

Science and cooking: the era of molecular cuisine

SSS Science & Society Series on Food and Science

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In January 2009, I participated in a roundtable discussion, “Does ‘Molecular Cuisine’ Exist?”, at Madrid Fusion, the largest gastronomy conference in the world. It was the most popular event at that conference, which is impressive considering that, until 20 years ago, the adjective molecular was never used in conjunction with the words gastronomy, cooking or cuisine. Indeed, when the poster for the first “International Workshop on Molecular and Physical Gastronomy”, held in Erice, Italy, appeared in 1992, many people at universities around the world thought it was a joke. Actually, its original title was simply “Science and Gastronomy”, but it had to be changed to sound less ‘frivolous’ and more academic for the printed announcement of the workshop. The term molecular was chosen as molecular biology was the hot scientific field at the time (McGee, 2008).

The interactions between science and cooking are as old as science itself...

The participants in the first Erice workshop included not only scientists, but also chefs and writers. The goal of the meeting was to explore four points: “to what extent is the science underlying these [cooking] processes understood; whether the existing cooking methods could be improved by a better understanding of their scientific bases; whether new methods or ingredients could improve the quality of the end-products or lead to innovations; whether processes developed for food processing and large scale catering could be adapted to domestic or restaurant kitchens.” As such, the novelty

of the workshop with respect to other food-science meetings was the emphasis on gastronomy and real kitchens, rather than industrial processes and products.

The interactions between science and cooking are as old as science itself: the French physicist Denis Papin invented the pressure cooker in 1679 and described it in a book that can be considered the first modern text on ‘science and cooking’ (Papin, 1681). However, at the end of the twentieth century, cooking was increasingly considered a frivolous and unimportant subject for scientists, and science itself had become detached from people’s everyday lives. Nevertheless, the recent, impressive advances in biochemistry and soft-matter physics have helped scientists to analyse and comprehend culinary processes in a way that would have been unthinkable a few years ago. One of the first indications that the scientific analysis of culinary phenomena could be improved was the publication of the now classic book *On Food and Cooking: the Science and Lore of the Kitchen* by Harold McGee (McGee, 1984), which is still a reference for cooks around the world.

Meanwhile, the young Spanish chef Ferran Adrià started the greatest culinary revolution of the century by using the siphon—originally designed to make whipped cream—to produce mousses and foams with unusual ingredients, such as vegetables, fruits, fish and meat. Adrià was looking for novelty in every area of cooking, and he started to experiment with new techniques and new ingredients, but did not interact with science or scientists. In

parallel, the Erice workshop took place five more times in 1995, 1997, 1999, 2001 and 2004, and was mainly devoted to exploring the more scientific aspects of traditional cooking, namely understanding the science underlying cooking processes and ways to improve existing techniques by applying this knowledge.

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True collaborations between chefs and scientists only started at the beginning of the past decade: in France, chef Pierre Gagnaire teamed up with Hervé This; Heston Blumenthal in England with Peter Barham; in Spain, Andoni Luis Aduriz and later Dani Garcia with Raimundo Garcia del Moral, and Ferran Adrià with Pere Castells. In Italy, I started collaborating with Ettore Bocchia and, in 2002, we presented an experimental menu of innovative Italian cuisine that was based on scientific investigation. We



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Sidebar A | The manifesto of Italian molecular cuisine

Italian molecular cuisine aims to develop new techniques for cooking and to create new dishes, remaining firmly loyal to the following principles.

- (i) Every innovation must expand, not destroy, the Italian gastronomic tradition.
- (ii) The new techniques and the new dishes must enhance the natural ingredients and the high-quality raw materials.
- (iii) It will be a cuisine attentive to the nutritional values of food and to the well-being of those who eat it, not only to aesthetic and sensory aspects.
- (iv) It must meet its goals by creating new textures with ingredients chosen according to the above criteria. It will create new textures by studying the physical and chemical properties of the ingredients and planning, from these, new microscopic architectures.

declared that it was inspired by molecular gastronomy, but a newspaper article introduced a new expression: molecular cuisine (Paltrinieri, 2002).

This term was unusual, but we decided to use it nonetheless because ‘cuisine’ sounded more practical and realistic than ‘gastronomy’, and it was better suited to describing our work (Cassi, 2004). In the following years, the term was unexpectedly successful, and people began to use it to describe any type of cuisine arising from collaborations between chefs and scientists. It goes without saying that each of the chef–scientist pairs mentioned above produced different types of cuisine. To more accurately define our style, we therefore decided to call it “Italian molecular cuisine”, and we published the *Manifesto of Italian Molecular Cuisine* (Cassi & Bocchia, 2005a,b; Sidebar A).

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These first examples of collaborations seemed to fulfil the third point of the goals of the Erice meeting—to apply new methods and ingredients to improve the quality of food and create new dishes—but eventually they also fulfilled the final point: to bring food processing techniques to domestic and restaurant kitchens. From 2003 to 2005, the European Union funded a project called INICON (Introduction of Innovative Technologies in Modern Gastronomy for Modernisation of Cooking), which helped to transfer ingredients and techniques from industrial food technology to restaurant kitchens. The most relevant result of this project was the introduction

and popularization of food additives—mainly texturizers—to the haute-cuisine world and ordinary restaurants. It also created the first problems for molecular cuisine; as the greatest chefs used these additives in a creative way, an increasing number of other cooks misused them, simply for special effects.

Soon, the media associated molecular cuisine with food additives, making no distinction between the great chefs and their bad imitators. As a consequence, many top chefs dissociated themselves from molecular gastronomy and molecular cuisine. At the end of 2006, Ferran Adrià, Heston Blumenthal and Thomas Keller, together with Harold McGee, published a statement on the ‘new cookery’: “The fashionable term ‘molecular gastronomy’ was introduced relatively recently, in 1992, to name a particular academic workshop for scientists and chefs on the basic food chemistry of traditional dishes. That workshop did not influence our approach, and the term ‘molecular gastronomy’ does not describe our cooking, or indeed any style of cooking” (Adrià *et al*, 2006).

Soon after came the first attacks on molecular cuisine, on the basis of allegations that additives dangerous to health were being used. In 2008, the Spanish chef Santi Santamaria published a book called *La Cocina al Desnudo* (‘The Bare Kitchen’; Santamaria, 2008) and, in 2009, the German journalist Jörg Zipprick published, in Spain, an even more explicit book, the translated title of which is *I Don’t Want to Go Back to the Restaurant! How the Molecular Cuisine Serves us Wallpaper Paste and Fire Extinguisher Powder* (Zipprick, 2009). In the same year, a satirical Italian television programme started an aggressive campaign against molecular cuisine and the use of additives in restaurants, which even prompted the health

ministry to issue an order restricting their use. Although all the additives used in restaurants are authorized by the European Union for human consumption and are no different to the additives we eat every day in industrial products, those campaigns had a great effect on public opinion, and many people became aware of molecular cuisine only through these attacks.

The round table discussion in Madrid in 2009 was organized to discuss this situation. The participants—myself, Ferran Adrià, Heston Blumenthal, Andoni Luis Aduriz and Harold McGee—agreed on two basic points: the term ‘molecular cuisine’ does not indicate a specific style of cooking, as the chefs labelled as ‘molecular’ have very different styles; and the role of science in cooking is usually limited to the development of a new technique or a new recipe and there is very little ‘science’ in the final preparation of a dish. In other words, one can learn a new technique that is the result of scientific experimentation and apply it without knowing the science, just as we can use a computer without knowing anything about the electronics inside. It is therefore necessary to distinguish between the scientific phase—or ‘scientific cooking’, in which we explore new techniques and dishes—and the practical phase, in which we realize that dish in a kitchen.

It is undeniable that during the past decade, a scientific approach to cooking has produced a huge number of new techniques and recipes—more than in any other period of history—and introduced new ingredients and devices. These techniques and dishes are what the media and commentators on the internet commonly call ‘molecular cuisine’.

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Many of these inventions are probably short-lived fads, but it is certain that many others will come to be commonly used in restaurants and in home kitchens, and become part of the culinary tradition. In fact, culinary tradition is not a fixed and unchanging list of old recipes, it is a structured set of ingredients, dishes,

techniques and rituals, united by a common spirit, that evolves continuously to adapt to present needs.

During the past few decades, it has become apparent that we need to change our diet for several reasons. First, our lifestyles have dramatically and rapidly changed, but our diet has not. Second, scientific inquiries and epidemiological data have shown that some elements of our diet—notably fats and carbohydrates—should be reduced, whereas other should be consumed in larger amounts, to meet nutritional requirements. In addition, new ingredients have become available and others are now more difficult to find in markets and supermarkets. Lastly, our tastes and our way of viewing food are changing continuously. All this takes place at an increasing rate, fostered by the greater ease of international travel and the fast dissemination of information through the media and the internet.

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To better understand the need for change and adaptation with regard to food and the role that science can play, it is illuminating to consider what Auguste Escoffier, the father of modern French cuisine, wrote more than a century ago: “If everything is changing, it would be absurd to claim to fix the destiny of an art based, in many respects, on fashion, and as unstable as it. If taste is becoming more refined, the culinary art too has to conform to it. To contrast the effects of modern super activity, cooking will become more scientific and precise” (Escoffier, 1903).

Even if it is impossible to determine which innovations will become an integral part of culinary tradition, we can make some predictions. The relationship between the world of haute cuisine—in which most innovations have been developed—and that of common cooking, is similar to the relationship between Formula 1 racing and the consumer car market; inventions only enter into common use if they meet certain basic requirements. Specifically, they have to be sufficiently simple to use, widely applicable, easily available and affordable, and in line with the main trends of the consumer market. Of course, trends tend to change and

evolve over time, but general trends have a much longer lifespan than mere fashions. For several years, these trends have been a nutritional-dietetic trend (food for health), a natural-biological trend (no ‘chemistry’, no synthetic ingredients), and an aesthetic trend. Taking into account these requirements, we can now discuss the main innovations introduced by molecular cuisine, and evaluate which ones are most likely to survive.

Texturizers are generally easy to use and allow the chef to, for example, simply and quickly transform a liquid into a gel or foam

Innovations can be broadly grouped into three classes: ingredients, tools and devices, and processing techniques, even with usual ingredients. New ingredients are generally food additives—which is the main focus of the criticism levelled at molecular cuisine. However, the definition of a food additive is not scientific, but legal: the European Union defines these as any substance not normally consumed as a food in itself—even if it has nutritional value—and not normally used as a characteristic ingredient in food, but which is added for a technological purpose in the manufacture, processing, preparation, treatment or packaging. This definition also does not say anything about the origin or possible health risks of these substances, which can be very different from each other.

These new ingredients are mostly texturizers—that is, substances that give food a desired texture—and they are usually sold as powders. It is not difficult to understand the reason for their success among cooks. To add taste, flavour or colour to a dish, we just add a pinch of a powder or a few drops of a liquid. Creating textures is considerably more complex: texture depends on the microscopic arrangement of molecules, and altering it can require both the addition of ingredients and the use of specific procedures. Texturizers are generally easy to use and allow the chef to, for example, simply and quickly transform a liquid into a gel or foam. The main categories of texturizers used in molecular cuisine are gelling agents, emulsifiers and thickeners. If they are used well, chefs can obtain results that are not possible with traditional ingredients (Sidebars B, C).

Until a few years ago, the only gelling agents used in the kitchen were gelatine and pectin for jams. Gelatine produces pleasant gels such as aspic, but it melts at 35°C and therefore does not allow the creation of hot gels. When Ferran Adrià realized that agar, a common ingredient in the Far East, melts at 85°C, he began to use it for a new class of preparations that were unusual for Western cuisine. Since then, other gelling agents with specific properties have been introduced into the kitchen: the most popular ones are carrageenans, gellan gum, methylcellulose and sodium alginate. The latter two enabled the creation of very original dishes. Methylcellulose behaves oppositely to gelatine: at temperatures above 55°C it forms a firm gel that melts as it cools. It is used to prepare so-called ‘hot ice cream’. Sodium alginate polymerizes into a gel in aqueous solutions that contain calcium ions: one calcium ion replaces two sodium ions and links two polymer chains together. Adrià uses it in a peculiar technique called spherification: sodium alginate is added to a liquid, which is dropped into an aqueous solution of calcium chloride. The alginate at the surface of the droplet becomes a gel and forms a thin film around the liquid inside.

The most widely used emulsifier is soy lecithin. It is useful not only for creating a variety of sauces based on fat-in-water emulsions, but also for producing extremely soft foams called ‘airs’. The latter contain a small amount of liquid with respect to their air content, have a pleasing appearance and are particularly suitable for diluting aromas and flavours to distribute them evenly in a dish. However, soy lecithin is not suitable for water-in-fat emulsions and air-in-oil foams; for this kind of preparation mono- and diglycerides of fatty acids are commonly used.

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Thickeners—substances that increase the viscosity of sauces and, more generally, of liquids—are already widely used in traditional cooking, most commonly flours and starches. However, large amounts of these traditional thickeners are usually required, which is a problem from the gastronomic point of view, because they dilute tastes and flavours. Cooks have therefore started to use

Sidebar B | Guggenheim Bilbao (Quique Dacosta)

Ingredients (serves 4)

Shellfish stock

- 400 g cockles
- 200 g barnacles
- 25 g shallots
- 3 oysters
- Half a clove of garlic with skin
- 1 l mineral water
- 25 g aloe vera

Base of the plate

- 0.5 dl shellfish stock
- 0.3 g agar
- 2 drops lemon juice
- 0.2 g silver powder
- 2 ml aloe vera juice

Silver and titanium veil

- 100 g shellfish stock
- 0.7 g agar
- 2 g gelatine
- 5 ml centrifuged aloe vera juice
- 0.2 g silver powder
- 0.2 ml liquid titanium

Preparation

Shellfish stock. Clean all ingredients, cover with water and bring to the boil. Skim and simmer for 1 h over a low heat, without boiling. Let the stock stand for 2 h, then strain.

Base of the plate. Boil the shellfish stock with agar, then add the juice of centrifuged aloe vera, cool to 40 °C and add the silver powder with the lemon juice. Pour 12 g of this preparation on to the bottom of the plate and let it solidify.

Silver and titanium veil. Boil the shellfish stock with agar and gelatine. Remove from the heat and let it cool to 40 °C, then add silver and titanium. Pour it into a pan, to form a 1 mm-thick layer. Let it stand until a gel forms that can be handled and heated under the grill.

Silver and aloe vera sheet. Bring the stock to the boil, add tapioca and aloe vera juice and cook for 15 min. Blend, strain and add the silver, stirring with a whip to get a thick paste. Roll it up on a sheet of parchment paper. Bake at 60 °C and let it dry until you get a crispy, thin and brittle layer.

Oysters. Shuck the oysters and heat them on the grill for 30 s, using juniper ember to flavour them.

Final preparation

Arrange the heated oysters on the plate, cover with the veil, heat under the grill for 30 s, let thicken and decorate with the silver and aloe vera sheet (Meldolesi & Noto, 2006).



Photo by Bob Noto, from the book *Grandi chef di Spagna*

Silver and aloe vera sheet

- 200 g shellfish stock
- 35 g tapioca
- 1 g silver powder
- 35 g aloe vera

Oysters

- 4 large oysters
- Juniper ember

might be used often, the most interesting new techniques are *sous-vide* cooking and ultra-rapid cooling in liquid nitrogen. The former was first used in France in 1974 by Georges Pralus, but only began to spread to restaurant kitchens in the 1990s. It involves cooking food—usually meat, poultry and fish—in vacuum-sealed plastic bags that are immersed in a water bath for long periods of time. The temperature is accurately maintained and is usually much lower than 100 °C—typical cooking temperatures for *sous-vide* range between 50 and 70 °C—and the cooking time can extend to three days. The vacuum-sealed bags are mainly used to prevent oxidation and exchange of matter between food and water, but the key point of this technique is temperature control, which makes it possible to produce a variety of textures and flavours.

The main reason for the slow uptake of this technique apart from in restaurants has been cost: the price of the most popular digital thermostat with thermal immersion circulator exceeds €1,500. However, one year ago a water oven was launched that costs only €600, and Heston Blumenthal announced a *sous-vide* cooking device for €300. At this point, it is easy to imagine that *sous-vide* cooking will arrive in home kitchens in the coming years, as the microwave did years ago.

Becoming more experienced, the interested cook can develop new custom dishes by applying the techniques that he or she has learned, or more general scientific principles

The second technique uses liquid nitrogen to cool food at a speed that is impossible by any other method. It allows not only deep-freezing of food at home—even just-cooked food, preserving all its flavours—but also new textures and dishes to be produced. Ultra-rapid cooling of a liquid below its solidification temperature generally produces many small crystals rather than a few big crystals, but it can also give rise to glassy structures with peculiar mechanical and thermal properties. Without going into more detail, by using liquid nitrogen cooks can make a smooth ice cream from almost any liquid—fruit juice, wine or beer, a cup of coffee or soup—without the use of additives such as thickeners or emulsifiers.

xanthan gum, which produces a significant thickening effect, even in small amounts.

All of these new ingredients are generally not too expensive and could become popular in household kitchens, despite attacks in the media against food additives. The biggest problem probably relates to methylcellulose, which is a synthetic compound and not a natural substance. At present, most of these additives can only be purchased at specialty retailers—with the exception of soy lecithin, which is sold in supermarkets in Italy—and this does not help their dissemination. In addition, they are not part of traditional food culture and people do not know how to use

them. It is likely that their use will become more common when a sufficient number of recipes are published by trusted chefs, or a sufficient number of dishes that make use of them are prepared on television cooking programmes.

Turning to new tools and devices, it is important to consider those that have wider applications. A good example of science applied to cooking is the microwave oven, which can now be found in nearly every kitchen. It also demonstrates the point that most people only invest in equipment that they will use regularly. If we limit ourselves to considering devices that

The main problems for the uptake of this technique are the availability and price of Dewar containers for storing liquid nitrogen—these usually cost a few hundred Euros. However, no special tools are required to use liquid nitrogen in a home kitchen, and these problems could be solved by selling it in small quantities, which can be stored for a day in a common metal thermos flask.

Several other interesting devices have been introduced in top restaurants, such as vacuum-pressure cookers, rotary evaporators and lyophilizers. However, their prices make them unaffordable for most restaurants and even more so for home users. Nevertheless, some small manufacturers have begun to successfully market food that has been processed with these devices, thereby increasing the availability of new ingredients.

In any case, it is not necessary to use new ingredients or new tools and devices to create new foods. We can invent new processing techniques for normal ingredients using normal tools and devices. This is one of the distinguishing features of the Italian approach to molecular cuisine. Indeed, science can help us to think of new ways to transform food, even in traditional contexts.

In 2002, I was looking for ‘frying’ methods that do not use fats. I needed a liquid that could be heated to temperatures high enough to generate Maillard reactions without evaporating or burning. The solution was molten glucose: glucose powder that is molten in a pot on fire. It conducts heat and retains flavours better than oil, and the results were excellent, from a gastronomic point of view.

Other good examples of new foods are the egg curd and marinated egg-yolk, which are created by using room-temperature techniques to denature and coagulate the egg proteins. For the former, we pour alcohol on the egg, stir and then wash the curd in cold water and wring it in cheesecloth. The second method, introduced by the Italian chef Carlo Cracco, denatures and coagulates the egg-yolk proteins in a mixture of salt, sugar and dry bean puree.

Another product in line with the Italian tradition is the legume-flour pasta that I introduced in 2007 with the chef Fulvio Pierangelini. The gluten-free legume flour is cooked for several hours at 90 °C in a dry oven and, once cooled, it is mixed with water and kneaded. The heat denatures

Sidebar C | Encapsulated olive oil with virtual Iberian bacon (Ferran Adrià)

Ingredients (serves 4)

For the solution of sodium alginate

0.5 l water
3 g sodium alginate

For the solution of calcium chloride

1 l water
10 g calcium chloride

For the olive oil capsules

500 g solution of sodium alginate
1 kg solution of calcium chloride
60 g olive oil

For the ham consommé

250 g scraps of Iberian ham
0.5 l water

For the melted ham fat

100 g Iberian ham fat

Preparation

For the solution of sodium alginate. Mix water and sodium alginate in a blender until sodium alginate is completely dissolved and store in refrigerator for 24 h.

For the solution of calcium chloride. Dissolve the calcium chloride in water and set aside.

For the olive oil capsules. Encapsulate the olive oil with an encapsulator, producing spherical capsules of 4 mm diameter. Prepare 15 g of capsules per person and store in refrigerator.

For the ham consommé. Cut the ham into small pieces and cover with water. Boil over medium heat for 15 min, skimming constantly. Filter and degrease the broth.

For the melted ham fat. Remove the lean part from the ham fat. Cook on a low heat for 20 min. Pour and store the liquid fat.

For the hot ham jelly. Dilute the agar in the ham consommé at room temperature and bring to the boil, stirring with a whisk. Remove from the heat and skim. Pour the gelatine on a flat plate and roll it up to get the sheets 1 mm thick. Let it solidify in the fridge for 2 h.

Final preparation

Melt the fat of Iberian ham and brush the sheets of jelly with the consommé. Place 15 g of oil capsules on the bases of four oval gold tray and sprinkle with Maldon salt. Heat the jelly under the grill and place 8 pieces of gelatine of approximately 2.5 cm above the capsules, to simulate the appearance of bacon. Heat under the grill and serve (Meldolesi & Noto, 2006).

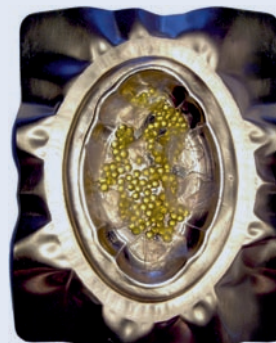


Photo by Bob Noto, from the book *Grandi chef di Spagna*

For the hot ham jelly
2.5 dl Iberian ham broth
4.5 g agar
Maldon salt to taste

the legume proteins, thereby facilitating the formation of bonds between them in the presence of water during kneading. This gives rise to a network structure without gluten. Subsequent cooking in boiling water reinforces the network and produces a unique *al dente* texture.

Moreover, it could encourage people to spend more time preparing and enjoying their food and, hopefully, adopt a healthier diet along the way

For obvious reasons, this type of innovation is the easiest to disseminate and it can be done in the home kitchen with common ingredients and tools. Anyone who is intrigued by this novel dish might then ask

about its basis and might be stimulated to learn more about the underlying science. Becoming more experienced, the interested cook can develop new custom dishes by applying the techniques that he or she has learned, or more general scientific principles. He or she can, for example, produce emulsified sauces without cholesterol, by using egg white or soy lecithin instead of egg yolk. He or she can also invent vegetarian versions of prawn crackers, by frying retrograded starch gels.

All of this is useful for both the popularization of science and the creation of new foods. It also enables the creation of a new cooking culture, in which the consumer is able to adapt cooking processes to his or her dietary needs and taste. Moreover, it could encourage people to spend more time preparing and enjoying their food and,

hopefully, adopt a healthier diet along the way. The application of science to cooking has another dimension: as scientists increasingly analyse what we eat, why we prefer certain foods and what we should eat to be healthier, it is therefore logical that science should also investigate and help us to improve the ways in which we prepare our food—not just for the culinary pleasure of haute cuisine, but for everyone who enjoys cooking.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

REFERENCES

- Adrià F, Blumenthal H, Keller T, McGee H (2006) Statement on the 'new cookery'. *The Observer* December 10
- Cassi D (2004) Science and cooking combine at gastronomic physics lab in Italy. *Phys Educ* **39**: 108
- Cassi D, Bocchia E (2005a) *Il Gelato Estemporaneo ed Altre Invenzioni Gastronomiche*. *Mangiare*

- Sano e Gustoso con la Cucina Molecolare*. Milan, Italy: Sperling & Kupfer
- Cassi D, Bocchia E (2005b) *La Ciencia en los Fogones. Historia, Ideas, Técnicas y Recetas de la Cocina Molecular Italiana*. Gijón, Spain: Trea
- Escoffier A (1903) *Le Guide Culinaire: Aide-Mémoire de Cuisine Pratique*. Paris, France: Colin
- McGee H (1984) *On Food and Cooking: The Science and Lore of the Kitchen*. New York, NY, USA: Scribner
- McGee H (2008) Modern Cooking, Science, and the Erice Workshops on Molecular and Physical Gastronomy. Some History and Documents. <http://www.curiouscook.com/cook/erice.php>
- Meldolesi A, Noto B (2006) *Grandi Chef di Spagna*. Assago, Italy: Giunti
- Paltrinieri B (2002) Scienziati ai fornelli: ecco la cucina "molecolare". *Il Messaggero* November 10
- Papin D (1681) *A New Digester or Engine, for softning Bones, the Description of its Makes and Use in Cookery, Voyages at See, Confectionary, Making of Drinks, Chemistry, and Dying, etc.* London, UK: London, printed by JM for H. Bonwicke
- Santamaria S (2008) *La Cocina al Desnudo. Una Visión Renovadora del Mundo de la Gastronomía*. Madrid, Spain: Temas de Hoy

- Zipprick J (2009) *No Quiero Volver al Restaurante!: De Cómo la Cocina Molecular nos Sirve Cola para Papel Pintado y Polvo Extintor*. Madrid, Spain: Foca



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