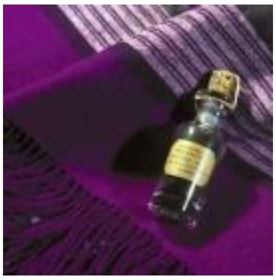
Chemhistory: Mauveine

A chemistry set and a young boy's curiosity led to a fruitful career, the first ever synthetic dye, and the birth of an industry, writes Alan Dronsfield



Some readers may have had their own chemistry sets – little commercially-produced kits of chemicals, increasingly chosen because of their “harmless” nature, a few test-tubes, a spatula and little more. There will have been a booklet of suggested experiments (nothing remotely dangerous, though), and for most cases, when they had been worked through, that would have been it: move on to something else, something perhaps more “interesting”.

This was not the case around 1850 for the young William Henry Perkin. I presume he started with a chemistry set (they were around in those days too) but he soon expanded this into a complete home laboratory. A committed chemist from an early age, as a 15 year old he attended classes at the Royal College of Chemistry in Oxford Street, London.

Perkin came under the influence of the great Victorian chemist, August Hofmann, and was appointed his assistant at the age of only 17. He wanted to continue his home laboratory experiments, and approached his chief for suggestions. Moreover, he didn’t want to replicate experiments well-described in books; he wanted to do something new.

Hofmann was a great pioneer in organic chemistry: the chemistry of complicated carbon-based molecules that had their source in nature (typically as natural colours, essential oils and some medicinal products) or, increasingly, in the rich array of chemicals being isolated from coal tar. This latter was available in large amounts as a by-product from the manufacture of coke and coal-gas.

Hofmann saw a way of connecting both those strands of organic chemistry. The world had a great need for quinine, a medicine derived from the bark of a South American tree. It was both a remedy for malaria and moreover, if taken regularly, it would act as a preventative against acquiring the disease. “Could it,” asked Hofmann “be cheaply made from coal-tar products?”.

At the time (1855) chemical equations were in their infancy and not very reliable, but he managed to construct one that at least showed a feasibility. He suggested that young Perkin should start with the coal-tar product, allyl toluidine, and oxidise it to form “quinine”.

$2(C_{10}H_{13}N) + 3O \rightarrow C_{20}H_{24}N_2O_2 + H_2O$

Perkin and his friend, Arthur Church, began work in his home laboratory. Using potassium dichromate as a source of the “3O”, he achieved a dirty reddish brown precipitate – clearly not the glistening white crystals of quinine. Lesser chemists would have abandoned the project and would have moved on to something else. But not Perkin, who later recorded:

“Unpromising though this result was, I thought it desirable to treat a more simple base in the same manner (to gain some insight into what might be going on). Aniline was selected and its sulfate treated with potassium dichromate; in this instance a black precipitate was obtained, and on examination, was found to contain the colouring matter known as aniline purple or mauve”.

Perkin understates his discovery. If you carry out the aniline/dichromate reaction under his conditions you get a material that just looks like soot, apparently as unpromising as his earlier brown precipitate from the allyl toluidine. Perkin must have been depressed and with a heavy heart would have washed up his equipment.

Had he used just soap and water, in which his dye would have been almost insoluble, he would have missed the discovery by which he is now famed. The black precipitate sticks tenaciously to glass apparatus, and he must have used a little alcohol to shift it off. At this stage he must have noticed among the stains on his washing-up cloth, the hint of a purple dye. He already had an interest in the colours that some chemical reactions produced, and decided to follow it up.

He extracted his black precipitate with petroleum spirit. This removed an intense brown colouration, and when all this had gone he repeated the extraction with alcohol. This extracted the mauve dye, leaving behind the sooty material as a useless by-product. But the purple alcoholic solution could be evaporated down to the give the solid dye. This he “dissolved” in boiling water containing a little tartaric acid.

On adding silk squares to the solution, they took up the dye and were tinted with an impressive purple colour. Aware of the possible commercial interest in the dye (bright, easily applied to silk, fast against washing) in June of 1856 he sent a sample to Messrs Pullars, dyers in Perth, Scotland, who reported “…your discovery is one of the most valuable which has come out for as long time. This colour is one which as been wanted on all classes of goods and could not be obtained on silks, and only at great expense on cotton yarns”.

The process was patented by the 18-year old Perkin in August 1856 and by June of the next year, assisted by his father and brother, he began work on the world’s first organic chemical factory, at Greenford Green, near Harrow. By December 1857 his dye was appearing on fabrics from Mr Keith’s dye-house, Bethnal Green, London.

This much sought-after dye made Perkin a fortune. He was soon able to retire on the profits made from the sale of his factory and continue with chemical research in his now much larger home laboratory. His later discoveries were important at the time, but none were as epoch-making as the synthesis and isolation of his mauve dye. It stimulated other workers to explore the coal-tar chemicals as precursors to other synthetic dyes and many were successful. Before Perkin, dyes were obtained from flower petals, roots and crushed beetles; post-Perkin, from coal-tar chemicals and more latterly from oil-derived products.

And this revolution was inspired by an 18-year old youth, and his home chemistry set…

Perkin honoured

Editor note: In 2006 the RSC honoured William Perkin with a Chemical Landmark at the old Perkin and Sons Dyeworks in Sudbury, to mark the 150th anniversary of his discovery. The RSC celebrated in many ways throughout the year, including a photoshoot with original mauveine-dyed dresses and mathematical model Carol Vorderman.

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