A History of Aerated Foods

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Throughout history, there has been a bi-directional interaction between “food” on the one hand and “science and technology” on the other. The need to produce, process, and preserve food has stimulated progress in technology and in scientific understanding, while scientific and technological advances have in turn inspired new food products and enhanced the appeal, nutrition, and shelf life of old ones. Examples of such interactions are too numerous to select representatively or review adequately. Heat transfer serves as a suitable example, its first technological application being to cook food via primitive roasting, then boiling, and ultimately sophisticated baking, but now fundamental to all processing industries and to our thermodynamic understanding of the universe, with concepts of conduction, convection, and radiation visited and revisited to enhance production and quality of food and non-food items of all kinds.

The premise of this article is that the interdependence between food and science/technology is disproportionately greater for aerated foods than for their mundanely solid- and liquid-phase alternatives. The logic of this argument begins with the observation that aerated foods represent the “best” that the domestic chef or his food technologist counterpart in industry can create, and that they are, as a result, the food products most valued by consumers for their novelty and luxury. This pre-eminence arises first from the perceived value associated with the challenge of creating and controlling aerated foods, such that they represent the height of culinary expertise and industrial food processing skill. Second, the esteem of aerated foods derives from the uniquely luxurious experience that they impart to the eater. Aerated foods therefore create desires among consumers that producers struggle to satisfy, demands that are not trivial to supply, the classic recipe for the perception of value. It follows, then, that these most valued and most challenging of foods demand the greatest mastery of food science and technology and that their exceptional challenges are the most likely to motivate advances or to benefit from new developments.

The purpose of the chapter in Bubbles in Food 2 from which this article is adapted is to begin the process of laying out the historical appearance and evolution of aerated foods alongside some of the other relevant developments in human history. In so doing, it aims to begin to organize the evidence for the premise, by collating the historical data, to allow some preliminary connections to be made and insights perceived. The current article focuses on cereal-based aerated foods—the original chapter also includes sections on chocolate, sugar confectionery, dairy- and egg-based foams, and beverages.

Somewhat inevitably the article focuses on aerated foods and their interaction with science and technology mainly from the Western perspective, in large part because aerated foods are more prevalent in the Western diet compared with that of the East. And this distinction in diets is exemplified most strongly with the staple of the Western diet and the archetypal aerated food, bread, with which our foray into aerated food history starts.

Bread

Bread is, quite simply, the world’s most important food. This is demonstrated comprehensively by Jacob (1944), who writes “Bread reigned over the ancient world; no food before or after exerted such mastery over men,” and shows us how bread has played pivotal roles throughout Western history, in the social organization of Egypt, the Hebrew Exodus, the rise and religion of Greece, the rise and fall of Rome, uprisings in the Dark and Middle Ages, the Protestant Reformation, the French Revolution, the defeat of Napoleon, the American Civil War, World Wars One and Two, and much in between. Because of bread, wheat is “the king of grains” and the world’s most extensively grown and traded cereal. But why are bread and wheat so supreme? Wheat is, after all, not the most high-yielding cereal nor the most nutritious. However, wheat has a unique advantage that sets it apart...
from any competition and that underpins its supremacy. Wheat flour alone is able, when mixed with water, to form a dough capable of retaining fermentation gases in bubbles to create highly raised bread. This unique ability arises from the gluten proteins of wheat that are able to form a viscoelastic, strain-hardening network capable of expanding to retain gas. (The proteins of rye allow some leavening of rye breads, but the result is insufficient to challenge wheat’s uniqueness in this respect.) Wheat is the world’s most important cereal because it gives us bread. Bread owes its distinction as the world’s most important food to its bubbles—bubbles are therefore arguably the world’s most important ingredient!

Bread owes its pre-eminence status to the superb palatability of its texture, the intriguing challenges of its manufacture, its diversity of forms, the transcendent mystery of the leavening process, its historical legacy and heritage, its low price, and its high nourishment— a winning combination that is unapproached by any other food. Of these, the first four derive from yeast fermentation, but in days past its inscrutability afforded symbolism of the divine. The challenge of bread-making centers around the consistent creation and control of the aerated structure, in the face of varying raw materials and processing constraints, while the variety and diversity that the leavening process allows give interest to bread eating along with social and cultural distinction. And the irresistible and matchless palatability of bread arises from the delicate, spongy texture that results when the starch and gluten matrix is stretched by the inflation of bubbles into a network of gossamer-fine interconnections. The pre-eminence of bread in the Western diet, which arises from its bubbles, probably underpins the West’s distinct appreciation of aerated foods in general.

The second duty of governments (after security) is to feed the people, and the need to address the provision of bread has exercised the creative resources of leaders, agriculturalists, philosophers, social reformers, scientists, and engineers throughout the centuries. In the limited space available, one can illustrate this no better than through a selection of quotations from Jacob (1944): “In Egypt, both [wheat and barley] might have continued peacefully side by side, but for the most important event in the history of grains. Bread was invented in Egypt”; “Bread made the Roman Empire great; but bread also destroyed it... The empire would have survived if Rome had not made a political football of bread!”; “Egypt was bread. He who owned the bread could also be [Roman] emperor.”; “Over the doctrine of bread the Church split into two and then into four new churches.”; “Without [agricultural reform], England would probably have experienced a revolution more terrible than the French revolution. But the reform of agriculture literally created bread for the English townspeople.”; In France, “Farmer, the earliest of modern nutritionists, asserted and proved that the health of nations depended upon the quality of the flour.”; “Bread spells victory. These words apply even more pointedly to the [American] Civil war than to Napoleon’s defeat. Because the North had bread, and because the South could not eat cotton, the Civil War produced a United Nation.”; “Since, after 1914, no nation believed in world peace, no nation could allow itself to rely fondly on an uninterrupted supply of bread from abroad.”; “Today the influence of the breadmaking class on America’s legislation can hardly be overrated.”; and finally, words written in 1944 in a world entrenched in war, a quotation from Herbert Hoover: “World peace means a peace of bread.”

In terms of scientific and technological advances, much of agricultural development, soil science, and crop biology has been prompted first and foremost by the need to secure adequate quantities and quality of wheat for bread. Meanwhile, wheat flour milling technology, in the pursuit of superior bread flour, has interacted to mutual benefit with areas of fluid dynamics and aerodynamics for the efficient harnessing of energy from water and wind, respectively, mechanical engineering for the transmission of that energy or the exploitation of new energy sources (one of the first applications of James Watt’s steam engine was in London’s Albion Mills), and process engineering for automation and control.

The history of bread (and its inseparable counterparts, wheat agriculture and wheat flour milling) and its contribution to human development has been extensively documented by Jacob (1944), Storck and Teague (1952), David (1977), and elsewhere. There is, however, a recent footnote that has raised the profile of bubbles in bread and, indeed, of bubbles in food generally. This is the development of Mechanical Dough Development (MDD) processes in the early part of the 20th century, and in particular the introduction of the Chorleywood Bread Process in the UK in the 1960s. This was the first batch MDD process, and one of its most distinctive features was to mix the dough under a partial vacuum. The direct effect of the bubble structure created during mixing on the final bread structure and quality, and the subsequent development of pressure-vacuum mixing to enhance oxidation, prompted a particular emphasis on dough and bread aeration studies in the UK over the past half-century, liberating gases from their status as “the neglected bread ingredients.” To this work the author has been privileged to contribute, and this interest in bread aeration directly inspired the first Bubbles in Food conference and book, and now the current proceedings. It is fitting that many of the chapters in Bubbles in Food 2 are devoted to elucidating bubble behavior in bread. Bread is the original
aerated food, and our understanding of food aeration more generally owes a debt to bubbles in bread.

**Other Bakery Products**

In our brief history, other bakery products might be expected naturally to be considered immediately after bread, but it was the arrival of sugar and egg foams on the historical scene that allowed the explosion of other bread-like-but-nicer products. Biscuits (from the Latin panis biscoctus, "twice-cooked") preceded this expansion, having been invented by the French in the 1300s, but also benefited from it as the new ingredients gave rise to an endlessly diverse variety. The Savoy biscuit, for example, originating in France in the early 17th century, was made from whisked eggs, sugar, and flour. Puff pastries and early eggless forms of brioche appear from about 1500, followed rapidly by cakes, waffles, choux pastry, profiteroles, crumpets, bagels, and hot cross buns. Then baking powder (a combination of sodium bicarbonate and an acidic powder such as monocalcium phosphate, which release carbon dioxide on wetting and, depending on the acidic component, the application of heat) appeared on the scene from about 1850 and prompted a further (or alternative) expansion of bakery novelties. Initially the motivation was to facilitate bread making by avoiding the need for yeast which was slow and, in the minds of some, positively poisonous (particularly following Pasteur’s identification in 1857 of yeast as a living organism, with the CO₂ evidently arising from decay processes). However, baking powders found readier application to products made from batters (which are too runny to allow effective leavening through the slow action of yeast), such as cakes, muffins, and pancakes.

The scope and variety of aerated bakery goods are far too great to list comprehensively. They include breads, biscuits, cakes, croissants, crumpets, pikelets, pizzas, profiteroles, waffles,affles, and Yorkshire puddings, to identify just a very few. Even flat breads are significantly aerated, and many puff impressively if briefly during manufacture, to create a useful cavity for subsequent filling with other foods. Within most of these generic names is an infinite variety of specific examples, particularly for breads of which there are endless local and national specialties, as well as for cakes and biscuits.

In fact, most cereal-based food products, not just bakery products, derive their distinctive natures and palatable textures from aeration to some extent, including breakfast cereals and popcorn, with pasta, rice, mueslis, and pie pastry the most notable exceptions. Given that grain-based foods are now recognized as the basis of a healthy diet, particularly those based on whole grains, this implies that mastery of the aeration of cereal-based foods is key to delivering healthy yet appealing options. “Bubbles for Health” is a legitimate and indeed important focus for research in the grain-based food sector.

Creation of aerated structure is so central to bakery goods that Matz (1960) proposed: “There are probably innumerable schemes for classifying bakery products, but the most sensible way to categorize them for the bakery engineer or cereal chemist would seem to be on the basis of the source of leavening gas.” He then classified bakery foods into yeast-leavened, chemically-leavened, air-leavened, and unleavened. In fact, this classification can be extended to most cereal-based food products, as shown in Table I (recognizing that air-leavened products are actually mainly leavened by steam entering bubble nuclei that initially contain air, and that air and steam similarly contribute to the yeast- and chemically-leavened goods). Table I, incomplete as it is, demonstrates the unparallelled variety of aerated cereal-based products, with the diversity of bread types giving the strong impression that the yeast-leavened category dominates as indeed, in terms of market size and overall volume of consumption, it does. The UK Bakery Market is worth around £3 billion, of which around £1.6 billion is bread, £500 million rolls and baps, £300 million “Breads of the World” such as naan and pitta breads, and £500 million bakery snacks (hot cross buns, crumpets, muffins, teacakes, brioches, etc.).

One of the intriguing aspects of bakery goods is that they achieve their enormous diversity despite being comprised of a very limited number of starting ingredients—flour, water, salt, and yeast for the most basic of breads, to which we can add butter, sugar, eggs, milk, and baking powder to expand the range and bring in cakes, biscuits, pastries, and the numerous products collectively termed bakery snacks. Forgetting the numerous additives that the industrial manufacture might employ, the artisan baker can achieve this great range of products from these few ingredients.

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Table I. Classification of selected cereal-based food products on the basis of the leavening action. (Note that some names are used variously in different regions or communities, and that recipes and formulations vary, so this classification is approximate and indicative rather than prescriptive or authoritative. It is also incomplete, in particular not listing the innumerable varieties of breads, cakes, and biscuits.) (Adapted from Campbell, 2003.)

<table>
<thead>
<tr>
<th>Yeast-leavened</th>
<th>Chemically-leavened</th>
<th>Air/steam-leavened</th>
<th>Unleavened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagels, baguettes, baps, barley bread¹, breadsticks, brioche, ciabatta bread, corn bread, croissants, buns, crackers, grissini, mueslis, naan breads, oatcakes, pain au levain, pancakes, panettone, pikelets, pita breads, potato bread, pretzels, quiche pastry, rice bread, rolls, rye bread, Sally Lunn, scones, simnel cakes, sourdough breads, steamed breads, stollen, toast, waffles, yeast cakes, yeasted wheat breads</td>
<td>Biscuits/cookies, cakes, cookies, doughnuts, expanded extruded products, fish batter, mandelbrot, soda breads, waffles</td>
<td>Angel food cake, bagels, biscuits/cookies, chapatis, choux pastry, cornflakes, crispbreads, éclairs, extruded breakfast cereals, flat breads, lasagne, matzos, parathas, piadine, popcorn, popovers, poppadoms, profiteroles, puff pastry, puffed rice, rice cakes, shredded wheat, soufflés, sponge cake, tortillas, vol au vents, wafers, Yorkshire puddings</td>
<td>Couscous, crépes, mueslis, granola, noodles, pie pastry, pasta, porridge, rice, shredded wheat, starch-based products (e.g. custard)</td>
</tr>
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¹Note that breads such as potato bread, rice bread, and barley bread, generally contain significant proportions of wheat flour.
While recipes, in terms of the proportions of the base ingredients, account for part of the variety, much more so is the nature of the processing. In particular, bakery goods are much more sensitive to temperature-time-shear \((T-t-\tau)\) interactions during processing, the order of ingredient addition, and the precise spatial positioning of components (think of layering of pastries, for example, or a two-tiered cottage loaf) than are most foods, precisely because creating the distinctive aerated structure is critically dependent on these things. Bakery chefs have for centuries been wrestling at a practical level with these \(T-t-\tau\) issues that are now being recognized in the consumer goods industries for products such as cosmetics, toiletries, and shampoos. (Interestingly, many of these products are now gaining distinction and aesthetic appeal by featuring bubbles trapped in a weakly gelled matrix.)

**Breakfast Cereals and Snack Products**

Cereals (in the sense of the grains—wheat, rice, maize, barley, etc., and the quantity and range of food products derived therefrom) are the source and ongoing basis of civilization, being sufficiently bountiful to support large populations and to free labor from mere subsistence living to allow the development of culture. As Tannahill (1988) puts it, “Historically, cities are the index of civilization, admired for their palaces and temples, poetry and philosophy, art and aqueducts, but seldom for their granaries. Yet the whole magnificent structure of the world’s first great civilizations rested on the granaries and the people who worked to fill them.” This dependence on cereals remains to this day; more than half our global food needs are supplied directly or indirectly by cereals. To the modern ear, however, “cereal” conjures up something less fundamental and much more recent, having become commodified for almost automatic association with breakfast cereals.

The story of the origin of breakfast cereals is a story of beliefs, in particular a confluence of religious and nutritional beliefs and, uniquely in our survey, an aerated food class that originated in North America. Specifically, the birthplace of the cereals industry was Battle Creek, Michigan, the time the latter decades of the 19th century, and the inspiration the nutritional beliefs of the Seventh Day Adventist Church. The resulting triumph of the breakfast cereals industry is a story of inventive experimentation, creative and energetic marketing, and the rise of the brand name.

In 1855 the Seventh Day Adventist Church made Battle Creek its national headquarters and established a sanitarium based on vegetarianism. Dr. John Harvey Kellogg, a recent medical graduate, joined the sanitarium in 1876 and gave credence to the vegetarian policy, but recognized that the sanitarium’s menus were unappealing. Following constant experimentation over several decades, in 1902 he had the brainwave of corn flakes flavored with malt. This was such a success that, with his brother William Keith, he founded in 1906 the Battle Creek Toasted Corn Flake Company. One hundred years later this has become the Kellogg Company, which boasts the food world’s fifth most valuable brand name with annual global sales of 7.4 billion U.S. dollars. (However, for some reason the conquest of breakfast cereals has largely been confined to the English-speaking world—possibly in part because breakfast cereals go so well with milk, which is more readily available and consumed in these parts. Kellogg’s is the market leader in the United States, the United Kingdom, and Australia, while in New Zealand the leader is the Sanitarium Health Food Company, also an offshoot of the Seventh Day Adventist Church.)

Meanwhile, Charles Post, having been a patient at the Battle Creek Sanitarium, developed Grape Nuts in 1898. This was similar to the earlier Granula product developed by James Jackson in 1863 and to Kellogg’s 1877 Granola, both being baked and ground products, but Grape Nuts proved to be commercially successful (it is still sold today) due to Post’s aptitude for advertising and marketing. At the same time, Shredded Wheat, invented by Henry Perky of Denver, contributed to the birth of the new breakfast cereals industry.

Shredded wheat does not appear exactly “aerated,” rather falling into the same general category as cotton candy and Cadbury’s Flake™ in being substantially dominated by air loosely trapped between layers or filaments. However, the shreds must in fact be expanded by bubbles during the toasting step, otherwise they are hard and inedible. At first glance, cornflakes are also not obviously aerated, but close inspection reveals them to be full of tiny bubbles that similarly give them their lightness and crispness. Puffed rice is, by contrast, unquestionably aerated. This was invented by Alexander Anderson at Columbia University in 1901, after which he joined Quaker Oats and invented the puffing gun. The 1904 St. Louis World Fair was once again the setting for the introduction of this new aerated novelty, initially marketed as a popcorn-like snack, but later transformed successfully into a breakfast cereal product. One can only imagine the delight on discovering the unbelievable bonus that this new product, when wetted with milk, went Snap, Crackle, Pop!

The breakfast cereal industry has been distinguished in its first century by the energy and creativity of youth, particularly in relation to advertising and marketing, and is credited with the rise of “the brand name” as a major driver of the food industry. One particular innovation was the introduction of giveaways (cards, toys, etc.) in cereal cartons, aimed at children. Combined with this was intense advertising exploiting the new medium of radio in the 1930s and 1940s. Following World War II, concerns over nutrition presented the cereals industry with a further opportunity in the form of fortification with minerals and the newly discovered vitamins, enhancing its reputation as a food class that was both “scientific” and healthful.

In terms of technology, particularly in relation to the conspicuously aerated cereals, two major steps forward were the introduction of oven puffing instead of gun puffing for puffed rice (although puffed wheat still requires guns) and the introduction of extrusion processes. These also contributed to the decline of gun puffing, being able to replace numerous cooking, forming, and puffing steps with a single item of equipment, and stimulated a further explosion of novel cereal products. Unfortunately extrusion rather destroys flavor, so artificial flavors and sweeteners must be added. This has led, ironically for an industry built on healthful purity, to a number of breakfast cereal products of dubious nutritional merit, although the industry is now strenuously distancing itself from such products.

Extrusion was invented in 1797 for the manufacture of seamless lead pipes and first applied in the food industry for macaroni products and later for sausage manufacture in 1869. Extrusion revolutionized the pasta industry in the early 20th century and was first applied to breakfast cereals by General Mills in the 1930s. Cooking extruders followed, with the first extruder-cooked and expanded product, corn snacks, commercialized in the 1940s. Since the 1950s, dry extruder-expanded pet foods have simplified the lives of dog owners the world over, while the ready crumbliness of such products facilitated their application to fish foods in the 1980s.

Extrusion is arguably the technology that has given the most significant boost to aerated foods in the last century, in particular in relation to breakfast cereals and snack products. However, the original aerated snack product and one of the most intriguing and entertaining of all foods is popcorn. Eaten by as ancient a group as the Aztecs, popcorn was popularized in America around the turn of the last century and...
became the favorite snack of movie-goers. This ancient snack enjoys a remarkable affinity with the modern phenomenon of the microwave; in 1946, popcorn was the first food item to be deliberately cooked with this new technology, and nowadays the majority of popcorn sold in supermarkets is for popping at home in the microwave oven.

The snack food market comprises a diverse range of products, sharing the designation of “snack” through how and when they are eaten rather than through a commonality of ingredients or technology. It includes popcorn, nuts, rice cakes, granola bars, and corn and tortilla chips, but is dominated by potato chips/crisps. Thinly sliced and fried, these too show themselves on close inspection to be aerated, and conspicuously and distinctively so for pre-mium types such as kettle chips. The now famous addition of salt in a trademark blue paper twist by Frank Smith in 1922 made crisps a favored product with publicans, as thirstier customers drink more beer.

**Aerated Foods, History, Science, and Technology**

Aerated foods have accompanied mankind throughout recorded history and at every step of social and industrial progress. Following the very early developments of bread, beer, wine, and cacao, the next leaps forward occurred in the centuries following 1492 and the discovery of the New World, again in the 1800s as a consequence of the Industrial Revolution, and continuing into the early 1900s as a result of increasing prosperity and further technological and scientific progress. Recent decades appear to be characterized by relative calm as, in the nature of these things, technological innovation has become subject to refinement through scientific investigation.

The explosion of aerated foods in the 16th and 17th centuries is striking; evidently the Age of Enlightenment also served to lighten foods. This was driven principally through the ready availability of new ingredients, most notably chocolate, sugar, and eggs. An interesting historical question is: When can an aerated food be considered first to have made its appearance—when it was first tasted by some uniquely privileged noble and his guests, but beyond the wildest imaginings of the poor peasant, or when it first reached a significant proportion of the population? This is a question that encompasses the distinctions between Aristocracy and Democracy, and between the Old and the New Worlds. Ice cream serves as an example—it was first enjoyed by the upper classes of Europe in the 17th century, but was not available to the general population for a further two centuries.

The axes of class structures and geography are correlated with the two further factors, in addition to novel ingredients, that underpinned the creation of new foods in recent centuries. The second factor was culinary skill—the skill of the cooks and chefs who experimented with ingredients old and new to delight their aristocratic masters with novelties, particularly in Italy and France. Social class structures allowed the presence of an aristocracy that, within cultures inclined to gastronomic extravagance, gave the opportunity for unhindered culinary experimentation. The third component of aerated foods’ tripartite parentage was technology. Technological innovations such as whisking, bottling, refrigeration, fermentation, flaking, puffing, extrusion, carbonation, and vacuum mixing found application for new aerated foods. While culinary skill for the benefit of the few was cultivated through the political and social structures of aristocratic continental Europe, technological innovation for mass markets was demanded by the democratic but labor-poor situation of colonial America, and enabled by the Industrial Revolution of England. So new aerated foods such as meringues, soufflés, and Chantilly cream arose in mainland Europe based on the inventiveness of cooks experimenting with novel ingredients to satisfy demanding masters representing a tiny proportion of the population, while in egalitarian North America and industrial Britain, even newer aerated foods such as ice cream, aerated confectionery, breakfast cereals, and carbonated soft drinks reached the general public through technological innovations and pioneering mass marketing.

Figure 1 summarizes these three contributing factors, with the circle in the middle representing bubbles in food, surrounded by the triangle of Ingredients, Skill, and Technology (to which we can add Science as a latecomer) from which aerated foods derive. But aerated foods are not passively dependent on these three factors—it is the argument of this chapter that they positively encourage advances in science and technology, and indeed in all three areas. Thus Figure 2 shows the same inner bubble and triangle, surrounded by an outer bubble representing the positive stimulation that aerated foods provide to these three areas, encouraging increasingly novel and sophisticated ingredients, putting demands on science to understand aerated foods and their processes better and on technology to deliver better and more novel aerated foods, and taking culinary skill to the level of creative genius.

Skill, novel ingredients, and technology worked together in the past to stimulate novel aerated foods. At present, the industry appears to rely for its innovations almost solely on either the ingredients companies or third-party equipment manufacturers. Today, when practically all food is manufactured for the mass market and tends towards lowest common denominators, the clever food companies must turn their attention to once again capture the novelty and luxury that rely on art and skill and translate them into premium products. Enlightened food companies of the future will strive to coalesce all three of the parents of aerated foods—constant exploitation of novel and more functional ingredients, vigorous technological innovation and scientific scrutiny, and extravagant nurturing of creative genius.

The aim of this article has been to outline the historical appearance of aerated foods, under the premise of their strong interplay with science and technology. At the end of our survey, having noted also the interactions with novel ingredients and creative culinary skill, is there anything in this premise? The triangle of ingredients, culinary skill, and science and technology applies to non-aerated foods as well—does it connect more intimately with aerated foods? It is perhaps informative to make a couple of closing observations. One is to mention the growing appreciation of food science beyond the industrialized food manufacturing sector, both in the popular
mind and in the minds of leading chefs. For domestic readers, the book The Science of Food is an example, in which the author Peter Barham, after some opening chapters on flavor chemistry and heat transfer, structures his book around eight food categories: meat and poultry, fish, breads, sauces, sponge cakes, pastry (including puff pastry, choux pastry), soufflés, and cooking with chocolate. It is interesting to note that fully half of these chapters (those italicized) are aerated foods. This seems to be a disproportionate representation and implies, in agreement with our premise, that aerated foods are those that are most demanding for the domestic chef, and that the “science of food” is disproportionately relevant to their successful creation.

A second observation that seems appropriate is to note the recent winners of the accolade “Best restaurant in the world.” In 2005, this went to The Fat Duck restaurant of Heston Blumenthal, and in 2006 to El Bulli in Catalonia, the restaurant of Ferran Adrià. Ferran Adrià has been called “the Salvador Dali of the kitchen,” “one of the most creative and inventive culinary geniuses in the world,” and listed by Time magazine as one of the world’s great innovators. The most prominent reason for his fame? Adrià is most famous for creating “culinary foams,” using the whipped cream dispenser for a whole host of concoctions far removed from this common use, including cod, raspberries, potatoes, carrots, shellfish, asparagus, and foie gras. Heston Blumenthal similarly has gained fame through foam, most notably by cooking in a vacuum jar to increase expansion of bubbles. It is pleasing enough to note that the latest thing in culinary circles is inventive use of foams, but it is surely more than a coincidence that both chefs are also famous for being “scientists” of cooking and following the route of “molecular gastronomy” or “culinary alchemy.” The leading edge of haute cuisine is foams, and is also science.

Aerated Foods and Foam Science

Given the long history of technological applications of food foams, it is surprising to learn that foam science and wider applications of foams are much more recent. Perkowitz (2000) observes “Much of what we know about foam we have learnt through its use in technology and in commerce,” which we can elaborate to indicate food technology and food commerce, first and foremost, as the first technological and commercial applications of foams were for foods. The birth date of serious foam science is 1873, which saw the publication of the seminal studies of the blind Belgian scientist, Joseph Antoine Ferdinand Plateau. Foams were still considered “the neglected materials” by the end of the 20th century, but many have suggested that the 21st century will be known as “the Foam Age,” when the unique properties of foams (such as lightness combined with strength combined with unusual rheology and low or even negative Poisson’s ratio) are exploited for peculiar applications. But foams are extremely difficult materials to study. The “easy” foam science has been done—new advances will be won with much more difficulty, Wears and Hutzler, in their book The Physics of Foams, end by noting that foams can be broadly represented on two axes, from dry (high void fraction of gas) to “wet” (lower void fraction of gas, but not necessarily a liquid continuous phase), and from static and stable to dynamic and unstable. They point out that present theory is confined to one corner of the subject—dry, stable foams—which represents only a very small part of the interesting science and technology that foams impact on. Noting the importance of understanding dynamic and low void fraction foams, and that further progress will not be easy, they state “Whenever this is the case, it is often the more empirical approach which can show the way.” Foam science has arguably had relatively little direct relevance thus far to the vast majority of aerated foods—very few are quasi-stable dry foams with liquid lamellae, the head on beer being almost the sole exception. But pragmatically motivated empirical studies of the wider variety of aerated foods, if undertaken with elegance and skill, may have a role to play in advancing the science of foams more generally. In any case, the wonders of the 21st century Foam Age will owe much to the practical experience and scientific knowledge derived from or inspired by aerated foods.

Summary

Today we enjoy an unprecedented variety of foods, with much of the novelty and distinction coming from skillful use of bubbles. The increasing number and variety of aerated foods and the innovations they inspire and benefit from suggest that the bubble of possibilities for aerated foods has not yet burst. Celebrity chefs are expanding horizons further, with their influences cascading down through the catering and food manufacturing industries all the way to the domestic kitchen, where home-foaming appliances are now cashing in on the ephemeral appeal of aerated foods.

The importance of a food is not just in the nourishment it imparts currently, but in the technological and social interactions it has engaged in historically to bring us to the “now” in which we live. The challenges and pleasures of aerated foods have shaped social and political structures and driven scientific and technological advances; these in turn have inspired and enabled a multitude of new aerated foods as well as non-food foams. Foams were first exploited technologically for foods, from which many of our practical experience of the creation and handling of foams derives. They are now at the forefront of materials science and technological promise for the new century. Aerated foods have led the way in demonstrating the practical use and aesthetic charm of foams. Scientific studies of food foams have the opportunity to contribute yet further to the appreciation and mastery of this most effervescent and versatile of materials.

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Additional Sources

In order to try to retain some fluency in the text, references have not been inserted throughout. The information presented in this brief paper has been collected from numerous sources, regrettably all secondary rather than primary as would be preferable for a study aspiring to be historical. The major sources of information were as follows:


Numerous Internet sites were also consulted, of which the most useful included: http://en.wikipedia.org/wiki; http://www.foodtimeline.org; http://www.candyusa.org; http://www.practicallyedible.com; and http://www.zubbles.com/.