NANOTECHNOLOGY OFFERS MAJOR INNOVATIVE BENEFITS TO FOOD INDUSTRY: REPORT

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INTRODUCTION

A LOW-FAT ice cream with the scrumptious flavour of a full-fat version, cooking oils that contain less harmful fats, and encapsulated pills embedded in your bread that give you extra vitamins - the food manufacturing industry is at the start of a long journey with nanotechnology. It's likely to be a bumpy ride, mainly because of the sheer scale of possibilities and the self-evident fact that the science is being developed for human ingestion.

In many ways, the nanotechnology currently being employed in foods is almost conventional, and employs nutrients or ingredients that are already commonly used - though now on a far smaller, nanoscale, which can enhance the body's take up of the substance, or can modify an existing taste or texture. This distinction is important, and is emphasised by manufacturers and scientists, because it separates this branch of nanotechnology from that associated with manufacturing - where the use of carbon nanotubes and other physical interventions require the development new products.

Most of the food giants including NestlÃ©, Kraft, Heinz, and Unilever, Cadbury Schweppes, Tate & Lyle, Numico (the baby foods giant that owns the brands Milupa and Cow & Gate) and Glaxo-SmithKline support specific research programmes and aim to capture a share of the nanofood market in the next decade.

There are likely to be clear benefits for the food industry as nanotechnology develops, though it is likely that headline-grabbing innovations, such as low-fat ice cream - being developed by Unilever - will be the exception rather than the rule. Dr Mark Morrison, scientific manager at the Institute of Nanotechnology in Stirling, suspects that nanotechnology's impact on the food sector will be two-fold, on packaging and encapsulation of vitamins in 'functional foods', rather than taste and texture enhancement. "Rather than just trying to make fatty foods less fat, the real emphasis will be on packaging," he said. "Sensors that give everybody a better idea if the food is fine or has gone off and that can track goods - that's where I think the benefits will really be.

"Increasing nutrient levels will also continue - but my personal impression is that people will have less of an issue with eating food that basically has a vitamin pill embedded in it than they would with foods that may be marketed as low-fat or containing other benefits. As for the engineering and self-assembly of compounds, I don't really see that happening in the food sector."

This point is echoed by Frank Behnam, of Germany-based Aquanova, a solubilisate technologies company, who stresses that nanotechnology and food must beware nanoparticles or modification onf substances: "Our principle is to translate nature's principle of micellation into industrial terms and manufacturing," he said. "Differentiation is very important if you are to understand the characteristics and benefits that nanoscale solutions can bring."

Packaging, as Dr Morrison suggests, looks set to benefit hugely from nanotechnology, a fact reflected in the scurried activity in the sector, but there are attendant issues. How does the food industry avoid the pitfalls that befell genetically modified foods? While there are continued attempts to promote GM, it has the inescapable sense of an industry knocking on the inside of the coffin. Dealing with public perception - whether it is informed or not - is crucial and goes hand in hand with regulation, which for now remains blurred and uncertain.

The food sector is just at the beginning of the road: according to the European Food Safety Agency (EFSA), for now there us no specific nanotechnology legislation in the food area officially noted in the EU acquis. However, Carola Sondermann, EFSA spokeswoman, admitted that the picture is a little cloudy: "Given the innumerable publications and press coverage in this field it is not always comprehensible whether the technology is already applied or the envisaged applications are still at the research stage," she admitted.

Yet, the ground is moving fast. While legislators, food scientists and environmental health experts debate the impact of nanotechnology, new products are turned out almost daily. Many of them are low profile and will alarm few members of the public; others are more eye-catching and may well inform and accelerate the debate over the extent to which nanotechnology should be used in the food we eat.

It would also be easy to think that nanotechnology's influence will be profound and far reaching- this may not necessarily turn out to be the case. Dr Morrison offers a cautionary note: "I can see that nanotechnology will have a more revolutionary effect in other industries, such as energy," he said. "The impact and effect on the food sector will be more incremental."

BENEFITS

Most scientists, manufacturers and independent experts recognise that nanotechnology will benefit the food industry in two major ways - in packaging and in the enhancement of the vitamin or mineral contents of everyday foods, increasing their nutritional value.

The key area where nanotechnology will directly affect the food that we eat is likely to come in the form of nanoencapsulation - basically, this means products that we swallow in the form of vitamin pills will instead be incorporated into everyday products, such as bread.

Food manufacturers require vitamins, emulsifiers, preservatives and food colours to be formulated for their products - and this is usually done through the medium of liquids, liposomes, encapsulation or powders. What science is now offering the industry is the opportunity to use versions of these products that have been enhanced at the nano level, offering higher degrees of efficiency, impact, absorption and solubility.

One major vehicle for this technique is the liposome, which is essentially a mini cell or intact membrane, where two lipids form a sheath around an aqueous core. Another method is the use of micells - which are in essence globules of fat, which can contain any vitamin or mineral you would chose. The added vitamin is absorbed through the body through a fat-soluble molecule.

"The technology in itself isn't really anything new - what's new is that we are doing this in the order nanometres rather than microns," said Dr Morrison. "It's basically chemists, physics and scientists who have been aware of how these things work for many years are now using them at a smaller scale, making them work more efficiently, and maximising their potential. You're not using engineered nanoparticles - you are just making sure that more of the benefits get into the gut."

Scientists and researchers are keen to stress that nanoencapsulation and another approach, bioavailability, are implementations of a natural process. "Bioavailibility means that we are looking to provide a higher level of absorption," said Aquanova's Frank Behnam, "and to transport these agents in an optimum way.

"The natural process - which the human body has always performed - is that the body takes these nutrients in, cuts them down to the nano level, builds a shell around them - a micell - and absorbs them. That is what we are doing - we are simply trying to follow nature's principles and bring it to the food. We are prolonging, or enhancing what industry has been doing for decades - we are bringing in a new and innovative approach to food, not new substances."

Ironically, people who chose to eschew nanotechnology-based food products may well benefit from it in ways they did not expect. A key area of research is that of using nanosensors to monitor crops for pests and drought. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens. In the near future nanostructured catalysts will be available which will increase the efficiency of pesticides and herbicides, allowing lower doses to be used.

"The idea is that the sensors can tell you how to grow the crops and significantly reduce the need for spraying herbicides," said Dr Morrison. "They can monitor the health of plants and water levels and may well have a big role in crop production. I can envisage a point in time, not too distant in the future, when the amount of pesticides is reduced because we are better able to detect what a crop specifically needs."

The process of turning traditionally fatty foods into healthier versions is appealing to many manufacturers but may be harder to sell on a mass scale. "I suspect these would look at a targeted market," said Dr Morrison. "It will appeal to people who see one health benefit and are not too bothered about anything else. Diet versions of fizzy drinks sell well to certain groups because they have few calories but many people are concerned about aspartin and other chemicals that are added. It remains to be seen which way this will go."

One of the main benefits of nanotechnology for the food sector appears to be efficiency savings - simply put, you need less of the original material you have always used, and it goes further. "You increase efficiency," said Mr Behnam. "You create the same effect and pay less - it really is that simple."

Good examples of this include food colours and water and fat solubility. "A lot of food has problems with ph values," said Mr Behnam. "Food preservatives are often not active in some ph values - they behave very strangely. Using nanotechnology makes it much easier to introduce substances. There is no chemical modification." Instead, with the nano-versions of preservatives, you can enhance their water and fat solubility, which may be particularly helpful with food products such as salami, where at present the fats need to be emulsified to enable the preservatives to work.

"The industry can reduce the amount of technical applications that they need, which reduces the costs that manufacturers and retailers have to bare," he said. "You have to use as less colouring as you can - in economic terms it makes sense but also physiologically it has benefits. It helps with a more even distribution of colouring which is targeted where it is really needed - you use lower doses to get the same effect."

CHALLENGES

A glance at the website of the European Nanotechnology Trade Alliance (ENTA) spells out the major challenges that lie ahead. "ENTA will openly interface with the public and watchdog organizations to ensure transparency and that new nanotechnologies are developed in a safe, and responsible manner," it reads, implicitly embracing the areas of public and governmental concern.

Yet the industry faces a variety of challenges, of which one of the most important is cost-benefit - the need to find products that will actually make a profit and repay the considerable investment currently taking place. According to Mr Behnam, there is a need to identify innovations that can allows manufacturers to grow margins, which are typically very low in the area of foods.

Safety and the perception that nanotechnology is safe are also crucial. "Nanotechnology is a term that describes a new, emerging technology which might find its application to food and feed products in Europe in the future," said Dr Carola Sondermann, of the European Food Safety Agency (EFSA). "Hence the safety of such products for consumers has to be guaranteed apart from the technological suitability and readiness."

A key part of this process, according to Dr Sondermann, will be for the European Union to legislate specifically on nanotechnology. "At present no common definition of nanotechnology/particles is in place," she said. "Many different aspects have to be addressed, for example, the natural occurrence of substances at nanoscale in the environment and food, different routes of exposure of manmade nanoparticles and analytical methods to measure and characterise them."

And while the majority of companies exploring nanotechnoly-related food products are looking at encapsulation, rather than the addition of nanoparticles, EFSA feels both areas should be seriouulsy considered and peer reviewed. "Nanoparticles appear to have a toxicity which is primarily a property of their small size rather than the type of material from which the particles are made, although research into this question is incomplete," said Dr Sondermann. "The basis of this toxicity is not fully established, but a prime consideration is the increased reactivity, with biomolecules, associated with the potential to permeate cell membranes. From the exposure point of view there are for the future two main scenarios imaginable - as a constituent in or on the surface of the food itself and secondly, as a contamination of food and feed from industrial applications other than food related areas."

PACKAGING

Packaging looks like being a key area that will benefit from the employment of nanotechnology. There are a number of main ways in which this may happen:

new cheaper membranes that stop gases from leaking out or fizzy drinks from going flat; colour sensing diagnostics that change colour if a food spoils, keeping track of what's in a product, and on the impact of temperature extremes. Scientists now believe they will be able to achieve these effects by modifying the permeation behaviour of foils, increasing barrier properties (mechanical, thermal, chemical, and microbial), improving mechanical and heat-resistance properties and developing active antimicrobic and antifungal surfaces.

One of those areas nearest commercial development is that of 'intelligent ink', which its supporters say, can greatly enhance the quality of food quality monitoring. The ink uses nanoparticles of titanium dioxide, a chemically and biologically inert compound. As with many nano-related products, the benefits of the nano version of the compound is that they have a much higher surface area than the traditional version. This means that with a small amount of material you can get the compound to exert a far greater influence than is possible with big particles.

Essentially, the nano ink is imprinted onto the packaging in the manner of a barcode. "The nano version of titanium dioxide has an interesting property - when you shine a UV light on it the compound can do photochemistry," said Professor Andrew Mills, head of Physics and Applied Chemistry at the University of Strathclyde, which is developing a version of nano ink. "This means that they become oxygen sensitive."

Typically, the ink dye is blue and, when the ink detects the presence of oxygen, the dye will bleach. "The oxygen-seeking molecules are looking into the package, interrogating the atmosphere in there for oxygen," said Professor Seaton.

The ink, which the University of Strathclyde is developing in association with a Finnish company UPM with a view to market commercially later in 2007, would appear to have significant commercial implications. "Most food is packaged in a modified environment," said Prof Mills. "Most packaged food contains 0.5% to 2% oxygen because food spoilage microbes need oxygen to survive and breed. At present the content of the package means that there is no ready indicator to say if the seal is intact or the food is OK to eat.

"There are implications for a whole lot of people," said Prof Mills. "Food packagers will get 100% confidence in their packaging, retailers will be able to check on the packagers and the consumers will know that their food has been packed properly. We've all bought food from a supermarket where the seal has been broken and we think it should be OK but the reality is that the integrity of the food has been compromised."

The university is exploring variations of the ink, so that some inks may react more slowly, allowing the consumer to work out when they first opened a product. "You open a packet of ham and leave it in the fridge and forget when you opened it - this would help us know when we opened it and whether it was still safe to eat," said Prof Mills.

The ink appears to be suffering one or two teething problems - mainly that it is so efficient: it may tell consumers immediately when there is any oxygen in the packet, prompting them to unnecessarily throw away the food. "They do need to have slightly more oxygen tolerance," said Prof Mills.

For now, nano ink is the main development where nanotechnology is having an impact on the food packing industry. Other developments, according to Prof Mills, may well grow from the way in which the ink's properties are implemented. "It may be that you can put this pigment into the food packaging, rather than on top of it," he said. "You'd just need a clear window, or a lamenent in which to place it - there are several layers of plastics in most packaging - it wouldn't come into contact with the food."

REGULATION

For now, the European Food Safety Agency (EFSA) has no working group on the subject of nanotechnology, and EFSA is understood to be following developments closely in order to act and react appropriately for future risk assessments. Its advisory forum only met to discuss nanotechnology for the first time last year (2006). "For future risk assessment of nanoparticles, additional information, knowledge and tools are needed," said Dr Sondermann. "These could include investigation of the mechanism and toxicological potential - reconsideration of the currently applied paradigms for risk assessment in the light of the altered properties of nanoparticles - development and allocation of analytical tools to monitor the occurrence and distribution of nanoparticles."

Governments may have to consider entirely new regulations to specifically deal with nanotech food products, according to EFSA. "The practical set-up of new legislation or adaptation of existing legislation is still in its infancy," said Dr Sondermann: "Most countries are still in the phase of raising awareness and investigating what the regulated topics should be."

The EU chemical control legislation REACH will require anyone manufacturing or importing more than a tonne of a product per annum to meet requirements in terms of information on health and safety and any potential impact on the environment. Many manufacturers and governments are already liasing with non-governmental organisations and public audiences in a policy aimed to dispel any disquiet about secrecy.

However, safety testing of nanotechnology-based food ingredients is likely to prove difficult for environmental health officers, according to a leading expert in the field. In many cases, officers will be almost entirely reliant on the good faith of food manufacturers when it comes to the verification and approval of products for the consumer market.

Neville Craddock, an independent consultant, believes there is a series of possible deficiencies in the scope and application of current legislation. One of the key challenges, he said, was the practical difficulty of testing for a nanoparticle that was embedded in a manufactured, processed product.

"The analysis of a particle-sized item in a food product would not be an every-day test," he said. As a result, inspectors would be relying on examining paper records of the process of manufacture.

"We need to get the regulatory and legal background absolutely clear even before the food goes out into the market, because when it does, enforcement is going to be extremely difficult," said Mr Craddock. "It will involve a very complex paper chase."

According to Professor Lynn Frewer, there is a need to be open with the public. "The regulatory framework needs to be transparent," she said. "Governments, institutions and manufacturers need to ensure that consumers have access to information that is relevant to them. There needs to be transparency in labelling and traceability."

Prof Frewer believes that any regulatory framework must have a pan-EU policy but should be operated in a de minimis way to enable individual governments to implement rules and guidelines in a fashion that suits local and cultural demands. "Some issues are unique to particular cultures," she said. "Research shows pretty clearly that the level of scepticism about science and food is far higher in the UK than it is in Greece."

LATEST RESEARCH

While there is abundant talk and theory about how nanotechnology will directly affect the food that we eat, the number of nano-products yet commercially available or officially in design is very small. A database of such lines produced by the Woodrow Wilson International Center for Scholars, a Washington research institute, lists fewer than 50 products and ingredients, of which a handful are directly related to food. The include a 'Nanotea', produced by a Chinese company, that will increase the amount of selenium absorbed from green tea through the process of micellation. Mars, meanwhile, has a US patent for nanoscale films that have been tested on M&Ms, Twix and Skittles to increase their shelf-life. The coatings are

made from nano oxides of silicon or titanium. NestlÃ© meanwhile is looking at employing nano-encapsulation to improve shelf life and engineer taste sensations in fatty foods like chocolates and spreads, offering significant cuts in the proportion of fats, salts and artificial additives that go into such products.

Meanwhile, researchers at the University of Bonn are developing dirt repellent coatings for packages using the 'lotus effect' (whereby, water beads and runs off the surface of lotus leaves as a result of wax pyramids which coat the leaves) - a process that could benefit abattoirs and meat processing plants. The process works by reducing the surface area available on which dirt can gather by creating tiny nanoscale wax pyramids - the same principle that is in operation with lotus leaves.

Functional nanostructures can incorporate individual biological molecules, which is useful in the development of biosensors that can use natural sugars or proteins as target-recognition groups.

Companies are also looking at ways in which nanotechnology can offer improvements in sensitivity or ease by which contamination of food is detected. For example, AgroMicron has developed the NanoBioluminescence Detection Spray which contains a luminescent protein that has been engineered to bind to the surface of microbes such as Salmonella and E. coli.

When bound, it emits a visible glow, thus allowing easy detection of contaminated food or beverages. The more intense the glow is, the higher the bacterial contamination. The company is looking to market the product under the name BioMark and is designing new spray techniques to apply in ocean freight containerized shipping and to fight bioterrorism.

Products developed by Germany-based Aquanova, include vehicles that allow for higher efficiency of natural antioxidants such as vitamin C or clear appearance in drinks such as vitamin E solubilisates.

For Vitamin E, Aquanova encapsulates the vitamin in a liquid form in what it calls a more "stabilised distribution" condition. Traditionally such encapsulation takes place at the level of 1,000 to 300,000 nanometres in width - and a side effect is that the liquid to which the encapsulated material is added becomes turbid. For fruit juices that already turbid in texture, this is not necessarily a problem, but it is for a transparent liquid. Aquanova performs the encapsulation at just 30 nanometres. "This is a size below the wavelength of light," said Mr Behnam. "And it means that you can get a liquid containing Vitamin E which has a crystal clear appearance.

Both products are available to the market - that is, to in a business-to business fashion rather than on the shelves of the supermarket. "We are the beginning of the value chain," said Mr Behnam, whose company sells the products to BSF, the largest supplier of Vitamin E worldwide.

Then there is that ice cream, being developed by Unilever, which aims to reduce the typical 40% fat content of ice cream to a far lower percentage while keeping the texture of the product the same. This is being achieved by manipulating the emulsion of the fats at the nano level.

Omega oils are another area where the technology is upon us. Israeli and German companies are developing liposomes that contain omega oils. Their reasoning is that many people dislike taking omega oils in pill form because of the sharply fishy tastes - but incorporated into bread or some other edible product, the taste vanishes. In Australia, Tip Top bread recently went on sale, incorporating undetectable nano-capsules of omega-3, so designed that consumers get their vitamins in a palatable fashion.

In Israel, Nutralease, utilises 'Nano-sized Self-assembled Liquid Structures'

(NSSL) technology to deliver nutrients in nanosized particles to cells. Nutraceuticals that have been incorporated in the carriers include lycopene, beta-carotene and lutein. The Nutralease particles allow these compounds to enter the bloodstream from the gut more easily, thus increasing their bioavailability. The technology has already been adopted and marketed by Shemen Industries to deliver Canola Activa oil, which it claims reduces cholesterol intake into the body by 14%.

Nanotechnology may also be bringing nearer the day when precision farming - maximising yields while minimising fertiliser use - finally arrives. Although not fully implemented yet, tiny sensors and monitoring systems enabled by nanotechnology will have a large impact on future precision farming methodologies, according to Dr Morrison. "One of the major roles for nanotechnology-enabled devices will be the increased use of autonomous sensors linked into a GPS system for real-time monitoring," he said. "These nanosensors could be distributed throughout the field where they can monitor soil conditions and crop growth."

Wireless sensors are already being used in certain parts of the USA and Australia. One of the Californian vineyards, Pickberry, in Sonoma County has installed wifi systems with the help of the IT company, Accenture. According to both companies, the initial cost of setting up such a system is justified by the fact that it enables the best grapes to be grown which in turn produce finer wines, which command a premium price.

The use of such wireless networks is not restricted to vineyards. Small

nanosensors are being used by Honeywell (a technology R&D company) to monitor grocery stores in Minnesota. This technology enables shop keepers to identify food items which have passed their expiry date and also reminds them to issue a new purchase order.

One of the world's largest agrochemical corporations, Syngenta, is using nanoemulsions in its pesticide products. One of its successful growth regulating products is the Primo MAXX plant growth regulator, which if applied prior to the onset of stress such as heat, drought, disease or traffic can strengthen the physical structure of turfgrass, and allow it to withstand ongoing stresses throughout the growing season.

Another encapsulated product from Syngenta delivers a broad control spectrum on primary and secondary insect pests of cotton, rice, peanuts and soybeans. Marketed under the name Karate Zeon, this is a quick release microencapsulated product containing the active compound lambda-cyhalothrin (a synthetic insecticide based on the structure of natural pyrethrins) that breaks open on contact with leaves. In contrast, the encapsulated product "gutbuster" only breaks open to release its contents when it comes into contact with alkaline environments, such as the stomach of certain insects.

The brewing industry is also closely following developments in nanotechnology for their packing. When it comes to selling beer, the weight and extra cost of glass has been non-negotiable for breweries. This is because beer reacts with plastic - which, being lighter and cheaper, would be the preferred vessel. But now Voridan, a division of US-based Eastman Chemical Company, and Nanocor, a US-based nanoclays technologies company, has developed a nanocomposite containing clay nanoparticles, called Imperm. The resultant bottle is both lighter and stronger than glass and is less likely to shatter. The nanocomposite structure minimises loss of carbon dioxide from the beer and the ingress of oxygen to the bottle, keeping the beer fresher and giving it up to a six-month shelf life. The technology has recently been adopted by several companies including the Miller Brewing Co, the United States' second largest brewer.

FRANKENSTEIN FOOD EFFECT

Governments, regulatory bodies and food manufacturers claim to have learnt the lessons of GM foods. "They are all much more aware of pubic opinion," said Dr Morrison. "They need to engage with the public and not just tell them 'this is how things are going to be and how these products benefit society and that we know what we are doing'. There's a need to be transparent - everyone recognises that GM food was handled badly - and that doesn't discount the fact that the wider public was not sure of its potential hazards.

"It all depends on how industry engages with the public, and indeed if the public really wants more nutritional foodstuffs."

According to Prof Frewer, the GM industry made several key errors that those working in the food sector would do well to avoid repeating in the sphere of nanotechnology. "Consumers suspected companies of developing GM food for their own economic benefit and were not looking after consumer protection. They did not trust people in the food chain to optimise consumer protection. And often the GM food was unlabelled, which meant people did not have a choice."

The legacy of GM means that nanotechnology has a battle to win over public perception, suggested Prof Fewer. "Consumers associate nanotech food with all the negative attitudes they had with GM - and that has profound implications for nanotechnology.

"The industry must ensure that their products are associated with benefits. Consumers would look at a GM potato and could not see what benefit it offered over a traditional potato. But all the research shows that consumers make decisions based on benefits rather than perceived risk. The industry must make sure that nanotechnology is not perceived to be ubiquitous - if people really don't want to buy nanotechnology-based foods then they should have the opportunity not to do so."

The European Commission is also aware of the need to avoid a repeat of the problems associated with GM food. The Commission has established a series of mechanisms whereby project that will enable scientists, policy makers and the public to discuss the benefits and potential impacts of nanotechnology across society and a range of industries, including the food sector.

The mechanisms have resulted from a consultation project called Nanologue, which, according to a spokesman for the Commission, aims to "promote an open and honest dialogue" about the potential benefits and pitfalls of nanotechnologies. Volker TÃ¼rk, of the Wuppertal Institute in Germany, co-ordinated Nanologue and believes that industry must above all be honest and transparent. "We should not pretend there are no risks, but we should also note that there are huge opportunities," he said.

A little surprisingly, given the huge furore around GM foods, Nanologue established that most people working on nanotechnologies were largely unaware of the ethical implications of their work. "We realised that there is a lot of discussion about ethics, but it is very academic and the people developing these technologies don't know these issues," said Mr TÃ¼rk.

The customer will always remain king. "The industry needs to remember that with food there is a customer involved and that people will be eating the product," said Dr Morrison. "Their opinion of what we can and can't do is really influential. We've

been here before - look at the surge in demand for organic produce and unadulterated food - 20 years ago the selling point was that food was cheap and lasted along time, and now more and more people are concerned about that."

Monitoring of ingredients is another area where nanotechnology can distance itself from GM, where ingredients were often not disclosed, for fear of alienating the public, according to Mr Craddock. "Fraud is what I'm getting it when it came to some elements of GM," he said. "Nano may go the other way. Nanotech is being seen as a beneficial addition to food, so producers are likely to highlight it. 'Nano' is seen as a whizz-kid marketing term and you may find it will be used for some products that are not actually being made at the nanoscale."

Nevertheless, Mr Craddock has some cautionary words for the food industry as it embraces nanotechnology. "Consumer suspicion is sometimes totally justified. We've had numerous incidents in the food industry where scientists have said something couldn't happen, but it did; and of politicians that denied that things happened. I would say to people who are highly pro-nano that they should remember the carpenter's advice: measure up twice, and cut once - get the product right before you go into the public domain. There are genuine public concerns - whether these concerns are valid scientifically is yet to be shown."

Nanotechnology is entering a critical phase that may well determine its long-termprospects. "It very much depends on what happens in the next couple of years," said Prof Frewer. "Nanotechnology and food has suddenly become a focus of societal debate. If the industry listens to the concerns of concerns, involves the n the decision making and informs them - and avoids the mistakes of the GM industry - then I don't think it will be a problem."

Links:

www.nano.org.uk

www.aquanova.de

www.efsa.europa.eu

www.euronanotrade.com

www.nanocor.com