Molecular Gastronomy: how encapsulation can support Modern Cooking

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Introduction

Molecular Gastronomy, a relatively new scientific discipline focusing on chemical and physical exploration of culinary processes (This, 2002), provides a link between scientists and top level cooks. This collaboration is driven by the need of Chefs for more creativity and rational approaches to novel dishes in "Nouvelle" or "Haute Cuisine". It opens a new and rich investigation field for researchers, providing a specific focus for technological developments and scientific knowledge on high-quality food production; it includes new challenges in comparison with industrial mass-food production. But the term "Molecular gastronomy" is controversial because it is overused: it does not describe any type or style of cooking and is *a fortiori* not synonym of creative cooking with new shapes, textures and flavours. This approach for the development of new dishes refers to the concept of science based cooking, i.e. the utilization of new tools (ultrasounds, liquid nitrogen, high speed homogenization, Rotavap), new ingredients (enzymes, thickening and gelling agents) and techniques for the development of novel or innovative food in the framework of modern cooking. One of the main aspects of science based cooking is destructuration of traditional dishes based on the use of unconventional ingredients and techniques inspired from those used in industrial production and close related to flavour encapsulation. Beyond the fashionable aspect, some chefs realized with the help of scientific collaborators that gel, encapsulation and emulsion technologies can support sensorial enhancement and combination of flavours: for example, the original idea of the bubbly juice developed by Arboleya *et al.* (2008) was to "trap the food within a bubble, so trap the aroma which may be either from food itself or smoke. (…) a sudden explosion of senses for the people".

We argue in this viewpoint paper that the bioencapsulation community will take advantage in opening its investigation fields to this emerging subset of food science and technology : the science and lore of encapsulation can contribute to some extent to the molecular gastronomy development: from rheological and textural knowledge of gelling agents to reflections about flavours retention and release…And vice versa, molecular gastronomy and its application, i.e. science based cooking, can supply our work with a sense of creativity inspired by the powerful complexity offered by cooking.

Definitions

The concept of molecular gastronomy was created by a physicist, Nicholas Kurti, and a physical chemist, Hervé This on the basis of the "gastronomy" definition by the French scholar Brillat-Savarin (1755-1826): "the reasoned study of all that is related to man as he nourishes himself" (Brillat-Savarin, 1848). Since the first workshop on this topic in 1992, the definition of molecular gastronomy was refined as "the branch of science that studies the physicochemical transformations of edible materials during cooking and the sensory phenomena associated with their consumption" (This, 2002). Today, it can be considered as a subfield of food science and technology consisting in the utilization of the scientific method to better understand and control the molecular,

physicochemical and structural changes that occur in food during their preparation and consumption (van der Linden, 2008).

As for any young discipline, the scientific program of molecular gastronomy was recently reformulated from the five original and generic aims as the scientific exploration of : (1) the technical part of cooking, i.e. the science behind recipes, (2) the artistic component of cooking, and (3) the social component of cooking.

In the general public, the term molecular gastronomy is systematically associated with the realization of new dishes in *haute* or *nouvelle* cuisine; but this association is erroneous and feed the current controversy surrounding this term. As developed by the world's most famous chefs representing innovative cooking, in their "Statement on new cookery" (Adria, 2006), the term molecular gastronomy doesn't describe their cooking, or indeed any style of cooking.

Thus it is important to distinguish between molecular gastronomy (i.e. the scientific understanding of cooking and eating) and the application of this scientific approach for the development of new dishes, particularly in the context of *haute cuisine* (Vega, 2008).

The terms "science based cooking" and "molecular cooking" can be considered as synonyms and consist in the application of the fundamental understanding developed by molecular gastronomy; "the conscious application of the principles and tools from food science and other disciplines for the development of new dishes, particularly in the context of *haute cuisine*" (Vega, 2008).

Above definitions and subjective points of view on interactions between scientists and chefs, one must recognize that bridging the gap between fundamental aspects of food (developed by molecular gastronomy) and chefs creativity via science based cooking offers a synergetic combination that stimulates both sides innovation (van der Linden, 2008). And when discussion arise on the fact that molecular gastronomy is a food fad and on the legitimacy (or utility) of this new scientific branch, it is obvious that a rational approach has been effectively lacking about production of small quantities of food relatively quickly consumed by a reduced number of consumers in opposition with mass-produced food.

A new development field for encapsulation

Among other food ingredients used in large quantities in industry, thickening and gelling agents are nowadays introduced in *haute cuisine* recipes "in order to develop special textures, with unusual dependence on environmental parameters such as temperature, pH and salt concentration" (Vega, 2008). Through collaborations between scientists and chefs, colloidal and thermodynamic observations are taken in account for their effects on texture and flavour release. Actually, since the realization of the first and basic "apple caviar" made from apple juice-alginate and calcium solution by Ferran Adria, *haute cuisine* integrated very "fundamental scientific principles to design and fabricate novel structures within foods to provide functional properties such as stability, taste, texture, appearance, or flavour" (van der linden, 2008).

Since the advent in the kitchen of flavour extraction techniques, Rotavap and gelling agents, new questions and new needs for know-how arose in chefs mind; it refers to biopolymer mixtures, interfacial tensions, volatility, partition coefficients, emulsions stability,…A considerable amount of fundamental knowledge and scientific results are available to address these questions; it is generally originating from industrial food research, pharmaceutical, paint or personal care R&D. Among these results, some can be derived from their original context (for example, the release of flavours

in low fat food, Malone *et al.*, 2003) to give new elements for enhanced flavour perception in modern cooking design. This study shows that the perception can be manipulated by controlling the temporal release, acting on flavour release through factors like composition (type of hydrocolloid) and microstructure of the product, dilution and mixing with saliva, temperature. The authors conclude that "by suitable choice of gelling biopolymer it was possible to control the breakdown of the particle in the mouth under physiological conditions so that the release of the flavour could be manipulated in a controlled manner". In van den Berg *et al*. (2008), the sensory perception (wateriness, crumbliness, spreadability) was related to polysaccharide gels in order to model both natural and fabricated semi-solid foods. Among several objectives in this kind of studies, the design of products with novel sensorial properties appears as a mutual goal for science based cooking.

An example of profitable collaboration between a chef and scientists is presented in Arboleya *et al.* (2008): "From the Chef's Mind to the Dish : How Scientific Approaches Facilitate the creative Process" relates the conversion of a culinary and artistic project, the bubbly juice (an aromatic bubble trapping the food) into a real dish. The technical developments based on interface tension, bulk viscosity, dilatational modulus and pH led to technical specifications ensuring a stable result and turned later into a recipe by Luis Aduriz.

Some aspects of controlled release of flavours, using encapsulation, where previously developed in a BRG congress : as example, N.J.Zuidam (2005) presented a compared study on microstructures and encapsulates for controlled release of flavours and other actives in food products. The author concludes that "high costs and lack of large scale production possibilities may hinder the successful commercialization of (micro)encapsulates…encapsulation via design of food microstructures might be more powerful in many cases". This typical kind of assertion has to be reconsidered in the perspective of science based cooking where quality and innovation constraints take precedence over cost reduction. Close related to this work, the mathematical model of in-mouth volatile release from gelled emulsion particles dispersed in a continuous aqueous phase developed by Lian *et al.* (2004) provides a basic tool for food designer: a relationship derived from this model describes the critical size above which the release of aroma from the dispersion of gelled particles (microbeads) is affected by the size of particles.

Conclusion

Molecular gastronomy and science based cooking offer a new investigation field for physical and (bio)chemical researchers, giving the opportunity to adapt their specific and hi-tech know-how in a new context. This assertion is particularly true for encapsulation and flavour release specialists since the technologies they develop or use as tools can be directly integrated into gastronomical considerations.

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