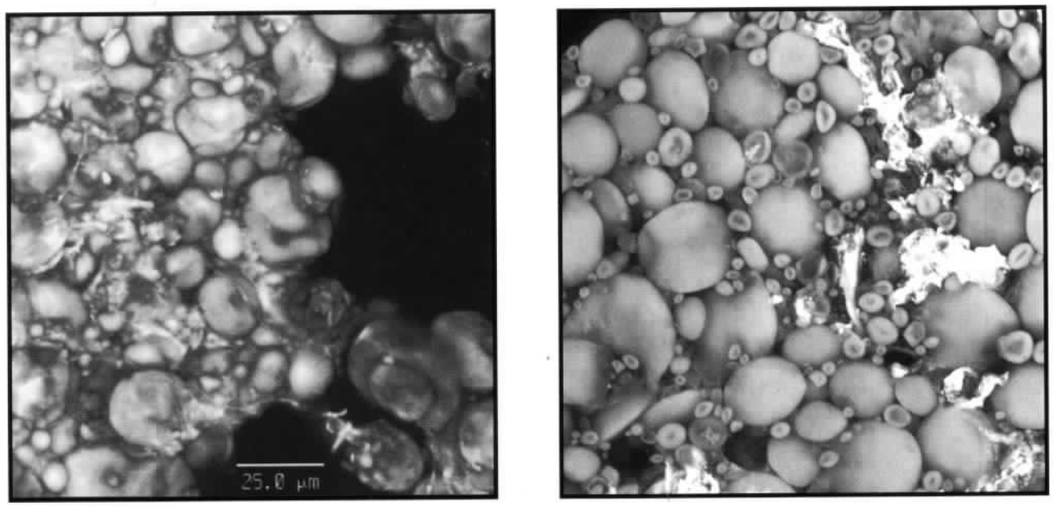
Scientific knowledge of nature, and particularly Physics, is based on two grand directives: research for the fundamental mechanisms that are at the base of everything, and the understanding of the functioning of ever more complex systems. In the first case, the voyage is toward elementary entities, Democritus' atoms. In the second case, one navigates in ever more labyrinthine archipelagoes; the individual islands count for little, but a lot depends on how they are mutually arranged.

Let's make an example by taking a short trip across dimensions. Dalton and Lavoisier's Chemistry brought about the notion of the molecule, the smallest particle (elementary) of material that preserves chemical properties. The physical existence of molecules was then definitely proven in Einstein's work on Brownian Motion. Molecules, however, are not elementary: they are made of atoms; this brings us to atomic measurements (10 billionths of a centimeter). Then penetrating within the atom, we see that it isn't elementary either: it is made up of electrons and a nucleus (a 100,000th of an atom) which contains almost all of the mass. Then, physicists penetrated the inside of a nucleus finding that it isn't elementary either, but made up of protons and neutrons. With modern particle accelerators that can examine matter on a scale that is unimaginably small, it has been discovered that protons and neutrons aren't elementary either, but made up of various combinations of quarks. On this voyage, which isn't over yet, to find the elementary, fundamental components of the Universe, it has always been shown that for every jump in scale, that which appeared elementary no longer was, but showed structure and complexity.

If we then reverse gear across the dimensions, atoms aggregate into crystals or form molecules which in turn organize themselves into molecular structures that are ever more extensive and ever more complex: lipids, amino acids, sugars, up to polymers and finally biological macromolecules. Then there are cellular structures, emulsions, suspensions, colloids until one gets to the aggregates that constitute many of the materials we experience in our daily existence. In this case, the characteristics of the material don't depend only on its chemical composition, but also on how the various components are arranged spatially in relation to one another. It is this very complexity deriving from all the possible topologies of the components that gives origin to characteristics of systems which don't linearly add up to the sum of their individual properties. With the progress in Disordered Systems Physics in the last part of the 20th Century, a new frontier has been opened: the quantitative study of complex materials - practically everything that surrounds us. We, and all living matter, are an example, perhaps even the most spectacular, of the fruits of this complexity.

In the end, the circle closes itself: in the search for the simplest, most elementary, most basic units of matter, we discover new structures and

Fig. 1 - Two microscope views of the 1837 pasta and modern pasta. The light areas are starch particles which are distributed much more unevenly in the historic pasta.

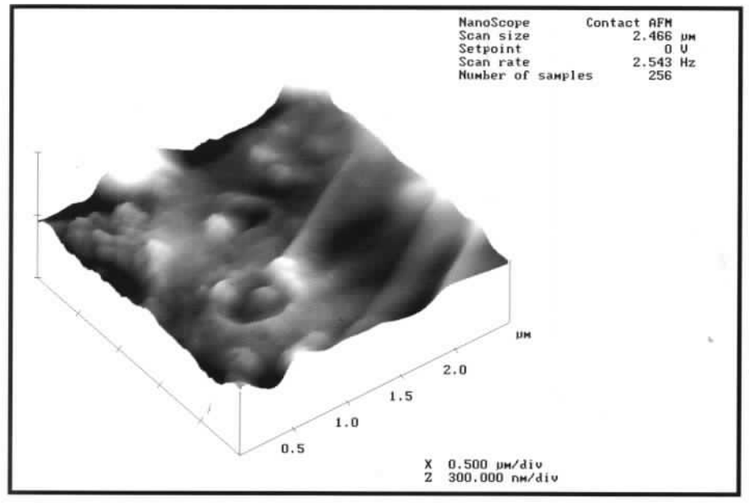


new complexities at every step. And, as much as we aggregate various ingredients in different ways, from simple molecules to polymers to biological cells, we discover behaviors that are always different and often unexpected.
Physics of Disordered and Non-Homogeneous Systems concerns this second condition in which it is essential to understand the role of the topology of the principal units of a material to determine its characteristics. Thus it becomes essential to be able to study the system's structure on various spatial scales in order to be able, in the apparent chaos and superimposition of structures, to slowly isolate those thought to be relevant for understanding particular properties in the system itself. In tandem, theoretical models vitally depend on Statistical Physics and pave the road through the interpretation of the results and the connection with the material's properties .

The physics of gastronomy in pasta

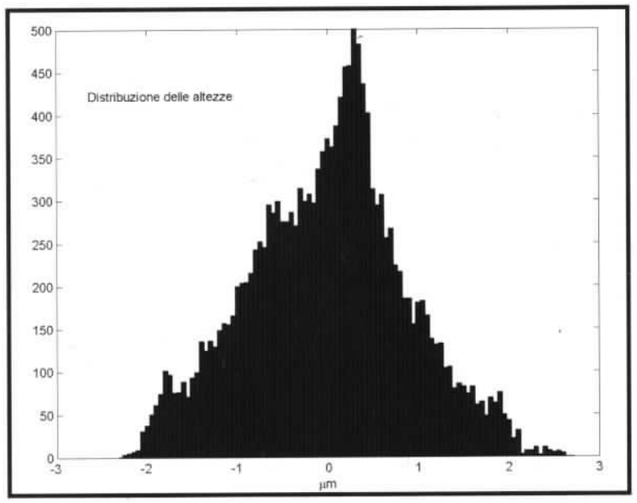
So called «Gastronomic Physics» was born out of theoretical conceptualization. Its ambition is to interpret and foresee the organoleptic characteristics of a food beginning with the dynamic and structural analysis of the spatial arrangement of the essential chemical components and their theoretical modeling.
How can spatial arrangement influence the flavor of a food, the pleasure that we get from it when we eat it? Take, for example, home-made mayonnaise: well-made mayonnaise and one that is poorly made have exactly the same chemical composition, but there is a big difference between the two! The gastronomic characteristics of mayonnaise are due to the spatial morphology of its components: very small drops of oil mixed in water (where they normally wouldn't want to be), and a small amount of egg proteins which stabili-

Fig. 2 - Surface of the historic pasta (1837) measured with an electron microscope (using the contact method) on a scale of 2.5 microns. It is the apex of a residual granule, probably of starch. Over time, many granules were lost (detached) as can be seen in the images with the confocal microscope. For those that remained, no substantial differences can be found in comparison to «modern» pasta on a sub-micrometric scale (AFM).



ze the suspention, place themselves at the interface between the two principal components.
Pasta, both modern and ancient, can be placed in this category of materials: substantially it is a dispersion of starch particles in a gel reticulate of gluten - i.e. various proteins that imprison the starch particles when linked together in an opportune structure. All together, glued by the so-called hydration water, which makes up approximately 15% of the aggregate mass, it forms the pasta which, shaped into the desired form and dried, becomes spaghetti, today, as it did two centuries ago.
Pasta, whether fresh or dried, appears to us as something homogeneous: what scale of observation should one go to observe the fundamental heterogeneity which is essential for its gastronomic properties? We propose two levels for this study: the chemical-analytical level, in which one tries to define the composition of the system - how many and which proteins, how much and which water, how much starch, how many and which additives? The other level, which is what interests us more here, is the structural-dynamic: how the various chemical components are organized in relationship to one another, and how this structure can alter over time after various processes the system is forced to undergo.
Optical microscopes are essential for these studies. In fact, the dimensions that characterize the structure are the starch particles , or the reticulate mesh of the gluten. These dimensions are on a scale of microns (millionths of a meter), and are thus accessible to optical microscopes. In Figure 1, the microphotography shows the pasta that was destined for the consumption by the prisoners, and modern pasta. The images were made with the CO.RI.AL. Barilla confocal microscope. The light areas are the starch particles. The more irregular structure with large gaps, that characterize the ancient pasta, is evident. A more in depth analysis of these results is

Fig. 3 - A statistical analysis of the distribution of the peaks in Figure 1. With these methods, it is possible to extract precious information for images that are seemingly completely random.



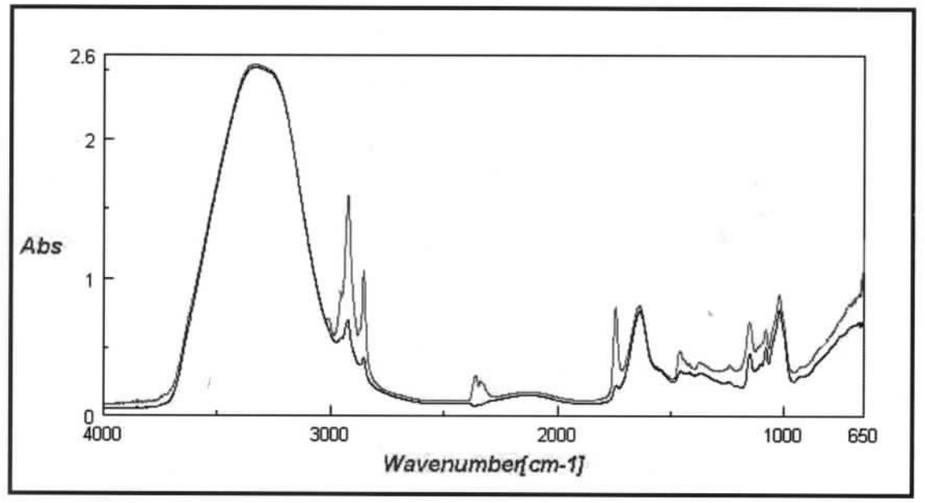
presented in the following chapter. If we now increase the spatial resolution for observing the pasta, and we zoom onto one of these grains, we see that its structure is not at all homogeneous as it had seemed, but rather is covered with a mesh of smaller particles. In Figure 2, we show an image taken with an electron microscope that is pointed at the center of one of these grains. This type of image is very similar for modern pasta too. So, while on a scale of tens of microns one could discern the morphological differences of the historic pasta, these differences seem to disappear when one pushes the analysis to the sub-micrometric scale.

However, one can do more with the statistical analysis of the images; in Figure 3, we show the profile of the peaks distribution from Figure 1. One can observe the clear asymmetry in relation to the zero height: the explanation for this asymmetry is that in pasta, the valleys are sheerer and steeper than the hills. One can immediately understand how this result can have a gastronomical value: this type of spatial morphology favors the pasta's retention of sauces!

How can we chemically distinguish the spatial arrangement of the various components in a non-destructive manner? A very powerful tool is the sophisticated application of spectroscopy - a Physics technique for materials analysis that has always been essential. There are various spectroscopy techniques, all of which can be used in a microscopic manner to study the microscopic quantity of a material, or to study microscopic areas.

Microspectroscopy allows one to simultaneously have both the chemical information (which molecule) and the structural information (where). It also allows one to follow the potential morphological mutations due to the preparation and successive treatment of the material. In Figure 4, we show an infrared spectrum of a pasta sample obtained through a rather sophisticated modification (ATR - attenuated total reflection) of the normal infrared spectroscopy

Fig. 4 - An infrared spectrum of a sample of cooked pasta obtained using Fourier spectroscopy in ATR mode. Curve 1 (blue): cooking in pure water. Curve 2 (green): cooking in water where a teaspoonful of oil has been added.



technique with Fourier Transform (FTIR). This allows one to see not only the principal components (starch and gluten), but also the water. In Figure 4, which examines cooked pasta, the large peak at approximately 3300cm-1 is due to the presence of water in the pasta. With the normal technique, the water part would have completely hidden the spectrum for the proteins and starches. The figure also shows the spectrum related to pasta cooked in water with a teaspoonful of oil added to it. Despite the minute quantity of oil added, the characteristic spectrum of oil shows itself intensely, a sign of a preferential absorption of the oil molecules into the pasta's surface. This effect is probably due to the surface crevices of the pasta, similar to those shown in Figure 1.

And finally, a bit of theory...

After the microscope determination of the pasta's chemical components, which are, after all, the «building bricks» of the pasta building, one has to face the other side of the question: how do these bricks connect to one another to give life to the building in its entirety? This is where the point of view radically changes. From what we have studied earlier, we must retain only a few essential bits of information: the dimensions of the constituents, their approximate shape, and their predisposition to connect to one another or to stay apart. As one can already imagine, a detailed description would be impracticable, not to mention unproductive. The number of bricks is too big, and we can forget about cataloguing them one by one. This is where statistical definition comes into play - in some way it reverses the rules of the game. I will no longer take the bricks one by one to describe their properties, but having selected the few truly important properties, I will count how many bricks possess them. Then I will pose the question of how these properties interact

between one another: if two «Type A» bricks are more often close together or far apart, if, on average, Type B prefers to be with its like or with Type C, and so on. This way, after only a few steps, we get to reconstructing the entire building. Now, we have to define the architecture - the geometry - as efficiently as possible. Here too, the procedure can be none other than statistical. Forget about the familiar geometrical shapes studied at school. You will never find regular polyhedrons or perfect spheres here. Nature's geometry, that of complex systems where simple bricks lose their identity, is far from regular: it is jagged, furrowed, broken up...fractal, to use the technical term of contemporary science. If the surface of a piece of spaghetti seen from afar reminds one of a cylinder, at mesoscopic scales, which is what interests us here, it is much more similar to an airplane view of the Alps mountain chain. Just as Earth seems to be more or less spherical as seen from space, from an airplane, its mountains, valleys, rivers, and oceans are revealed. While cubes are all cubes and spheres are all spheres, mountains, even though there is something similar between them, are all different from one another! So how do we distinguish and characterize two different mountain scapes? Again, it's statistics that come to our help.

We have to forget about the individual peaks and count how many of them are above a certain height, how many of them are rounded, and how many of them are close together or separated by deep valleys. In the end, we will have an excellent description of the scenery as a whole and we will be able to understand if it will be possible to cross it staying at the same altitude or if we could easily end up trapped in some narrow and deep valley. Imagine now that wandering through this rough terrain (see Figure 2), it isn't an intrepid explorer, but a tasty sauce or the cooking water that has been properly salted: before you lies pasta molecular gastronomy!

THE CHARACTERIZATION OF PASTA IN THE 19TH CENTURY: FOOD CONSIGNMENT TO THE PARMA PRISON

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Introduction

The past has always held a great fascination for human beings, and even more so when elements are found that have a direct link to modern life. This is the case for the fragments of pasta found in the Parma State Archives. Produced more than 150 years ago, this pasta represents a unique find for Italian cultural gastronomy. If it is in fact possible, through documents and citations, to go back to the eating habits of the past, rediscover history and evolution, only by studying the samples, it is possible to try to understand how the foods adorning the table for our ancestors were and compare them to those that we consume today. The chance is fairly remote, though, that there be the possibility to have food samples, usually very perishable, last over time.

Thus one can understand how finding these samples represents a unique, extraordinary occasion to more profoundly examine our historical knowledge of one of the most important and representative foods for Italy: pasta.

The origins of this pasta lot and the production technologies in the first half of the 19th Century are well detailed by historical documents and have been widely discussed in the preceding chapters. What remains to be clarified is how, or better, with what raw materials this pasta was made. In fact, in the last century, durum wheat (Triticum turgidum var. durum Desf.), grain par excellence for making pasta, wasn't cultivated in the northern Italian regions where, instead, bread wheat (Triticum aestivum L.) was and still is widespread.

Fresh pasta, typical of the North, was prepared by housewives using soft wheat flour to which eggs were commonly added in order to obtain a stronger dough.

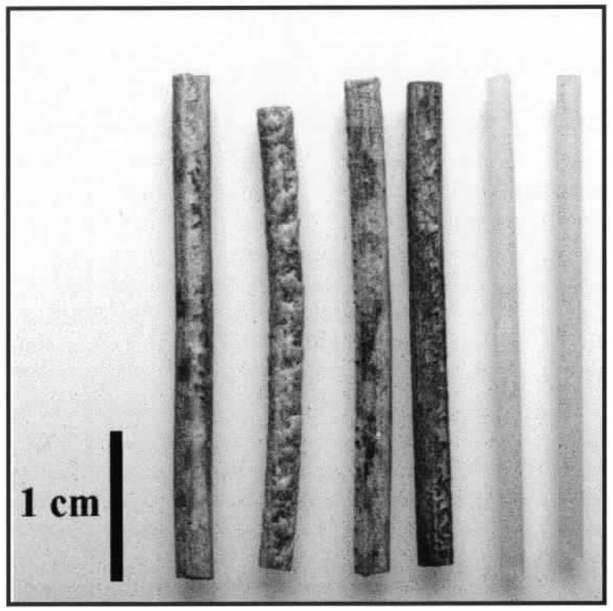
The main problem to be solved in our scientific research was therefore to try to understand what types of raw materials were used for this pasta batch: bread wheat? Durum wheat? Were eggs used too?

To try to answer these questions, the samples were subjected to the most modern analytical techniques concentrating attention both on its physical structure and on its biochemical and genetic composition.

To do studies on the internal structure of the samples and do the classical qualitative analyses, use was made of the experience and the instrumentation available at CO.RI.AL., the research center founded by Barilla in 1993 in the industrial area of Foggia. In fact, Barilla develops research programs on durum wheat and pasta at CO.RI.AL. This is where durum wheat's basic components, its behavior in transformation, and the final qualitative characteristics of pasta are studied.

The study of the biochemical composition was done in the laboratories of the Section for Applied Genetics of the Istituto Sperimentale

Fig. 1 - Comparison between spaghetti produced in 1837 (left) and Barilla spaghetti, Format 5 (right). Compared to modern pasta, the spaghetti found in the Parma State Archives is slightly larger in diameter and has a rather irregular surface. The dark color is probably due to the phenomenon of browning over time. However, one can't exclude that the original coloring wasn't brownish-gray as a result of using a floury meal that still had an appreciable bran flake content.

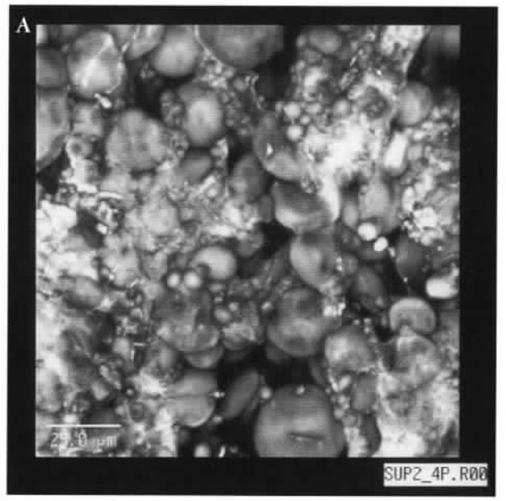


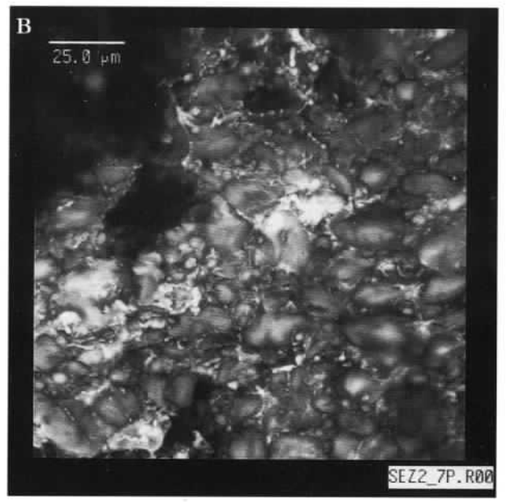
per la Cerealicoltura. The laboratory offered its experience on molecular biology techniques based on DNA and on the reserve proteins of wheat.
Despite the apparent excellent state of external preservation (Figure 1), a more in depth analysis on the sample showed clearly evident signs of the passing of time. Most molecular tests are based on the principal compounds of the cells (DNA and proteins) which had undergone severe degradation and rendered difficult, if not impossible, the compounds' identification.
Unfortunately, the small amount of material that was available to be analyzed (a few grams per sample) and the denaturation of these compounds made the prospects for success of some of the analyses bleak.

Materials and methods

The study of the physical structure of the historic pasta samples was done at CO.RI.AL. through two main microscopy analyses methods: the optical microscope with polarized light and the laser confocal microscope. In the first case, a sample of pasta was cut into sections 20 microns thick and lit with polarized light. The light that passed through the sample was then observed through an optical microscope after passing though a second polarizing filter that was at a right angle to the first. In this way, it was possible to notice the characteristics of the starch that is crystalline in natural conditions. Because of this, the plane of polarized light turns in a particular way (double refraction). Under microscope observation, one can note a very characteristic cross-shape on the starch granules that looks like a Maltese Cross and stands out against the light background of the granule.
However, this characteristic is lost when one treats the sample with specific procedures that induces the gelatinization of the starch. Passing from a crystalline to a gel structure, in fact, the starch loses its double refraction characteristics

Fig. 2 - Lateral surface (A) and cross-section (B) of a piece of spaghetti made in 1837. Both the surface and the inside of the spaghetti display the presence of empty spaces probably caused by the loss of the larger sized starch granules. The regular shape of the granules, which are integral and don't show signs of significant damage or deformation, allows one to suppose that the making of the pasta shapes wasn't done under intense pressure. One can also note the presence of what remains of the protein matrix (light and translucent) that partially envelops the remaining starch granules.

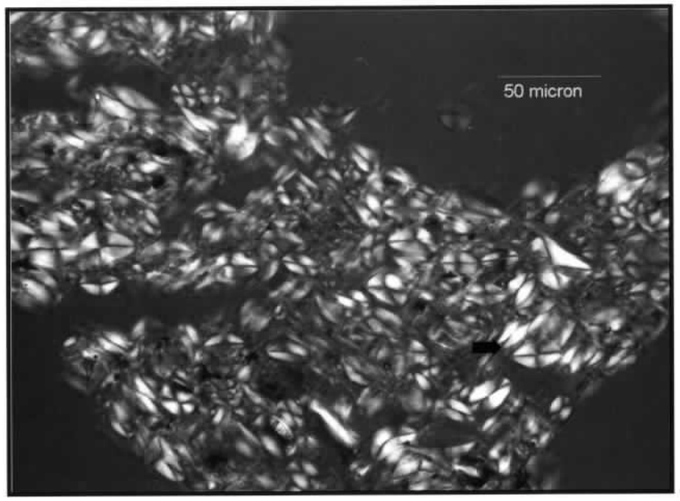




and as a result the «Maltese Cross» disappears. As its light source, the laser confocal microscope uses a laser that induces a fluorescent reaction when it hits the sample. This fluorescent light is then observed and analyzed by a computer which allows one to reconstruct three-dimensional image of the portion of the sample analyzed.
This technique allowed us to study the physical characteristics of the pasta penetrating through the surface to the inside without damaging the structure or destroying the sample. The wavelength of the light used was 488nm. Several scans were done beginning from the surface to a depth of 0.01 mm. A specific algorithm then allowed for the reconstruction of a three-dimensional image (Figures 2 and 4).
Since the protein content (nitrogenous substances) is one of the characters most associated with the qualitative values of pasta, the sample was subjected to traditional chemical analysis with the Kjeldahl method.

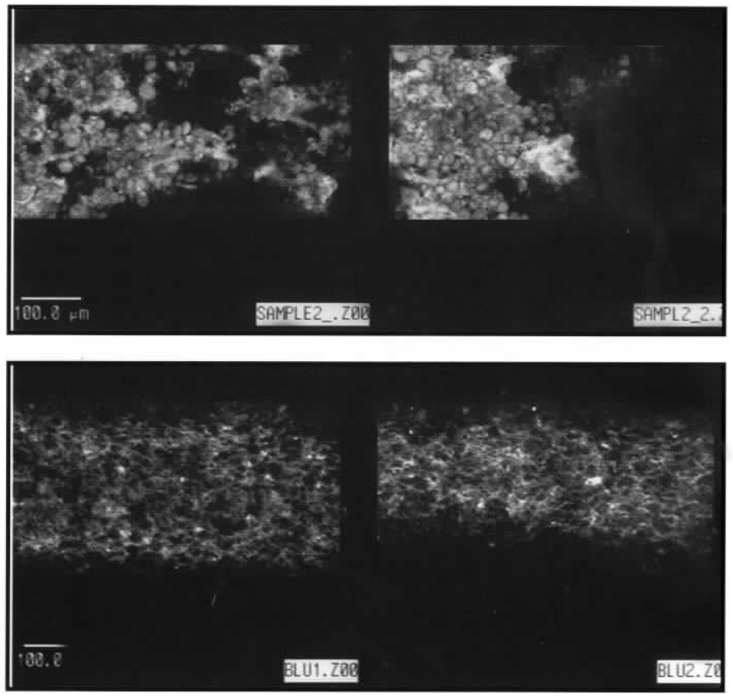
To identify the raw materials used in making this pasta, modern methods for molecular analysis were used.
The composition of storage proteins is a characteristic and distinctive element for both soft and durum wheat to the point that it can be used not only to distinguish one species from another but also to identify certain varieties within the same species. To identify the type of grain used, proteins were extracted from the historic pasta samples and subjected to classic electrophoretic analysis. This technique consists of placing the extracted proteins on a gel (in relation to the chemical compounds used to make the gel we are speaking of A-PAGE or SDS-PAGE) and subjecting them to the action of an intense electrical field. The proteins electrically charged, move on the gel in relation to their size and mobility, separating from each other in a constant and repeatable manner. Thus, knowing the characteristics, one can identify the presence of

Fig. 3 - Cross-section of a piece of the 1837 spaghetti under an optical microscope using polarized light. One can note the characteristic «Maltese Cross» (see arrow) on the starch granules that is typical in starch when it is in its natural crystalline form.



proteins that are specific to durum or to bread wheat in the sample analyzed.
A different system used to identify the composition of a sample is based on the use of markers: specific elements or characters that unequivocally identify, mark, what one is looking for. In our case, the most interesting markers are two proteins: ovalbumin, typical of a hen's egg, and friabilin (puroindoline b). The latter is a protein specific to bread wheat and absent in durum wheat. This is why it is sometimes used to determine bread wheat contamination in durum wheat lots.
To single out these two proteins, the «Western Blotting» technique was resorted to. In both cases, the proteins were separated using electrophoresis (SDS-PAGE), then transferred to cellulose nitrate membrane, and then hybridized with a specific antibody. For friabilin, the antibody was marked with peroxidase and developed with 4-chloronaphthol and hydrogen peroxide in an appropriate buffer, whereas for the ovalbumen, the specific antibody - derived from rabbits - was further hybridized against rabbit immunoglobin and then marked with peroxidase.
A different approach, possible only for friabilin, is done by using not the piy protein, but the gene directly responsible for the synthesis of the protein itself as a marker. Knowing the marker gene (the friabilin gene has been extensively studied and analyzed by many researchers), it is possible to isolate and identify its presence, even if the concentrations are very low, through a molecular biology technique called Polymerase Chain Reaction (PCR). The PCR technique consists in the amplification of specific DNA sequence done through three successive steps:
1) denaturation: separation of the DNA double helix into single chains as a result of increased temperature;
2) hybridization: after lowering the temperature, the primers (short DNA sequences that are complementary to the portion of the gene to be amplified) are introduced into the sample link to the single DNA helixes;
3) elongation: the primers function as starters for the polymerase, an enzyme responsible for the synthesis of DNA, provoking the synthesis of the portion of DNA enclosed within the pair of primers.
With the cyclical repetition of these phases, the DNA sequence can be amplified (multiplied) countless times, even if there are only a few pairs present. At the end of the process, the DNA reaches elevated concentrations and can thus be viewed through electrophoresis.

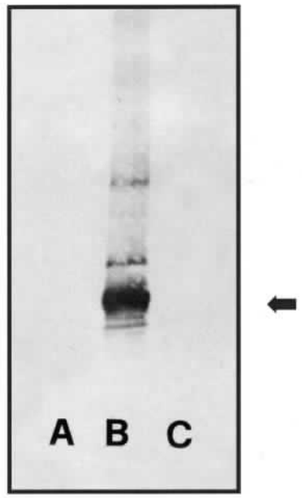
Fig. 4 - Microscopic analysis of the lateral surface of the spaghetti produced in 1837 and of modern spaghetti. Different from modern spaghetti, where a diffuse and continuous protein matrix that envelops and hides the starch granules is evident, in the historic spaghetti the gluten is scarce and fragmented. The starch granules, on the other hand, are quite evident. Furthermore, the surface appears irregular and discontinuous probably as a result of the loss of starch granules that were only weakly held by the protein matrix.



Results

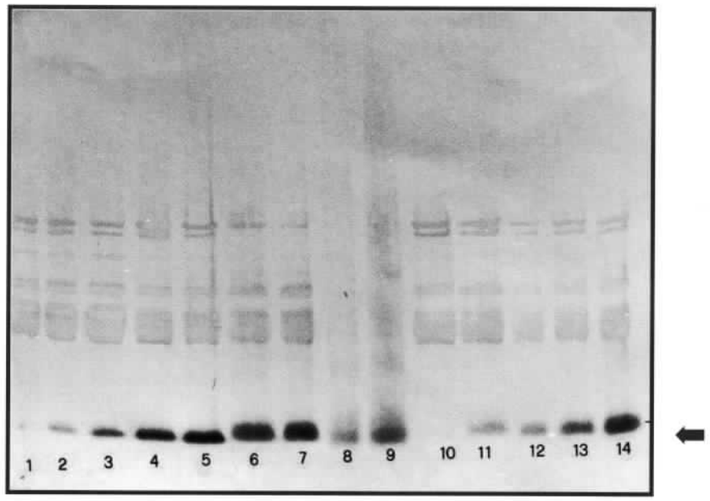
The pasta samples, seemingly well preserved, are dark in color and have a coarse surface (Figure 1). The reasons for this coarseness become clear after structural analysis of the sample with a laser confocal microscope: observing the surface, one can note numerous empty spaces, probably caused by the pasta having lost matter. For the layers of the piece of spaghetti close to the surface, one notes a rather considerable loss of material equal to 20-25% of the volume (Figure 2).
Proceeding with the analysis toward the center of the piece of spaghetti, the missing fractions are reduced significantly to values lower than 10%. Looking at the photos, the starch granules are particularly evident, they have convex and roundish shape with the size varying from 3 to 10 microns. Normally, wheat has bigger starch granules as well (40 microns), even if those are many fewer than the small ones. These starch grains don't show any particular signs of having been flattened or compressed, as occurs in modern pasta granules because of the high extrusion pressure used today on production lines. This fact confirms the hypothesis that the pressure exerted for extrusion was rather low: in

Fig. 5 - Molecular analyses (Western Blotting) to identify the ovalbumin. As one can see in the spaghetti found at the State Archives (lane C), like with semolina pasta of today (lane A), the band relative to the ovalbumin is absent. Instead, it is present in the evidence (lane B) as is indicated with the arrow. This result allows us to exclude the presence of eggs in the historic pasta.



the first half of the 19th Century manual presses were still used for making pasta.
From the analyses with the optical microscope under polarized light (Figure 3), the formation of the «Maltese Cross» on the starch granules is quite visible for the historic sample as with modern pasta. Thus, during the transformation process the pasta was not subjected to conditions (temperature, level of hydration) such that it would induce gelatinization of the starch. The starch granules are sorrunded by what remains of the protein matrix (Figure 4). Normally in a piece of spaghetti, the protein matrix works as a «column-beam» and the starch granule as the «brick». In the case of the historic pasta, the original protein matrix seems to be broken up and disintegrated, even if the chemical analyses of the nitrogenous substances shows a high presence of it percentage-wise (14%). This value, quite comparable to the protein percentages in current pasta, can be explained by the fact that, as a result of the degradation of the protein matrix, the starch granules detached from the pasta structure forming the empty spaces observed under the microscope. The pasta thus seems to have lost proportionally more starch than protein. In fact, it is difficult to hypothesize that the protein content of wheat cultivated 150 years ago could be higher than that of actual production.
A different explanation for the elevated protein content could be linked to the use of eggs in the dough. Eggs, in fact, are a typical ingredient in preparing fresh homemade pasta in the regions of northern Italy. With molecular biology analyses (Western Blotting) and specific antibodies and hybridization, it wasn't possible to isolate the presence of ovalbumin (Figure 5, lane C). This is the reason why it is believed that eggs were not used in the making of this specific pasta.
The same technique was employed to show that, amongst the ingredients, bread wheat is of notable importance. The identification of friabilin (Figure 6, lane 8 and 9) prove the presence of soft wheat in the pasta. In fact, this protein is present in soft wheat starch granules, but is absent in other grains such as durum wheat. Though the analysis permitted us to prove the presence of soft wheat in the pasta, it isn't possible to exclude or confirm the use of durum wheat. As far as this is concerned, the molecular analyses didn't allow us to obtain any further information.
In fact, these analyses, as sensitive as they are, nevertheless require the presence of the protein or of the gene that codifies it in conditions such that it is possible to identify it.

Fig. 6 - Molecular analyses (Western Blotting) for the identification of friabilin in the spaghetti produced in 1837-38. Friabilin is a typical protein in soft wheat and is absent in other grains. The strip indicated by the arrow shows presence of friabilin in the historic pasta (lane 8 and 9), which is absent in pasta made only of durum wheat (lane 1 and 10). The intensity of the band is proportional to the quantity of soft wheat present in the control pasta (lanes 2-5 and 11-14).



In the case of our sample, on the other hand, over the years both the proteins and the relative DNA have undergone serious denaturation that, having provoked its breaking down into fragments of very small dimensions (the DNA, for example, is in fragments with less than 20 pairs of bases), rendered the success of some of the molecular analyses impossible.

Conclusions

Despite the excellent exterior state of preservation, the pasta has undoubtedly suffered from its 160 years of age and for this reason it wasn't possible to demonstrate if it was made up mainly of durum wheat. On the other hand, we were able to demonstrate the use in considerable quantity of a raw material that is quite plentiful in northern Italy, soft wheat.
Furthermore, we can exclude the presence of eggs as a possible other ingredient, though its use was common in the making of fresh homemade pasta in northern Italy.
Finally, it is possible to deduce, based on the enlarged views of the starch granules, that the pressure applied during extrusion was particularly low.

BIBLIOGRAPHY

- AACC, Approved Methods Committee
(1995) *Approved methods of the American Association of Cereal Chemists*. AACC - American Association of Cereal Chemists, St.Paul, MN.
- BLONK JCG, VAN AALST H
(1993) *Food Research International*. 26: 297-311
- BURNETTE WN (1981)
Western Blotting: Electrophoretic transfer of proteins from sodium dodecyl sulfate-polyacrylamide gels to unmodified nitrocellulose and radiographic detection with antibody and radioiodinated protein. A. Anal Biochem. 112: 195
- FABRIANI G, LINTAS C
(1988) *Durum wheat: chemistry and technology*. AACC - American Association of Cereal Chemists -, St. Paul, MN.
- HEERTJE I, VAN DER VLIST P, BLONK JCG, HENDRICKX HACM, BRAKENHOFF GJ
(1987) *Food Microstructure*. 6: 115-120
- HERMANSSON AM, SVEGMARK K
(1996) *Trends in Food Science & Techn*. 7: 345-353
- KALAB M, ALLAN-WOJTAS P, SHEA MILLER S
(1995): *Trends in Food Science & Tecn*. 6: 177-186
- MULLIS KB, FALOONA FA
(1987) *Specific synthesis of DNA in vitro via a polymerase catalyzed chain reaction*. Meth. Enzymol. 155, 335-350
- MORRISON WR, GREENWELL P, LAW CN and SULAIMAN BD
(1992) *Occurrence of friabilin, a low molecular weight protein associated with grain softness, on starch granules isolated from some wheats and related species*. Journal of Cereal Science 15: 143-149
- MORRIS CF, GREENBLATT GA, BETTGE AD, MALKAWI HI
(1994) *Isolation and characterization of multiple forms of friabilin*. Journal of Cereal Science 21: 167-174
- NIGLIO A, GAZZA L, IORI A, POGNA NE
(1999) *Detection of bread wheat adulteration of high-temperature-dried pasta by using an anti-friabilin antibody*. Tecnica Molitoria Aprile 399-405
- POMERANZ Y
(1988) *Wheat chemistry and technology*. AACC - American Association of Cereal Chemists, St.Paul, MN.
- RANIERI R, ROMANO R
(1996) Premio Barilla, *Dal grano alla pasta*. Barilla, Parma. IT.

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