Nano-in-food - Threat or Opportunity for Organic Food?

Paull, J.[1] & Lyons, K.[2]

Key words: nanotechnology, engineered nanoparticles, nanoscale materials, organic agriculture, organic farming, regulation, labelling, IFOAM, standards.

Abstract

Nanotechnology is creating engineered particles in the size range 1 to 100 nanometers. At the nano-scale, materials exhibit novel behaviours. Nine billion dollars is currently invested annually in nano-research, with the explicit intention of rapid commercialisation, including food and agriculture applications. Nanotechnology is currently unregulated, and nano-products are not required to be labelled. Health, safety and ecological aspects are poorly understood, and there have been calls for a moratorium. Two consumer surveys indicate that public awareness of nanotechnology is low, there is concern that the risks exceed the benefits, that food safety is declining along with declining confidence in regulatory authorities. A majority of respondents (65%) are concerned about side effects, and that nano-products should be labelled (71%), and only 7% reported they would purchase nano-food. There is an opportunity, for the organic community to take the initiative to develop standards to exclude engineered nanoparticles from organic products. Such a step will service both the organic community and the otherwise nano-averse consumers - just as GMOs have been excluded previously.

Introduction

In his 1986 book *Engines of Creation,* Eric Drexler introduced a world readership to his concept of nanotechnology. “Arranged one way, atoms make up soil, air and water, arranged another, they make up ripe strawberries” (Drexler, 1986, p. 3). He proposed tiny machines using atoms as building blocks, and for Drexler this was the essence of nanotechnology. Life itself was his proof-of-concept: “Ribosomes are proof that nanomachines built of protein can be programmed to build complex molecules” (p. 8).

In the twenty years since Drexler shared his bold vision for a future of nano-machines, little of his vision has come to pass. Nevertheless, in the past decade nanotechnology has developed into a multi-billion dollar research enterprise (Fig. 1).

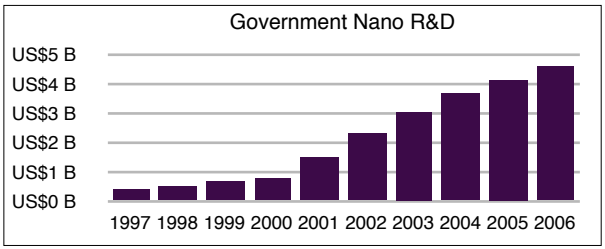

Figure 1: Estimated government nanotechnology R&D, cumulated over USA, EU, Japan and others. Data source: Roco (2007).

[1] The Fenner School of Environment and Society, Australian National University, Canberra, ACT, 2601, Australia. <john.paull@anu.edu.au>

[2] School of Biomolecular and Physical Sciences, Griffith University, Brisbane, Qld, 4111, Australia.

Nanotechnology *"is the creation and use of materials, devices and systems that exploit novel properties arising from the structure and properties of matter in the nanometre size range" (*DEST, 2003, p. 293), that is in the range 1 to 100 m^{-9}. Nanotechnology is developing both "nanoscale versions of existing materials, [and] entirely new classes of materials" (NNCO, 2006). Nano-developments have proceeded mostly out of the public eye. We can only speculate why this has been the case: the topic is "too hard", it is seen as futuristic, as science fiction, even far fetched, and in any event it appears non-threatening - all perceptions that can flow from Drexler's writings. Drawing a lesson from the GMO debate, nano-proponents have an interest in nano attracting a low profile.

Table 1: Selected nanotechnology milestones

Date	Nano-Milestones
1986	• Engines of Creation, Eric Drexler
1992	• Nanosystems: Molecular Machinery, Manufacturing and Computation, E.Drexler
1999	• US National Nanotechnology Initiative (NNI) proposed (Roco, 2007)
2000	• First national Nano R&D programme: US National Nanotechnology Initiative (NNI) established, US $ 270 million (Roco, 2007)
2001	• National R&D programmes: Japan, Korea (Roco, 2007) • USDA US 1.5 million nano-research (Roco, 2007)
2002	• The ETC Group call for a moratorium (ETC, 2004) • National R&D programmes: EU, Germany, China, Taiwan (Roco, 2007)
2003	• US 21st Century Nanotechnology R&D Act (Roco, 2007)
2004	• Nanoparticles transported via blood, lymph and nerve cells (Hoet et al 2004) • Proposal that use of free (not bound) manufactured nanoparticles be prohibited (Royal Society& Royal Academy of Engineering, 2004)
2005	• US NNI supports over 4000 projects & 60 new research centres (Roco, 2007)
2006	• Nanotechnology as the foundation for "advanced agriculture" (NNCO 2006) • President Bush list Nanotechnology as "a top technological opportunity for national competitiveness (Roco, 2007) • OCA calls for moratorium <www.organicconsumers.org> • "No studies of the effectiveness of personal protective equipment against nanomaterials" (NNCO, 2006)
2007	• 580 consumer nano-products (WWICS, 2007) • US$50 Billion (WWICS, 2007) • ETC Group runs Nano warning label competition <www.etcgroup.org>. • EPA Whitepaper: "nanoparticle toxicity is complex &multifactorial" (EPA, 2007). • US DOD cumulative research US$1.9 billion+, 2000-2007 (Roco, 2007)
2008	• US $1.44 billion US government nano-research budget (Marburger 2007).
by 2015	• US $1 trillion of nano-products pa estimated (Roco, 2007).

Nanoparticles have novel properties, they have the capacity to pass through cell membranes (Hoet et al., 2004), and there is a lack of safety and toxicity data (RS & RAE, 2004; EPA, 2007). Nevertheless, food and agriculture are being targeted for nano-implementations (DEST, 2003; Marburger, 2007; Roco, 2007).

As with other crypto-pollution, organic standards can potentially exclude intentional and incidental nano-pollution, but probably not adventitious contamination (Table 2).

Consumer Surveys

In a US national survey of adults survey, conducted for The Woodrow Wilson International Center for Scholars, N = 1014, 71% of respondents reported to have

heard little or nothing of nanotechnology (HRA, 2007). “Initial impressions of risks and benefits” are reported as: 18% believed that benefits outweighed risks, 6% believed the risks outweigh the benefits, 25% indicated the risks and benefits are equal, and 51% of respondents indicated “not sure”. The safety of the food had declined over the past five years according to 61%; it had improved according to 29%, and the residual reported “not sure” or no change. At the same time, public confidence in food regulatory bodies is declining. Over the period 2001 to 2007, evaluations of the FDA (US Food & Drug Administration) as doing “an excellent/pretty good job” showed a steady decline from 67% to 49%. Over the same period, evaluations of the EPA (US Environmental Protection Agency) as doing “an excellent/pretty good job” fell from 65% to 50%.

Table 2: Potential sources of Nano-contamination in food

Sources of Nano in Food	Examples
Adventitious	Nano-pollution from: airborne, rain-borne, water-borne nanoparticle-drift from off-farm and/or off-site.
Incidental	Nano-pollution from: nanonized packaging; surface coatings - in packaging, sorting, storage, sales areas; utensils; packaging equipment; transport equipment; filtration equipment.
Intentional	Nano-pollution from: nanonized production inputs; food processing additives; foliar or systemic sprays.

On nano-purchasing intentions, 29% declared they “would NOT purchase food enhanced with nanotechnology”, and 62% indicated they “need more information“ before doing so. Only 7% indicated a willingness to purchase such food.

A national telephone survey of Australian randomly selected households, conducted for the Department of Tourism and Resources, N = 1000, reported that 36% of respondents “could nominate a *definition of nanotechnology*”, 27% could not, and 37% “were not aware of the term nanotechnology” (MARS, 2007). On the implications of nanotechnology, 83% were *excited* or *hopeful*, while 14% were *concerned* or *alarmed*. On risk, 5% reported risks outweigh benefits, 54% benefits outweigh risks, with 41% reporting risks and benefits as “equal” or “don’t know”.

On safety, 65% agreed that “I am concerned about the unknown and long term side effects”. On the need to know, 71% agreed “it will be important for me to know if the products I buy are made with nanotechnology” (Fig. 2), and the report concluded that “people want to know what they are buying” (MARS, 2007, p. 25). On food, 35% “perceived nanotechnology offered potential benefit”, down from 40% in 2005 (p. 16, 17). Willingness to purchase nano-food was not canvassed in the Australian survey.

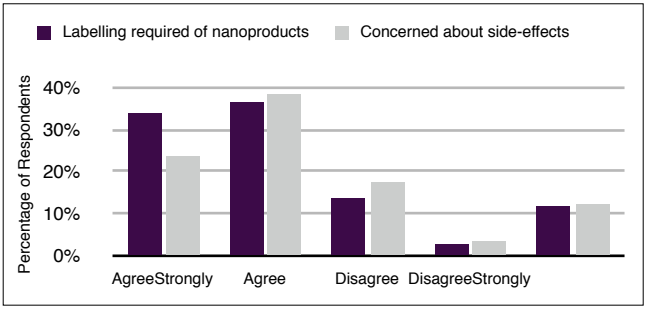

Figure 2: Questions: “It will be important for me to know if the products I buy are made with nanotechnology” & “I am concerned about the long-term side effects of nanotechnology”, N = 1000. Data source: MARS, 2007.

Conclusions

Governmental oversight will take time, may never be congruent with organic customer expectations, and labelling regulations may never arrive. So it would seem incumbent on the organic community to take the initiative, and declare nano-ingredients as *verboten*, excluded inputs. The organic sector is in a better position to implement such an exclusion than other food sectors because (a) organic production champions low farm inputs and (b) already has an auditing system in place, (c) already has traceability protocols in place for all inputs, including farm inputs and processing inputs, as well as packaging, (d) already has a consumer-trusted certification and labelling system and (e) has a labelling-literate constituency of consumers.

Organic producers are at risk of introducing nanoparticles into the organic food stream by inadvertently or purposefully using inputs that incorporate engineered nanoscale material. Use of such products risks migration of nanoparticles into organic food. The sources of incursion of nanomaterial into organic food includes, but is not limited to: on-farm chemical inputs, surface treatments including paint, filtration products including water treatment, food processing additives, clothing and textiles, packaging including degradable and biodegradable plastics (Table 2).

Nanotechnology is currently not addressed in any organic standard. This can be remedied, ideally at the IFOAM level, and failing that, at national, or even failing that, at the certifier level. An exclusion of nanotechnology from the organic food chain keeps faith with the philosophy and principles of organics, serves as a precautionary act to protect organic consumers, processors and farmers, and there is the opportunity to attract a new cohort of consumers to organics - the nano-averse.

References

DEST, 2003, Mapping Australian Science and Innovation - Main Report, Department of Department of Education, Science and Training (DEST), Canberra.

Drexler, K. E., 1986 (reprint 1996), Engines of Creation - The Coming Era of Nanotechnology, Fourth Estate, London.

EPA, 2007, Nanotechnology White Paper, Science Policy Council, Nanotechnology Workgroup, US Environmental Protection Agency, Washington, February.

ETC Group, 2004, Down on the Farm: The impact of Nano-scale Technologies on Food and Agriculture, Action Group on Erosion, Technology and Conservation. Ottawa, Canada, November.

Hoet, P. H. M., Bruske-Hohlfeld, I. & Salata, O. V., 2004, Nanoparticles - known and unknown health risks, Journal of Nanobiotechnology, 2:12, 1-19.

HRA, 2007, Awareness of and Attitudes Toward Nanotechnology and Federal Regulatory Agencies, A Report of Findings, Peter D. Hart Research Associates Inc., Washington, 25 September.

Marburger, J. H. (ed.), 2007, Supplement to the President's 2008 Budget, The National Nanotechnology Initiative, National Science and Technology Council, Washington, July.

MARS, 2007, Final Report: Australian Community Attitudes Held About Nanotechnology - Trends 2005 - 2007, Market Attitude Research Services, Miranda, NSW, Australia, 12 June.

NNCO, 2006, Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials, The National Nanotechnology Initiative, National Nanotechnology Coordination Office, Washington, September.

Roco, M. C., 2007, National Nanotechnology Initiative - Past, Present, Future, in Taylor & Francis (eds.), Handbook of Nanoscience, Engineering and Technology, 2nd ed., preprint.

RS & RAE, 2004, Nanoscience and nanotechnologies: Opportunities and uncertainties, The Royal Society & The Royal Academy of Engineering, London.

WWICS, 2007, A Nanotechnology Consumer Products Inventory, Woodrow Wilson International Center for Scholars, Project on Emerging Technologies, (data set as at September 2007).