Nanotechnology – no place in organic food and farming?

Blake, F.[1]

Key words: nanotechnology, nanoparticles, organic standards, food processing, cosmetics,

Abstract

The technology of the VERY small is new, rapidly developing and totally unregulated. The properties of nanoparticles are very different from larger particles of the same material, often in unpredictable ways. This gives them both their extraordinary potential and their unknown risks. How should we in the organic movement react to this? The Soil Association has taken a precautionary approach and is the first organisation in the world to have set standards banning nanomaterials in its standards. This paper suggests that the rest of the organic movement should follow suit.

Introduction

Nanotechnology involves the manipulation of materials and the creation of structures and systems at the scale of atoms and molecules. This can be either through simple physical processes or by specific engineering. Nanoparticles are commonly defined as measuring less than 100nm – one hundred millionths of a millimetre.

Nanomaterials include:

- nanoparticles and nanoemulsions
- nanostructures including nanocapsules, nanotubes, fullerenes (buckyballs), quantum dots and nanowires.

The properties of nanomaterials can differ significantly from those at larger scales because quantum effects start to occur at the nanoscale. These differences may be in chemical reactivity and biological activity, solubility and mobility, colour and transparency, among others. Nanomaterials may therefore introduce new or heightened risks of toxicity, which are currently little understood. The possible effects of these nanomaterials on the environment, human and animal health are currently unknown.

These are examples of known and developing uses of nanotechnology:

- food additives, such as for flavouring, enhanced absorption of nutrients or modifying texture
- cosmetics, such as in transparent mineral sunscreens and make-up products

[1] The Soil Association, South Plaza, Marlborough Street, Bristol, UK BS1 3NX, E-mail fblake@soilassociation.org

- packaging, including quantum dots for traceability, UV light filters, nanoclays as gas barriers and carbon nanotubes to alter strength-to-weight ratio
- medicinal, such as drug delivery, DNA vaccines and advanced therapies
- industrial, such as fuel additives and window coatings
- environmental, such as soil remediation
- electronic, such as nanocomponents in electronic circuits
- pesticides, such as pesticide delivery in nanoemulsions, and
- textiles, such as stain and water resistant coatings.

Manufactured nanoparticles include:

- engineered nanoparticles that are intentionally produced to have a specific novel property, such as for the uses listed above, and
- other manufactured nanoparticles that are produced incidentally by industrial processes, particularly modern high energy processes such as those using high pressure (for example, some types of homogenisation).

Materials and methods

The Soil Association standards department was first alerted to this emerging technology in 2004. It followed an application by an organic cosmetics company to certify a sunscreen that contained titanium dioxide nanoparticles. Titanium dioxide is an allowed mineral that is used to absorb UV rays and therefore acts to protect the skin. It is opaque and colours white under normal circumstances, but is transparent at nanoparticle size. Understandably, companies want their sunscreens to be transparent.

As a precautionary measure, our standards board decided that we should develop standards to prohibit nanoparticles. So our standards department set about researching nanotechnology to find out more about it and to identify what the standards should say.

- As with genetic modification (GM), the risks of nanotechnology are unknown, untested and unpredictable. Nanoparticles change in properties even with a tiny variation at nm size (Royal Society and the Royal Academy of Engineering, 2004).
- Because nanoparticles are so small, they can bypass the body's natural protective boundaries such as skin, or the blood-brain barrier (Howard, 2003).
- As with GM, the risks are so great that they are likely to be un-insurable, according to Swiss Re, one of the world's largest reinsurance companies. Its 2004 review stated that: "The danger is most probably not of an acute but chronic nature and it could be some time before it manifests itself. This is where the real risk for insurers lies, and the comparison with asbestos should be seen in this light" (Swiss Re, 2004)
- As with (GM), the commercial aspects are outstripping regulations - which are currently non-existent. A report for the UK Government by the Royal Society and the Royal Academy of Engineering recommended that "particles and nanotubes should be treated as new chemicals under UK and EU legislation, in order to trigger

appropriate safety tests and clear labelling". It also recommended a ban on environmental releases, that industry should publish details of safety tests, and that research is conducted into the toxicity, epidemiology, persistence and bio-accumulation of nanoparticles and nanotubes (Royal Society and the Royal Academy of Engineering, 2004).

- As with GM, there is a race to file nanotech patent applications – 80,000 every year. Investment in nanotech was $8.6bn in 2004 and it is predicted that the industry will be worth $1 trillion globally by 2011 (ETC Group, 2004).
- Organic farming methods are based on the use of natural biological and ecological processes. The use of synthetic nano-particles which would not exist in nature and whose basic physical structure has been modified at a very fundamental level would be incompatible with this important organic principle.

Faced with this information about the nature of this technology, its burgeoning application and the associated (and unknown) risks, it was clear that it had no place in organic food and farming, and that we should prohibit nanoparticles outright.

In order to make sure we were basing our decision on the best scientific advice, we formed an expert group on nanotechnology, composed of prominent scientists and experts in this new field. Using their advice, we formulated and then consulted on an appropriate standard.

Our normal standards decision making process involves:

- initial research and development by the standards department,
- review and approval by the appropriate standards committee(s),
- consultation with licensees (4500) and Soil Association members (24000),
- decision by the standards board,
- final authorisation by the council (elected by the members).

Results

One aspect that emerged during this process was that there are many cases of naturally occurring nanoparticles, for example, from volcanic eruptions, and in wood smoke. We needed to make sure these fell outside the scope of the standard.

Similarly, some manufacturing processes may produce nanoparticles incidentally, for example certain forms of homogenisation that involve very high pressure. We realised we need to investigate these further. We have scheduled some research into this for early 2008, and will be able to report our findings at the Congress.

The standard that the council finally approved was as follows:

"You must not use ingredients containing manufactured nanoparticles, where:

- *the mean particle size is 200nm or smaller, and*
- *the minimum particle size is 125nm or smaller.*

Note – we recognise that this standard will have implications for some established manufacturing processes that produce nanoparticles incidentally. Until we research

these more fully, we will not apply this standard to them. The standard does apply to engineered nanoparticles."

Discussion

The standard was approved by our council in July 2007. It was published in our 2008 standard in chapter 3, section 6, Genetic engineering and nanotechnology (Soil Association, 2008).

To our knowledge, we are the first organisation in the world to set a standard either limiting or prohibiting nanotechnology.

Currently, the implications of this new standard for organic licensees are likely to be minimal, with the possible exception of sunscreens. However, new nanotech products and new uses are developing all the time in all the areas of our operation – farming, food processing, cosmetics and textiles. Therefore, we see this standard as preventative, laying down a marker before the problems emerge.

Conclusions

This is an issue for the whole organic movement. It is potentially bigger than GM, with much wider uses, and of course the one technology is already feeding into the other. It is vital that we all address it before it is upon us and before we are fighting a rear-guard action, as we are (still) doing with GMOs. We are happy to share the work that we have done on nanotechnology and call on all private standards organisations to adopt this standard.

Acknowledgements

The author gratefully acknowledges the support of colleagues in the Soil Association, its standards committees, standards board and council, together with the experts in the nanotechnology expert working group.

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