Institution:
University of Glasgow

Unit of Assessment:
B7 – Earth Systems and Environmental Sciences

Title of case study:
World Leader in Detecting and Regulating Irradiated Food

1. Summary of the impact

Researchers at the Scottish Universities Environmental Research Centre (SUERC, University of Glasgow) were the first to develop methods and equipment for screening foodstuffs for irradiation. Their work led to new UK and European standards (BS EN 1788 and BS EN 13751) which provide protection and reassurance to consumers. Professor David Sanderson's laboratory is recognised as the world-leader in the detection of food irradiation. The laboratory is also the only establishment to develop, design and sell photostimulated luminescence (PSL) systems to detect irradiated food. Since 2008 134 laboratories worldwide have taken up these UK-manufactured PSL systems to prevent irradiated ingredients from entering the food manufacturing chain.

2. Underpinning research

Prior to the research conducted at SUERC, it was believed that irradiated food could not be detected. The UK Advisory Committee for Irradiated and Novel Foods (ACINF) reported in 1986 that "there are as yet no generally applicable chemical or physical tests which would be adequate for the enforcement of legal and commercial requirements, or for investigation purposes, for determining whether a food or a food ingredient has been irradiated". At the time it was increasingly common for products ranging from root vegetables to cereals, fruits, seafood, meats and spices to be subjected to ionising radiation by gamma rays and high-energy X-rays. But there was no legal or other statutory requirement for such irradiation to be disclosed to retailers and consumers, despite potential health hazards.

Professor David Sanderson (Lecturer then Senior Lecturer 1986-2004, Reader 2004-08, Professor 2008-present), was working with luminescence research based on single photon counting for several years and was convinced that it would be a suitable technique for detection of irradiated foods. Sanderson received the first of a series of contracts from the Ministry of Agriculture in 1987 to investigate the suitability of luminescence methods for this purpose.

The underlying processes, when minerals and other dielectric media store energy from ionising radiation by charge trapping at defect centres, leading to luminescence emission under stimulation, were known from solid-state physics research. Thermoluminescence dating of ceramics and thermoluminescence dosimetry using natural and synthetic materials applies such principles. Sanderson had previously been involved in development and application of these phenomena using single photon counting methods. The application to bioinorganic systems and to mixed organic/inorganic materials, however, was new. In particular he recognised that PSL might be capable of detecting food irradiation using anti-Stokes wavelength shifts in new luminescence instruments. Exploratory spectroscopy verified the applicability of the phenomena and systematic work on herbs, spices, fruits, vegetables and shellfish had been completed by 1994. Parallel development of novel high sensitivity pulsed photostimulation systems, patented in 1993, led to the production of commercial screening instruments.

Sanderson developed two international standard methods based on luminescence. BS EN 1788 describes the application of thermoluminescence to silicates extracted from a wide variety of foods using techniques first developed at his laboratory. BS EN 13751 describes the use of pulsed PSL for rapid instrumental screening. These standards are still the most widely used methods to detect irradiated food.

The development and validation of these methods has been the result of a series of externally funded research projects including those supported by the UK Ministry of Agriculture, Fisheries and Food (MAFF) and the Food Standards Agency.

This research has been carried out by Professor Sanderson and his research team, Dr Lorna Carmichael (Postdoctoral Research Associate 1990-present) and Dr Saffron Fisk (Technician 1996-99 and 2004-11).

3. References to the research

1. Carmichael, L.A., Sanderson, D.C.W. and Ni Riain, S. (1994) Thermoluminescence measurement of calcite shells. *Radiation Measurements* 23, 455–463. (doi:10.1016/1350-4487(94)90079-5)
2. Sanderson D.C.W., Carmichael L.A. and Naylor J.D. (1996) Recent Advances in Thermoluminescence and Photostimulated Luminescence Detection Methods for Irradiated Foods, in *Detection Methods For Irradiated Food: Current Status*, Ed. McMurray, C. H., Stewart, E., Gray, R. and Pearce, J. Royal Society of Chemistry, Cambridge, pp 124–138. ISBN 085 4047700 (Available from HEI) *
3. Carmichael, L.A. and Sanderson, D.C.W. (2000) The use of acid hydrolysis for extracting minerals from shellfish for thermoluminescence detection of irradiation. *Food Chemistry* 68, 233–238. (doi:10.1016/S0308-8146(99)00200-9) *
4. Sanderson D.C.W, Carmichael L.A. and Fisk S. (2003) Thermoluminescence detection of irradiated fruits and vegetables: International interlaboratory trial. *Journal of AOAC International* 85, 971–975.
5. Sanderson D.C.W, Carmichael L.A. and Fisk S. (2003) Photostimulated luminescence detection of irradiated shellfish: International interlaboratory trial. *Journal of AOAC International* 85, 983–989.
6. Sanderson D.C.W, Carmichael L.A.and Fisk S. (2003) Photostimulated luminescence detection of irradiated herbs, spices, and seasonings: International interlaboratory trial. *Journal of AOAC International* 85, 990–997.

* best indicators of research quality

Grants

- 1994-96: £110,196 from MAFF for establishing luminescence detection methods for fruits and vegetables and shellfish, by means of international interlaboratory trials (ref 1B073)
- 2004-07: £154,157 from the Food Standards Agency – Development of proficiency testing for detection of irradiated foods (ref E01068)

Patent:

- D. C. W. Sanderson, Detection of Irradiated Samples, 1993. Patent Numbers: GB877 940425; WO9425851; GB2291707; EP0699299-A; DE69411385; AU6543594-A

4. Details of the impact

Food safety is a major political, economic, social and health issue, with recent contamination scares raising the pressure still further on producers, processers and retailers to deliver safe food to the consumer. This means striving to reduce insect infestation of crops, delay ripening to extend shelf life and to improve yields.

This trend means that it is vital that consumers continue to be protected against potentially dangerous processes being applied secretively to fresh food before it reaches the shelves. One of these processes involves the use of high-energy ionising radiation to extend shelf life by reducing the bacteria associated with natural foods. This process can be substituted for good sanitary practices in food production. Legislation on labelling of irradiated food was prevented by the absence of reliable and efficient detection methods. Thus before legislation was introduced in 1996, consumers were unaware of whether or not food had been irradiated. SUERC researchers led by Sanderson were the first to develop methods and equipment for screening foodstuffs for irradiation, and this work led to the formulation of UK and European standards providing protection and reassurance to consumers.

In 2001 Sanderson's tests on UK food supplements found that a high proportion (42%) had been irradiated and were not in compliance with the law. Subsequent testing in other countries found that this was a widespread problem and this information was made public. Sanderson's team has continued to analyse samples for food retailer and supplier clients, testing over 3,000 since 2008.

Sanderson and his team developed two international standard methods based on the use of luminescence to detect irradiation: BS EN 1788 (first introduced in 1996) and BS EN 13751 (first introduced in 2001). Today, these standard methods are the most widely used to detect irradiated foods and remain unchanged since their introduction. Every consumer in the UK and Europe has benefitted from the added protection provided by the work of Sanderson's team in relation to food labelling and screening. Authenticity and traceability of foodstuffs are important to consumers, regulators and the food industry. In compliance with EC legislation, the UK Food Labelling Regulations 1996 and the Food Irradiation Provision Regulation 2000 require all foods, or listed ingredients of food, that have been irradiated, to be labelled with the words "irradiated" or "treated with ionising radiation". Therefore the work carried out in SUERC has provided consumers with substantially enhanced protection from unlabelled irradiated food.

The International Atomic Energy Agency's Food Irradiation Specialist states:

> *EN1788 and EN13751 are the most widely used methods to detect irradiated foods. In a regulatory sense, EN1788 and EN13751 are necessary to ensure that food can be tested for compliance with the law. Both tests used together are a powerful tool in ensuring compliance with food irradiation regulations and also labelling regulations [to ensure that food is correctly labelled as irradiated]....*
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> *The use of these tests by regulators has ensured that food businesses (especially those who deal in food supplements) take action to check their products for irradiation on a routine basis. The availability of these tests for use by the food industry has also helped to settle disputes between companies. The tests are also available to be used by consumer groups and others who would like to test the authenticity of food.*
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> *Professor Sanderson's laboratory is recognized as the foremost in the use of and development of luminescence techniques to detect irradiated food.* [Full statement available from HEI]

To support enforcement of these regulations, the two standard methods are employed successfully by governments across Europe. There have been several cases where companies have been found to be supplying irradiated products in violation of the legislation, leading to costly recalls (often sanction enough) and other enforcement action including at least one UK prosecution. Food retailers and suppliers also use Sanderson's methods for screening ingredients, thus managing their regulatory risk.

Sanderson's laboratory is recognised as the world-leader in the detection of irradiation in foods. As well as setting new standards for testing, it is the only establishment to develop, design and sell PSL systems to detect irradiated food. The team has supplied over 250 laboratories worldwide (134 since 2008) with its own systems to ensure that ingredients have not been irradiated. These instruments are capable of making many tens of thousands of measurements per annum across the world. Training courses and reference materials are also supplied to laboratories worldwide.

5. Sources to corroborate the impact

- European Standard BS EN 1788, 1996; 2001; Detection of irradiated foods containing silicates using thermoluminescence. European standard developed by the CEN Technical Committee 275 Working Group 8, and published in two revisions following international consultation and voting procedures. The method implements almost all of the thermoluminescence procedures developed at SUERC between 1987 and 1994, and put through international validation studies from 1992-1997.
- European Standard BS EN 13751, 2002; Detection of irradiated foods using photostimulated luminescence. European standard developed by the CEN Technical Committee 275 Working Group 8, and published following international consultation and voting procedures. The method is based on the pulsed PSL screening system, developed at SUERC and internationally validated between 1996 and 2000.
- Testimonial from Food Irradiation Specialist, International Atomic Energy Agency (available from HEI)
- European Member State Official Testing Report OJ 2007/C122/3-21 (referring to BS EN 1788 and BS EN 13751)
- European Member State Official Testing Report OJ 2008/C 282/3-19 (referring to BS EN 1788 and BS EN 13751)