ACTES D'HISTÒRIA DE LA CIÈNCIA I DE LA TÈCNICA
NOVA ÈPOCA / VOLUM 9 / 2016, p. 37-54
ISSN: 2013-9640 / DOI: 10.2436/20.2006.01.194
http://revistes.iec.cat/index.php/AHCT
Rebut: 20/06/2016 - Acceptat: 03/08/2016

RESPONDING TO THE COLOURFUL USE OF CHEMICALS IN NINETEENTH-CENTURY FOOD

CAROLYN COBBOLD
CAMBRIDGE UNIVERSITY

Abstract: *The paper explores how chemists tried to deal with one of the first examples of mass-produced industrial chemicals to enter daily life, through investigating the use of coal-tar derived dyes to colour food in the late nineteenth century. From the mid 1850s European chemists manufactured a range of new chemicals included drugs, dyes, scents and flavourings from the derivatives of coal-tar waste. Initially greeted by the nineteenth-century press and public as 'wonder dyes', the vibrant new colours were seen as an example of how chemistry could transform society. The new dyes, produced for the textile industry, were widely employed to colour food and drink across Europe and America. This paper, a summary of a comparative historical study, demonstrates how cultural differences influence the understanding and management of new scientifically produced substances. The research highlights the difficulties that scientists face in helping determine how new scientific products and processes are applied in the marketplace. It also provides insights into early consumer risk management, the rise of scientific experts, and public health legislation. The second half of the nineteenth century was a time when food production was becoming increasingly industrialised and consumers faced complex and contradictory food knowledge claims. Food manufacturers introduced synthetic colourings and began to employ chemists during a period when food adulteration was of considerable social concern. At the same time, analytical chemists were being paid by the government to identify harmful and fraudulently applied food additives as well as by food companies, raising questions of whom to trust and how 'scientific' knowledge is formed and evaluated. Chemists, and chemical preservatives and colourings, became part of the armour employed by food producers and retailers to secure market share. However, the rapidly changing food market,*

* Correspondence: Carolyn Cobbold
Cambridge University
cac85@cam.ac.uk

intensifying industrialization and rising imports of food, led to mounting anxieties about chemical food colourings.

Key words: *Risk management, expertise, environmental health.*

Introduction

By examining the nineteenth-century introduction of coal-tar derived dyes into food, this paper explores how chemists tried to deal with one of the first examples of mass-produced industrial chemicals to enter daily life. From the mid 1850s European chemists began to synthesise a manifold array of new chemical substances extracted from coal tar waste. These manufactured chemicals included drugs, dyes, scents and flavourings. Initially greeted by the nineteenth-century press and public as 'wonder dyes', the vibrant new colours were seen as an example of how chemistry could transform society. Although produced primarily for the textile industry, the new dyes were also widely employed to colour food and drink across Europe and America.[1]

This paper summarises an in-depth analysis of documents from government and company archives in different countries and a wide range of nineteenth-century publications from Britain, France, Germany and the US. The comparative historical study demonstrates how profoundly cultural differences influence society's understanding and management of new scientifically produced substances. By examining the unintended use of new textile dyes as food colourings, the research reveals the difficulties that scientists face in helping determine how new scientific products and processes are applied in society. It also provides important insights into early consumer risk management, the rise of scientific experts, and public health legislation.

The second half of the nineteenth century was a time when food production was becoming increasingly industrialised and consumers faced complex and contradictory food knowledge claims.[2] Industrial chemists and food manufacturers introduced synthetic colourings and began to employ chemists during a period when food adulteration was of considerable social concern. At the same time, analytical chemists were being paid by the gov-

1. John Joseph Beer, *The Emergence of the German Dye Industry* (Chicago: University of Illinois Press, 1959); L. F Haber, *The Chemical Industry During the Nineteenth Century: A Study of the Economic Aspect of Applied Chemistry in Europe and North America* (Oxford: Clarendon Press, 1969); A.S. Travis, *The Rainbow Makers: Origins of the Synthetic Dyestuffs Industry in Western Europe* (Bethlehem,PA: Lehigh University Press, 1993); Carolyn Cobbold, "Managing the Risk of Unintended Applications of New Science and Technology: An Historical Example" (European Social Science History Conference, Valencia, Spain, April 30, 2016).

2. Peter William Atkins, *Liquid Materialities: A History of Milk, Science and the Law* (Farnham: Ashgate Publishing, Ltd., 2010); Michael French and Jim Phillips, *Cheated Not Poisoned?: Food Regulation in the United Kingdom, 1875-1938* (Manchester: Manchester University Press, 2000).

ernment to identify harmful and fraudulently applied food additives as well as by food companies, raising questions of whom to trust and how 'scientific' knowledge is formed and evaluated.

Food manufacturing and distribution underwent dramatic structural change during the second half of the nineteenth century, with the increase of branded foods, the emergence of large multiple retailers and the growth of sizeable food manufacturers and importers. As firms sought to consolidate their position and power in the marketplace, they increasingly turned to chemists and chemistry to standardize processes and products, prevent fraudulent adulteration or contamination in the supply chain, and to endorse their products as 'hygienic.' Chemists, and chemical preservatives and colourings, became part of the armour employed by the large food production and distribution companies in their drive to secure market share and to ensure that their products were seen as trustworthy, reliable, consistent, unadulterated and good value.[3] However, the rapidly changing food market, with the increasing financial power and political influence of the major food producers and retailers, intensifying industrialization and rising imports of food, led to mounting anxieties about chemical food additives, including artificial colourings. An article in the sanitary press in 1892 pointed out that in every country except England the use of new chemical preservatives 'in food has been prohibited (but) we allow the foreign producers to physic us without hindrance.'[4] While this quote is far from accurate since few countries totally banned the new chemical preservatives, it provides a flavour of the widespread concern about the use of chemicals in food at the time as well as the increasingly global food trade and subsequent fears surrounding food importation.

Coal-tar dyes were introduced into food across Europe and the US at a time when many countries were busy introducing and amending food legislation to combat adulteration. One of the reasons countries, including Britain, introduced food legislation during the mid-nineteenth century was due to concerns about the long-standing use of toxic dyes in food and drink, including lead, copper, and arsenic. However, countries responded differently to the replacement of these former dyes with the newly manufactured chemical dyes.

3. Melanie Miller, "Food Colours: A Study of the Effects of Regulation" (PhD, Aston University, 1987). Michael J Winstanley, *The Shopkeeper's World 1830-1914* (Manchester: Manchester University Press, 1983); James B Jefferys, *Retail Trading in Britain, 1850-1950*, Economic and Social Studies / National Institute of Economic and Social Research 13 (Cambridge [Eng.]: University Press, 1954); E. J. T. Collins, "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries," *Food Policy* 18, no. 2 (1993): 95–109.

4. Anon. *The Public Analytical Journal and Sanitary Review*, (October 1, 1892): 6. Collins; "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries."; B. R. Mitchell and Phyllis Deane, *Abstract of British Historical Statistics* (Cambridge: Cambridge University Press, 1962); William J. Ashworth, *Customs and Excise: Trade, Production, and Consumption in England, 1640-1845* (Oxford: OUP Oxford, 2003); Great Britain Customs Establishment, *Customs Tariffs Of The United Kingdom From 1800 To 1897: With Some Notes Upon The History Of The More Important Branches Of Receipt From The Year 1660* (Nabu Press, 2012).

From the 1880s, France, Germany and other European countries banned specified coal tar dyes believed to be harmful. Taking a precautionary approach, the US, in 1907, advised against the use of all coal tar dyes except for seven dyes, which the government recommended as safe to use. Britain's legislation, meanwhile, did not specifically mention coal tar dyes until 1925 and only produced a permitted list of chemical dyes in 1957, five decades after the US introduced such a list.[5] While this paper is a result of a comparative study of the situation in nineteenth-century Germany, France, the US and Britain, it primarily questions why Britain, one of the world leaders in food legislation and the appointment of food chemists, lagged so far behind in legislating against coal-tar colours.

Most western countries now tightly regulate the chemical colourings that food and drink manufacturers use, producing lists of either permitted dyes or prohibited ones. However, many countries have only introduced regulations in recent decades, more than a century after their first appearance in food, and regulatory agencies continue to disagree as to which synthetic dyes should be permitted and which prohibited.[6] Why did it take so long for Britain to investigate and regulate on the use of new and, in many cases dangerous, chemicals being used in food production?

According to Anthony Giddens, the creation of twentieth-century expert systems marked an acknowledgment that many risks in life are a result of human intervention. Expert-led risk management systems provide trust and faith in a product or service where the consumer is removed spatially and in time from the providers or designers of the product or service.[7] Legitimisation of the industrial food supply, dating from before the twentieth century, is one of the first examples of such a system and demonstrates that such arrangements of managing and controlling changing environments are the result of compromises between different communities and vested interests.

Synthetic colours were – and still are – introduced into food for a host of reasons. Beside replacing poisonous minerals as a way of making food more attractive and, in the case of processed food such as tinned peas, look more natural -the chemicals which formed synthetic dyes often had a preserving effect on food, thus increasing its shelf-life. As a result, synthetic dyes are open to an array of interpretations as to their use in food. They may

5. Edgar Richards, "Legislation on Food Adulteration," *Science* 16, no. 394 (1890): 101–4; Sheldon Hochheiser, "Synthetic Food Colors in the United States: A History under Regulation" (University of Wisconsin, 1982); Miller, "Food Colours."

6. While there is a growing consensus as to which additives should be permitted, there are still differences in national regulation. For more information and current regulation see the web-sites of national and international food agencies eg.

http://www.fda.gov/Forindustry/ColorAdditives/default.htm

http://www.food.gov.uk/science/additives/foodcolours/#.U4LvXy_gLZs

http://www.efsa.europa.eu/en/topics/topic/foodcolours.htm

http://www.efsa.europa.eu/en/faqs/faqfoodcolours.htm

(all accessed May 26, 2014)

7. Anthony Giddens, *The Consequences of Modernity*, New Ed (Cambridge, UK: Polity Press, 1991).

be seen as a scientific improvement and a way of preserving and making food more attractive, and increasing food choice and availability. At the same time they may be viewed as a means of deceiving, and sometimes harming, the public. In a study of the Dutch consumer movement in the late twentieth century, Annette Van Otterloo described the increasing divide between the public, who viewed additives such as colourings, flavourings and preservatives as adulteration, and scientists who saw them as part of the legitimate food process.[8] This historical example shows that the incongruity between public perception and commercial and scientific sensitivity was very much alive in the late nineteenth century

In many ways, the new industrially manufactured dyes represented what science could achieve and as such their reputation was tied to the status of chemistry and chemists. However, while the public initially hailed the new colourings as wonders of science, concerns about their use as textile dyes increased during the 1870s, as reports of skin rashes and other physiological complaints circulated in the press. By the 1880s, when the press reported widespread use of the same dyes in food, the chemical dyes began, like earlier metallic and vegetable colourings, to be viewed as food adulterants and potentially poisonous.[9] This proved a difficult dilemma for public analysts, who were appointed and funded by local authorities in order to ensure safe and honest food supplies. The new dyes were used to colour many types of food and drink but because of the tiny quantities of dye used even expert chemists were often unable to detect them, still less identify each one. Tests were sought to address growing public and political concerns about the use and long-term physiological effects of chemical additives and to inform food legislation. Reaching agreement over the accuracy, standardisation and interpretation of experiments to evaluate them was not easy to achieve. New ways of assessment and control had to be created to deal with these novel substances.[10]

The understanding and authority of science outside of the laboratory is not one that can be easily controlled by any one group of actors, as other historians examining the contested position of nineteenth-century experts have discovered.[11] Recent discussions

8. A. H. Otterloo, 'The Development of Public Distrust of Modern Food Technology in the Netherlands,'' in A P den Hartog, ed, *Food Technology, Science and Marketing* (East Linton, Tuckwell Press, 1995), 253-267.

9. Carolyn Cobbold, "From Adulation to Adulteration - How Chemical Dyes Were Presented in the Victorian Press" (Consuming (the) Victorians. British Association of Victorian Studies, Cardiff, Wales, September 1, 2016).

10. Carolyn Cobbold, "The Silent Introduction of Synthetic Dyestuffs into Nineteenth-Century Food," in *The Silences of Science*, ed. Felicity Mellor and Stephen Webster (London ; New York: Routledge, 2017), 221–41; Carolyn Cobbold, "Managing the Risk"; Carolyn Cobbold, "Controlling Chemical Dyes in Food: International and Institutional Comparisons" (Geographies of Alchemy and Chemistry. Society for the History of Alchemy and Chemistry, Amsterdam, Netherlands, October 24, 2014); Carolyn Cobbold, "The Introduction of Chemical Dyes into Food - Industrial Risk or Revolution?" (Living in a Toxic World. Experts, Activisim, Industry and Regulation. European Spring School on History of Science and Popularization, Menorca, May 14, 2014).

11. Christopher Hamlin, *A Science of Impurity: Water Analysis in 19th Century Britain* (Oakland, California: University of California Press, 1990); Christopher Hamlin, "Scientific Method and Expert Witnessing: Victorian Perspectives on a Modern

among sociologists of science surrounding the social underpinnings of expertise also demonstrate the fluidity and complexities at the boundaries and interaction between different groups of experts.[12] Examining the public analysts' response to the unmonitored introduction of new indeterminable substances into the food supply is a valuable addition to the emerging scholarly research into risk and environmental health, which examines the interaction between scientific experts, the public, producers, retailers, the media and government in the management and regulation of industrial and scientific processes and products.[13]

In the nineteenth century, as today, expertise, knowledge and authority was contingent on prolonged and extensive debate and mediation between diverse groups, in different social, institutional and geographical settings. Public analysts attempted to draw boundaries between scientific and other expertise, whether legal, commercial, public or political, but those boundaries were always blurred and open to negotiation even among 'experts' from within the same scientific discipline. Public analysts formed their expert opinions in a climate of diverse political, commercial and cultural sentiment, and not in an isolated laboratory, confirming the view of Sheila Jasanoff that there is no politically neutral expertise.[14]

Problem," *Social Studies of Science* 16, no. 3 (1986): 485–513; Ian A Burney, *Bodies of Evidence: Medicine and the Politics of the English Inquest, 1830-1926* (Baltimore ; London: Johns Hopkins University Press, 2000); Ian A Burney, *Poison, Detection, and the Victorian Imagination* (Manchester; New York: Manchester University Press ; Distributed exclusively in the USA by Palgrave, 2006); Tal Golan, "The History of Scientific Expert Testimony in the English Courtroom," *Science in Context* 12, no. 1 (1999): 7–32; Tal Golan, *Laws of Men and Laws of Nature The History of Scientific Expert Testimony in England and America* (Cambridge, Mass.; London: Harvard University Press, 2007).

12. Harry Collins, *Changing Order: Replication and Induction in Scientific Practice* (Chicago: University of Chicago Press, 1992); H. M. Collins and Robert Evans, "The Third Wave of Science Studies Studies of Expertise and Experience," *Social Studies of Science* 32, 2 (2002): 235–96; Harry Collins and Robert Evans, *Rethinking Expertise* (Chicago: University of Chicago Press, 2008); Sheila Jasanoff, "Breaking the Waves in Science Studies: Comment on H.M. Collins and Robert Evans, 'The Third Wave of Science Studies,'" *Social Studies of Science* 33, 3 (2003): 389–400; Sheila Jasanoff, *States of Knowledge: The Co-Production of Science and the Social Order* (London: Routledge, 2004); Sheila Jasanoff, *Science and Public Reason*, Reprint edition (London: Routledge, 2013).

13. Barbara Adam, Ulrich Beck, and Joost Van Loon, eds., *The Risk Society and Beyond: Critical Issues for Social Theory* (Thousand Oaks, CA: SAGE Publications Ltd, 2000); Ulrich Beck, *Risk Society: Towards a New Modernity* (Thousand Oaks, CA: SAGE Publications Ltd, 1992); Ulrich Beck, "Critical Theory of World Risk Society: A Cosmopolitan Vision," *Constellations* 16, 1 (2009): 3–22; Jean-Baptiste Fressoz, "Beck Back in the 19th Century: Towards a Genealogy of Risk Society," *History and Technology* 23, 4 (2007): 333–50; Soraya Boudia and Nathalie Jas, "Introduction: Risk and 'Risk Society' in Historical Perspective," *History and Technology* 23, 4 (2007): 317–31; Soraya Boudia, "Global Regulation: Controlling and Accepting Radioactivity Risks," *History and Technology* 23, 4 (2007): 389–406; Pierre-Antoine Dessaux, "Chemical Expertise and Food Market Regulation in *Belle-Epoque* France," *History and Technology* 23, 4 (2007): 351–68; Jean-Baptiste Fressoz, "Gaz, Gazomètres, Expertises et Controverses. Londres, Paris, 1815-1860," *Le Courrier de L'environnement de l'Inra*, 62 (2012): 31–56.

14. Jasanoff, Breaking the Waves in Science Studies.

Media representation of the dyes

William Perkin inadvertently stumbled across the first aniline dye, mauveine, in 1856 while working at Royal College of Chemistry in London under the tutelage of the German chemist August Wilhelm von Hofmann.[15] Although it took Perkin about two years to turn his discovery into a commercial product, as soon as it hit the market it was hailed by the press as evidence of Britain's supremacy in industry and science.

The news of Perkin's breakthrough was reported widely in newspapers and periodicals, an expression of British scientific and technological achievement. This is evident in articles throughout the British media at the time. During this period of 'scientific wonder' chemistry was producing visible and practicable products, such as the new dyes, that made eye-catching exhibits at the exhibitions and trade fairs that were becoming increasingly popular. Describing the 'exquisite dyes produced from coal' in an article about the 1862 International Exhibition, the *Ladies Treasury* waxed lyrical about the array of colours released from 'that imprisoned life which thousands of years long past was encased in decaying vegetable substance –[that] has at last sprung into light and beauty, at the magic touch of science'.[16]

The media praised the wonder of science and the ingenuity of chemists as well as the democratizing potential of chemistry in bringing products to the masses. Articles in the press during the 1860s suggest that the 'scientific' coal-derived additives were, at this point in time, perceived as harmless, an example of science's ability to improve food products and their availability and accessibility. Within a few years, entrepreneurs and chemists across Europe began producing hundreds of new chemical dyes on an industrial scale. The vibrant new colours continued to be a source of wonder and amazement.[17]

For the first few decades of their existence, coal-derived textile dyes were being incorporated into food, with few questions asked of their suitability, whether by food producers, retailers, wholesalers, public analysts, physicians, or politicians. That the new dyes were being used extensively in food is evidenced by references in newspapers and periodicals. In 1869 *The Bradford Observer* listed the wide range of uses for aniline dyes. The article pointed out that the use of aniline dyes 'has been of undoubted service. They have superseded the metallic substances – the preparations of mercury, of bismuth and of lead – which were almost all injurious to health'.[18] Aniline dyes became a ubiquitous and unchallenged replacement for toxic minerals such as arsenic, lead and copper, previously used as colourants. Indeed it was the earlier use of the harmful *mineral* dyes in food that had led to food

15. Simon Garfield, *Mauve: How One Man Invented a Colour That Changed the World* (London: Faber, 2001).

16. Anon, "Perkins's Purple," *All Year Round*, no. September (1859): 222; Anon, "A Ramble into the Eastern Annexe of the International Exhibition," *The Ladies Treasury*, no. 1 November (1862): 342.

17. Carolyn Cobbold, "From Adulation to Adulteration - How Chemical Dyes Were Presented in the Victorian Press."

18. Anon, "Aniline Colours," *The Bradford Observer*, no. 1892 (January 14, 1869): 3.

regulation in England in the mid-nineteenth century and the appointment of public analysts to monitor food safety in 1872.

Some of the earliest concerns about the possible toxicity of the new chemically synthesised coal-tar dyes were raised in France and the US. An 1871 article in *The Health Reformer* warned that 'the candy makers' of New York are spreading death among children since 'various cheap devices are employed as substitutes for cochineal and saffron'. According to the journal, the 'red colour is usually produced by amboline, which is obtained in a crystallized form from coal tar during its process of refining'. Sold for $2 an ounce, amboline 'will equal in colouring twenty times its weight in cochineal'. The article noted that other red dyes used included another aniline colour, fuchsine.[19]

It is only from the late 1870s that one can find any evidence of concern in the British press with the identification of the synthetic food colorants as a new form of adulteration and not necessarily a safe replacement for the poisonous metals previously used to colour food. Over the next four decades, synthetic dyes were transformed by the popular press from a bright new substance of science into a harmful instrument for commercial deception. From the 1880s, aniline and other coal-derived dyes were being employed extensively in food preparation, from milk, butter and margarine to meat products such as sausages as well as jams, pickles and confectionery. However, few food or drink producers publicly acknowledged using the new dyes. Indeed, evidence from food company archives and government enquiries suggest that most food manufacturers were unaware what the dyes they were using were made from. Most dyes were sold under brand names such as 'butter yellow', giving no indication of their origins and evidence given by food company representatives to a government inquiry in 1901 suggests that they rarely asked their suppliers what the 'harmless dyes' they were buying actually were.[20]

Despite growing concerns raised in the general press, an examination of *The Analyst,* the monthly journal published by the British Society of Public Analysts, indicates that the use of the novel dyes in food and drink was not a priority for Britain's food chemists or regulators. Most of the articles mentioning their use, detection or possible harm were extracts from overseas journals.[21] British food analysts were far more reluctant to address the issue than their overseas peers, even though coal-tar colours were being used by British food manufacturers as liberally as by foreign food producers. It seems anomalous that analytical chemists, who from the outset were highly critical of the use of toxic metals used to colour foods, ignored growing press concern about the toxicity of aniline dyes.

19. Anon, "Poisoned Candies," *The Health Reformer* 6–7 (1871): 131.

20. Committee on Food Preservatives, 1901. *Report of the Departmental Committee appointed to inquire into the use of preservatives and colouring matters in the preservation and colouring of food: together with minutes of evidence, appendices and index*. (London: H.M.S.O, 1901).

21. Carolyn Cobbold, "Controlling Chemical Dyes in Food: International and Institutional Comparisons."

Chemical Dyes Prove Elusive

To understand this diffidence, several factors need to be considered. These include the location and state of knowledge in organic chemistry at this time, the social status and technical proficiency of Britain's public analysts, and the political and economic clout of the food and chemical sectors. By the 1880s the organic chemistry knowledge base and industrial production of coal-tar dyes was centred in Germany. This newly united country was using science and technology as an economic driver to compete with the empires of Britain and France. Germany trained more chemists than any other country in the world and provided economic and political support to its thriving chemical industry.[22] Academic and industrial chemists in Germany were synthesising new compounds from coal-tar waste by the hundreds. However, identifying and understanding individual substances was not an easy task, even for their discoverers. There was no uniformity in the nomenclature of organic chemistry during this period and assessing the exact molecular structure of any organic substance was not an accurate science.[23]

The difficulty for the analytical chemists was that, by the 1880s, there were hundreds of dyes in the European and American marketplace – some known, many unknown. Meanwhile, food and drink manufacturers often added several colouring additives to one product making the detection of discrete dyes harder. By 1904, a compendium of dyestuffs listed nearly 700 dyes, with little consistency in how they were named and classified. Some names were given to dyes because of their chemical construction, others described their colour such as 'butter-yellow', while some reflected the dye's inventor or place of manufacture such as 'Martius Brown' and 'Manchester Brown'. Two – Magenta and Sulpherino – even celebrated Napoleonic victories. In other cases, dyes names were linked to the manufacturer or a brand name. Moreover, chemically identical dyes had different names in different countries or when sold by different wholesalers. Dye manufacturers would often keep the chemical formulae of their new dyes secret, leading to uncertainty and confusion, while producers and retailers frequently re-used established names for commercial reasons, resulting in the same name being applied to several different types of dye. The German chemist Theodore Weyl complained that this practice led to confusion in the market, which traders used to their advantage.[24]

22. Mitchell G. Ash and Jan Surman, *The Nationalization of Scientific Knowledge in the Habsburg Empire, 1848-1918* (Basingstoke, UK: Palgrave Macmillan, 2012); Johann Peter Murmann, *Knowledge and Competitive: the Coevolution of Firms, Technology, and National Institutions* (Cambridge: Cambridge University Press, 2003); Andrew Pickering, "Decentering Sociology: Synthetic Dyes and Social Theory," *Perspectives on Science* 13, 3 (2005): 352–405; Carolyn Cobbold, "Controlling Chemical Dyes in Food: International and Institutional Comparisons."

23. Evan Hepler-Smith, "'Just as the Structural Formula Does': Names, Diagrams, and the Structure of Organic Chemistry at the 1892 Geneva Nomenclature Congress," *Ambix* 62, 1 (2015): 1–28.

24. Arthur G. Green, Gustav Schultz, and Paul Julius, *A Systematic Survey of the Organic Colouring Matters* (London, Macmillan, 1908); William Jervis Jones, *German Colour Terms: A Study in Their Historical Evolution from Earliest Times to the*

The identification of tiny amounts of the new chemical additives in food, most of which were unknown or described under a variety of different names or chemical formulae, was impossible to accomplish. A lack of initial concern and awareness of the extent to which these new substances were being used in food and a lack of standardised tests to identify the dyes or test their toxicity had left the analysts playing continual catch-up with the food and drink manufacturers.[25]

Analysts from across Europe and the United States employed an array of analytical techniques to identify these new substances, incorporating distillation, heating, filtration, acidic reagents and titration to spectroscopy and microscopy, relying extensively on their sense of smell, taste and sight. They adapted and blended methodology and techniques from traditional analytical chemistry as well as existing industries and crafts, particularly textiles and dye-making, together with new chemical and industrial techniques and emerging concepts of structural and synthetic chemistry.[26] However, reaching international consensus as to how to test for and know these new labile substances was difficult to achieve.

For the under-funded and poorly resourced public analysts in Britain, trying to detect and prove adulteration and then defend their position in court against producers, retailers and expert witnesses, including other chemists, was not an easy task. The absence of agreed-upon tests for the new dyes meant that to stake one's reputation in court upon the presence of particular dyes in food was risky. The proliferation of the colours meant that analysts who claimed that a particular dye was present in a particular food were liable to find themselves countered by claims that a different colour had been used.[27]

Leading British analysts agreed that it would be counterproductive to go beyond the duty of the analyst simply to prove adulteration and to attempt to identify particular additives. August Dupré argued that a public analyst was not bound to state the exact composition and character of the adulterant, and emphasised that doing so increased the chance of being proved wrong.[28] Dupré, like many of his contemporaries in Britain, had completed part of his training in Germany.[29] The difficulty in detecting and identifying individual dyes in food proved so problematic that it risked not only the reputation of analysts but the credibility of chemistry itself.

Present (John Benjamin Publishing, 2013); Theodor Weyl and Henry Leffman, *The Coal-Tar Colors: With Especial Reference to Their Injurious Qualities and the Restriction of Their Use* (P. Blakiston, 1892).

25. Bernhard Conrad Hesse, *Coal-Tar Colors Used in Food Products* (Washington, Government Printing Office, 1912); Weyl and Leffman, *The Coal-Tar Colors*.

26. Carolyn Cobbold, "Controlling Chemical Dyes in Food: International and Institutional Comparisons."

27. Hesse, *Coal-Tar Colors Used in Food Products*; Hamlin, *A Science of Impurity*; Hamlin, "Scientific Method and Expert Witnessing"; Cobbold, "Coal-Tar Food Dyes."

28. Charles Cassal, "On Dyed Sugar," *Analyst* 15 (1890): 141–49.

29. Ernst Homburg, A. S Travis, and Harm G Schröter, *The Chemical Industry in Europe, 1850-1914: Industrial Growth, Pollution, and Professionalization*, Chemists and Chemistry, v. 17 (Dordrecht ; London: Kluwer Academic, 1998).

The analysts' reluctance to tackle the increasing use of chemical dyes in food should be viewed in the context of their own professional and technical insecurity and their desire to boost their authority and credibility of science and scientific expertise in public life. This was a time when public analysts were very much at the centre of disputes surrounding authority, standards and methodology in public health.[30] Acknowledging the contested position of public analysts, together with an appreciation that these cutting-edge chemicals synthesised from coal-tar waste were indeterminable and being used in food in such small amounts as to be almost impossible to detect, helps explain why public analysts were reluctant to target their use.

Food Is a Political Issue

The presence of synthetic dyes in food from the outset was a contested issue among analysts involved in food monitoring. Aside from the issues surrounding the democratisation and transparency of the food supply, analysts also remained divided on the subject of toxicity. While some chemists had proved that aniline dyes, when consumed by some animals in large quantities, could be toxic, they were divided as to whether their accumulative use in tiny quantities, in many different items of food, over a prolonged time period could be harmful to human health.[31] They also acknowledged the positive benefits of the dyes to food production, availability and consumer choice. The introduction of industrial chemicals into food production in the late nineteenth century demonstrates the difficulty of determining the boundaries between legitimate and illicit interventions in food. The question as to whether certain ingredients should be regarded as food improvers or adulterants divided analysts, as well as food manufacturers, the public, politicians and the growing sanitarian and health and food reform movements.[32]

Food historians have shown that issues of deception and commercial competition often prevail in debates surrounding food adulteration and regulation. Whether food is adulterated or not is itself a slippery and contested concept as the difference between a legitimate ingredient and a deceptive one can be debatable, and depend upon a complex framework of views and legislation, which themselves depend upon many factors including disputes

30. Hamlin, *A Science of Impurity*; Jacob Steere-Williams, "A Conflict of Analysis: Analytical Chemistry and Milk Adulteration in Victorian Britain," *Ambix* 61, 3 (2014): 279–98.

31. Harry W. Paul, *From Knowledge to Power: The Rise of the Science Empire in France, 1860-1939* (Cambridge: Cambridge University Press, 2003), 212; P.Caseneuve, *Les Colorants de la houille au point de vue toxiologigue et hygiénique:Affaire de la succursale de la B.Anilin et Soda, Fabrik à Neuville-sur-Saône* (Lyon, 1887); B. Schuchardt, "Ueber Die Wirkungen Des Anilins Auf Den Thierischen Organismus," *Archiv Der Pharmazie* 156, no. 2 (1861): 144–64; Dr Wilhelm Filehne, "Ueber die Giftwirkungen des Nitrobenzols," *Archiv für experimentelle Pathologie und Pharmakologie* 9, no. 5–6 (1878): 329–79; Roderich von Engelhardt, *Beiträge zur Toxikologie des Anilin,* (Dorpat, 1888).

32. French and Phillips, *Cheated Not Poisoned?*; Ingeborg Paulus, *Search for Pure Food a Sociology of Legislation in Britain: A Sociology of Legislation in Britain* (Fred B Rothman & Co, 1974).

between rival groups of knowledge experts and merchants. Stanziani concluded that rules about food adulteration were never completely under the control of any one interest group, with final outcomes dependant on strategic alliances and market structures.[33] Pierre-Antoine Dessaux also demonstrated the complex mediation involved in the understanding and acceptance of chemical additives in food, with the analytical chemists just one group in a 'crowded arena' of self-proclaimed experts that included the food producers, retailers and consumers. He showed how French nineteenth-century chemists needed to work in co-operation with the food and drinks industry to secure any scientific authority.[34] Similarly Ximo Guillem-LLobat has shown that commercial disputes and private sector lobbying played a more decisive role in affecting the outcome of food legislation in Spain in the late nineteenth and early twentieth centuries than science and scientists.[35]

Comparing the situation in several countries, including Britain, shows both the extent of negotiation between many parties and the diverse cultural dynamics at play in determining whether certain food additives are considered to be adulterants or legitimate food ingredients. The 1872 Sale of Food and Drugs Act in Britain promoted the appointment of public analysts by local authorities to monitor food quality. However, such appointments initially were voluntary and, for many years, many local authorities failed to appoint public analysts or combined the posts with Medical Officers of Health.[36] While the main focus of 1872 Act was the use of poisonous substances in food, such as toxic metallic dyes, a subsequent Adulteration Act in 1875 focused on the concept of economic fraud.[37] Determining what constituted 'harm' to the consumer, whether physical or economic, was never straightforward for nineteenth-century public analysts and British legislation did not specify any individual coal-tar dyes as prohibited or permitted in food.

The Society of Public Analysts (SPA) was formed in 1874 in Britain, in response to political and public criticism about the inexperience of public analysts and their inconsistent

33. Alessandro Stanziani, "Negotiating Innovation in a Market Economy: Foodstuffs and Beverages Adulteration in Nineteenth-Century France," *Enterprise and Society* 8.2 (2007): 375–412; Alessandro Stanziani, "Information, Quality and Legal Rules: Wine Adulteration in Nineteenth Century France.," *Business History* 51, 2 (2009): 268–91; Alessandro Stanziani, "La Mesure de La Qualité Du Vin En France, 1871-1914," *Food and History* 2, 1 (2004); Hans Teuteberg, "Adulteration of Food and Luxuries; and the Origins of Uniform State Food Legislation in Germany," *Zeitschrift Für Ernährungswissenschaft* 34, 2 (1995): 95–112; French and Phillips, *Cheated Not Poisoned?*; Jim Phillips and Michael French, "Adulteration and Food Law, 1899–1939," *Twentieth Century British History* 9, 3 (1998): 350–69; Jim Phillips and David F. Smith, eds., *Food, Science, Policy and Regulation in the Twentieth Century: International and Comparative Perspectives* (Abingdon: Routledge, 2000).

34. Dessaux, "Chemical Expertise."

35. Ximo Guillem-Llobat, "Losing the Global View in the Establishment of New Limits to Food Quality. The Regulation of the Food Market in Spain (1880-1936)," *Food and History* 6, 1 (2008): 215–46; Ximo Guillem-Llobat, "The Sugar Industry, Political Authorities and Scientific Institutions in the Regulation of Saccharin: Valencia (1888-1939)," *Annals of Science* 68, 3 (2011): 401–24.

36. Atkins, *Liquid Materialities*; Phillips and French, "Adulteration and Food Law, 1899–1939."

37. Atkin, *Liquid Materialities,* 180.

decisions, as well as a lack of consensus over what constituted adulteration. Correspondence and reports of the SPA's meetings reveal the degree to which these new public appointees felt the need to justify their position and demonstrate their expertise.

For decades, public analysts felt under attack from all directions, from the press and members of the public as well as food producers and retailers. They also found themselves in constant disputes with fellow chemists. This was a time when professional chemists were attempting to define who they were. The profession of the chemist, and the scientist in general, was in the midst of a rapid and broad transformation. Those earning their living as consulting and analytical chemists, found themselves working for many different clients. Success came from taking jobs whenever and wherever available, alongside a vigorous self-promotion and public endorsement of the chemical profession and of chemistry in general.[38]

While passionate about their role as guardians of food safety, British public analysts also regarded themselves as pioneers of the new science of organic chemistry. Moreover, many had been taught by, or had worked with, the organic chemists who were producing these new chemical dyes. They were forging a new path towards a scientifically controlled and enhanced food supply for the nation at a time when food scarcity and concerns about the reliance of the nation's food supply on foreign imports were omnipresent. As consultant chemists who were unable to rely on a life-long state salary, they found themselves touting their skills to chemical and food companies, local authorities and members of the public. Many public analysts supplemented their income as consultants for food companies or as paid expert witnesses for food manufacturers and retailers involved in food adulteration cases.[39] This was a period when food producers and retailers were expanding rapidly, becoming economically and politically stronger. By the end of the nineteenth century, several British industrial food families such as the Colmans, Frys, Cadburys and Blackwells were very prominent in British society and many members had seats in Parliament.[40]

Conclusion

Synthetic dyes, created and manufactured by a burgeoning chemical industry, entered the food supply system in Britain during a period when public analysts were fighting to secure their place as creditable and trustworthy professionals. At the same time these analytical

38. Anon, "The Public and 'Public Analysts,'" *Analyst* 1, no. 9 (1876): 155–56.; Association of Public Analysts (Great Britain), *A Hundred Years of Public Analysts, 1860-1960* (London: Assoc. Public Analysts, 1960); Bernard Dyer and C. Ainsworth Mitchell, *The Society of Public Analysts and Other Analytical Chemists . Some Reminiscences of Its First Fifty Years* (Cambridge: Heffer, 1932); Carolyn Cobbold, "Managing the Risk."

39. Cobbold, "The Silent Introduction of Synthetic Dyestuffs into Nineteenth-Century Food"; Carolyn Cobbold, "Living in a Toxic World"; Cobbold, "Coal-Tar Food Dyes."

40. Phillips and French, "Adulteration and Food Law, 1899–1939"; Paulus, *Search for Pure Food a Sociology of Legislation in Britain*.

chemists were seeking to persuade the public that chemistry was the foremost sanitary and socially useful science. As such their professional status was aligned with that of the new chemical substances. Perhaps, therefore, it is not surprising that public analysts did not choose to question the new chemical colours being used in food, while they struggled to reach agreement between themselves and other professional chemists and scientists about existing and long-standing food additives and disputed adulterations. With no agreed tests to identify or assess the safety of the new substances, it would not have been in the public analysts' interest or that of the reputation of chemistry itself to question the safety of science's latest invention.

These dyes were being produced and discovered by organic chemists, many of whom the public analysts may have known or been tutored by. Moreover, the ability to determine the exact synthetic dye used in any food product would have been very difficult for most public analysts, with few financial resources and no standardised tests. Moreover, other scientists, including the government's excise chemists, and chemists employed by food manufacturers, often disputed the accuracy of their analyses in court, challenging the authority and credibility of the public analysts. For all these reasons, tackling the issue of synthetic dyes, which were being created by specialist organic chemists in well-equipped German industrial laboratories, may have been a step too far. Reticence on the matter, if not silence, was the more prudent strategy.

As has also been noted, synthetic dyes produced by organic chemists were seen by many public analysts as a safer alternative than the mineral-based dyes formerly used to colour food. At the same time, the use of the new dyes was not being disclosed by food producers and retailers, while other issues of adulteration, such as the dilution of milk with water, was a constant cause of concern.[41] All these contextual factors need to be considered in order to assess objectively why public analysts in Britain did not regard the use of coal-tar-derived dyes to be of serious concern.

Exploring the introduction of new chemical dyes into food in the late nineteenth century demonstrates many issues experienced by the introduction of new scientific products or processes. These new products initially were hailed as miracles of science and the solution to existing problems. For many years they were added to food and drink, without many people being aware of their presence. By the time concern was raised their use had become widespread and normalised. Consumers expected certain, uniform colouring in their food, manufacturers had adopted specific techniques and ingredients to meet consumer expectations and market conditions, politicians recognised the need to adequately feed the nation and chemists saw science as the means to do this. Vested interest in the continued use of the chemical dyes was widespread, encompassing consumers, producers, politicians, regulators and scientists.

41. Atkins, *Liquid Materialities*.

Synthetic dyes, many of which were found during the twentieth century to be highly toxic, were originally produced to colour textiles and paints. Their unintended use as food colourings for so long was the result of many factors, including a lack of consensus and status among scientists, political anxiety about food security, consumer expectations and economic competition in the marketplace. Like many scientific risks we face today, this unintended and unmonitored application of science occurred without any one group being in a position to grasp the full situation. Regulation and control became more and more complicated as the practice was normalised and vested interest increased and widened.

In the nineteenth century, as today, expertise, knowledge and authority were contingent on prolonged and extensive debate and mediation between diverse groups, in different social, institutional and geographical settings. Public analysts formed their expert opinions in a climate of diverse political, commercial and cultural sentiment. What counted as knowledge, and who proclaimed to have access to that knowledge, was as political and fluid in the late nineteenth century as it is in today's society.

References

ADAM, B., BECK, U. and VAN LOON, J., eds. *The Risk Society and Beyond: Critical Issues for Social Theory*. Thousand Oaks, CA: SAGE Publications Ltd, 2000.

ANON. "A Ramble into the Eastern Annexe of the International Exhibition." *The Ladies Treasury*, no. 1 November (1862): 342.

—. "Aniline Colours." *The Bradford Observer*, no. 1892 (January 14, 1869): 3.

—. "Perkins's Purple." *All Year Round*, no. September (1859): 222.

—. "Poisoned Candies." *The Health Reformer* 6–7 (1871): 131.

—. "The Public and 'Public Analysts.'" *Analyst* 1, no. 9 (1876): 155–56.

—. *The Public Analytical Journal and Sanitary Review*, (October 1, 1892): 6.

ASH, M. G., and S. JAN. *The Nationalization of Scientific Knowledge in the Habsburg Empire, 1848-1918*. Basingstoke, UK: Palgrave Macmillan, 2012.

ASHWORTH, W. J. *Customs and Excise: Trade, Production, and Consumption in England, 1640-1845*. Oxford: OUP Oxford, 2003.

ASSOCIATION OF PUBLIC ANALYSTS (Great Britain). *A Hundred Years of Public Analysts, 1860-1960*. London: Assoc. Public Analysts, 1960.

ATKINS, P. W. *Liquid Materialities: A History of Milk, Science and the Law*. Farnham: Ashgate Publishing, Ltd., 2010.

BECK, U. "Critical Theory of World Risk Society: A Cosmopolitan Vision." *Constellations* 16, 1 (2009): 3–22.

—. *Risk Society: Towards a New Modernity*. Thousand Oaks, CA: SAGE Publications Ltd, 1992.

BEER, J. J. *The Emergence of the German Dye Industry*. Chicago: University of Illinois Press, 1959.

BOUDIA, S. "Global Regulation: Controlling and Accepting Radioactivity Risks." *History and Technology* 23, 4 (2007): 389–406.

BOUDIA, S. and JAS N. "Introduction: Risk and 'Risk Society' in Historical Perspective." *History and Technology* 23, 4 (2007): 317–31.

BURNEY, I. A. *Bodies of Evidence: Medicine and the Politics of the English Inquest, 1830-1926*. Baltimore ; London: Johns Hopkins University Press, 2000.

—. *Poison, Detection, and the Victorian Imagination*. Manchester; New York: Manchester University Press ; Distributed exclusively in the USA by Palgrave, 2006.

CASENEUVE, P. *Les Colorants de la houille au point de vue toxiologigue et hygiénique:Affaire de la succursale de la B.Anilin et Soda, Fabrik à Neuville-sur-Saône.* Lyon, 1887.

CASSAL, C. "On Dyed Sugar." *Analyst* 15 (1890): 141–49.

COBBOLD, C. "Controlling Chemical Dyes in Food: International and Institutional Comparisons." presented at the Geographies of Alchemy and Chemistry. Society for the History of Alchemy and Chemistry, Amsterdam, Netherlands, October 24, 2014.

—. "From Adulation to Adulteration - How Chemical Dyes Were Presented in the Victorian Press." presented at the Consuming (the) Victorians. British Association of Victorian Studies, Cardiff, Wales, September 1, 2016.

—. "Managing the Risk of Unintended Applications of New Science and Technology: An Historical Example." presented at the European Social Science History Conference, Valencia, Spain, April 30, 2016.

—. "The Introduction of Chemical Dyes into Food - Industrial Risk or Revolution?" presented at the Living in a Toxic World. Experts, Activisim, Industry and Regulation. European Spring School on History of Science and Popularization, Menorca, May 14, 2014.

—. "The Silent Introduction of Synthetic Dyestuffs into Nineteenth-Century Food." In *The Silences of Science*, edited by Felicity Mellor and Stephen Webster, 221–41. London ; New York: Routledge, 2017.

COLLINS, E. J. T. "Food Adulteration and Food Safety in Britain in the 19th and Early 20th Centuries." *Food Policy* 18, no. 2 (1993): 95–109.

COLLINS, H. M., and EVANS, R. "The Third Wave of Science Studies Studies of Expertise and Experience." *Social Studies of Science* 32, 2 (2002): 235–96.

COLLINS, H. *Changing Order: Replication and Induction in Scientific Practice*. Chicago: University of Chicago Press, 1992.

COLLINS, H. and EVANS, R. *Rethinking Expertise*. Chicago: University of Chicago Press, 2008.

COMMITTEE ON FOOD PRESERVATIVES, 1901. *Report of the Departmental Committee appointed to inquire into the use of preservatives and colouring matters in the preservation and colouring of food: together with minutes of evidence, appendices and index*. London: H.M.S.O, 1901

DESSAUX, P.-A. "Chemical Expertise and Food Market Regulation in *Belle-Epoque* France." *History and Technology* 23, 4 (2007): 351–68.

DYER, B. and C. AINSWORTH, M. *The Society of Public Analysts and Other Analytical Chemists . Some Reminiscences of Its First Fifty Years*. Cambridge: Heffer,1932.

ENGELHARDT, R., VON. *Beiträge zur Toxikologie des Anilin,* (Dorpat, 1888).

FILEHNE, Dr W. "Ueber die Giftwirkungen des Nitrobenzols." *Archiv für experimentelle Pathologie und Pharmakologie* 9, no. 5–6 (October 1878): 329–79.

FRENCH, M. and PHILLIPS, J. *Cheated Not Poisoned?: Food Regulation in the United Kingdom, 1875-1938*. Manchester: Manchester University Press, 2000.

FRESSOZ, J.-B. "Beck Back in the 19th Century: Towards a Genealogy of Risk Society." *History and Technology* 23, no. 4 (2007): 333–50.

—. "Gaz, Gazomètres, Expertises et Controverses. Londres, Paris, 1815-1860." *Le Courrier de L'environnement de l'Inra*, no. 62 (2012): 31–56.

GARFIELD, S. *Mauve: How One Man Invented a Colour That Changed the World*. London: Faber, 2001.

GIDDENS, A. *The Consequences of Modernity*. New Ed. Cambridge, UK: Polity Press, 1991.

GOLAN, T. *Laws of Men and Laws of Nature The History of Scientific Expert Testimony in England and America*. Cambridge, Mass.; London: Harvard University Press, 2007.

—. "The History of Scientific Expert Testimony in the English Courtroom." *Science in Context* 12, no. 1 (1999): 7–32.

GREAT BRITAIN CUSTOMS ESTABLISHMENT. *Customs Tariffs Of The United Kingdom From 1800 To 1897: With Some Notes Upon The History Of The More Important Branches Of Receipt From The Year 1660...* Nabu Press, 2012.

GREEN, A. G., SCHULTZ. G. and JULIUS, P. *A Systematic Survey of the Organic Colouring Matters*. London, Macmillan, 1908.

GUILLEM-LLOBAT, X. "Losing the Global View in the Establishment of New Limits to Food Quality. The Regulation of the Food Market in Spain (1880-1936),." *Food and History* 6, 1 (2008): 215–46.

—. "The Sugar Industry, Political Authorities and Scientific Institutions in the Regulation of Saccharin: Valencia (1888-1939)." *Annals of Science* 68, 3 (2011): 401–24.

HABER, L. F. *The Chemical Industry During the Nineteenth Century: A Study of the Economic Aspect of Applied Chemistry in Europe and North America*. Oxford: Clarendon Press, 1969.

HAMLIN, C. *A Science of Impurity: Water Analysis in 19th Century Britain*. Oakland, California: University of California Press, 1990.

—. "Scientific Method and Expert Witnessing: Victorian Perspectives on a Modern Problem." *Social Studies of Science* 16, no. 3 (1986): 485–513.

HEPLER-SMITH, E. "'Just as the Structural Formula Does': Names, Diagrams, and the Structure of Organic Chemistry at the 1892 Geneva Nomenclature Congress." *Ambix* 62, 1 (2015): 1–28.

HESSE, B. C. *Coal-Tar Colors Used in Food Products*. Washington, Government Print Office, 1912.

HOCHHEISER, S. "Synthetic Food Colors in the United States: A History under Regulation." University of Wisconsin, 1982.

HOMBURG, E, TRAVIS, A. S. and G SCHRÖTER, H. *The Chemical Industry in Europe, 1850-1914: Industrial Growth, Pollution, and Professionalization*. Chemists and Chemistry, v. 17. Dordrecht ; London: Kluwer Academic, 1998.

JASANOFF, S. *States of Knowledge: The Co-Production of Science and the Social Order*. Routledge, 2004.

JASANOFF, S. "Breaking the Waves in Science Studies: Comment on H.M. Collins and Robert Ev-

ans, 'The Third Wave of Science Studies.'" *Social Studies of Science* 33, 3 (2003): 389–400.

—. *Science and Public Reason*. Reprint edition. London: Routledge, 2013.

JEFFERYS, J. B. *Retail Trading in Britain, 1850-1950*. Economic and Social Studies / National Institute of Economic and Social Research 13. Cambridge [Eng.]: University Press, 1954.

JONES, W. J. *German Colour Terms: A Study in Their Historical Evolution from Earliest Times to the Present*. John Benjamin Publishing, 2013.

MILLER, M. "Food Colours: A Study of the Effects of Regulation." PhD, Aston University, 1987.

MITCHELL, B. R. and PHYLLIS DEANE. *Abstract of British Historical Statistics*. Cambridge: Cambridge University Press, 1962.

MURMANN, J. P. *Knowledge and Competitive Advantage: the Coevolution of Firms, Technology, and National Institutions.* Cambridge: Cambridge University Press, 2003.

OTTERLOO, A.H. 'The Development of Public Distrust of Modern Food Technology in the Netherlands,'' in A. P den Hartog, ed, *Food Technology, Science and Marketing* East Linton: Tuckwell Press, 1995, 253-267.

PAUL, H. W. *From Knowledge to Power: The Rise of the Science Empire in France, 1860-1939*. Cambridge: Cambridge University Press, 2003.

PAULUS, I. *Search for Pure Food a Sociology of Legislation in Britain: A Sociology of Legislation in Britain*. Fred B Rothman & Co, 1974.

PHILLIPS, J. and FRENCH M. "Adulteration and Food Law, 1899–1939." *Twentieth Century British History* 9, 3 (1998): 350–69.

PHILLIPS, J., and SMITH, DAVID F., eds. *Food, Science, Policy and Regulation in the Twentieth Century: International and Comparative Perspectives*. Abingdon: Routledge, 2000.

PICKERING, A. "Decentering Sociology: Synthetic DYES AND SOCIAL THEORY." *Perspectives on Science* 13, 3 (2005): 352–405.

RICHARDS, E. "Legislation on Food Adulteration." *Science* 16, no. 394 (1890): 101–4.

SAMUELSON, J. *The Civilisation of Our Day: Essays*, 1896.

SCHUCHARDT, B. "Ueber Die Wirkungen Des Anilins Auf Den Thierischen Organismus." *Archiv Der Pharmazie* 156, 2 (January 1, 1861): 144–64.

STANZIANI, A. "Information, Quality and Legal Rules: Wine Adulteration in Nineteenth Century France." *Business History* 51, 2 (2009): 268–91.

—. "La Mesure de La Qualité Du Vin En France, 1871-1914." *Food and History* 2, 1 (2004): 191–226.

—. "Negotiating Innovation in a Market Economy: Foodstuffs and Beverages Adulteration in Nineteenth-Century France." *Enterprise and Society* 8.2 (2007): 375–412.

STEERE-WILLIAMS, J. "A Conflict of Analysis: Analytical Chemistry and Milk Adulteration in Victorian Britain." *Ambix* 61, 3 (2014): 279–98.

TEUTEBERG, H. J. "Adulteration of Food and Luxuries and the Origins of Uniform State Food Legislation in Germany." *Zeitschrift Für Ernährungswissenschaft* 34, 2 (1995): 95–112.

TRAVIS, A.S. *The Rainbow Makers: Origins of the Synthetic Dyestuffs Industry in Western Europe*. Bethlehem,PA: Lehigh University Press, 1993.

WEYL, T. and LEFFMAN, H. *The Coal-Tar Colors: With Especial Reference to Their Injurious Qualities and the Restriction of Their Use*. P. Blakiston, 1892.

WINSTANLEY, M. J. *The Shopkeeper's World 1830-1914*. Manchester: Manchester University Press, 1983.