

Household remedies

The science behind the folklore

Andrew Parsons

Can chemistry explain old household remedies? By looking at the scientific evidence, we see how some traditional practices are supported by chemical principles

Exam links

- acids and bases
- complexation
- functional groups
- redox

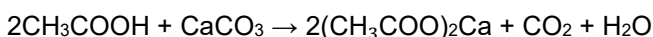
Many of us will be aware of everyday tips and tricks passed down through families and communities. Examples include vinegar for streak-free mirrors, walnuts for scratched furniture, conkers to keep away spiders, and potatoes to clean rusty cutlery. At first glance these sound like quaint household lore, but many are rooted in real chemistry. For students, these 'old wives' tales' (a phrase used to describe folklore passed down through generations) offer more than quirky anecdotes. They are gateways into applied chemistry, showing how concepts like acids, bases, redox reactions and intermolecular forces play out in the real world.

In this article, we will explore some of the most enduring household remedies and investigate the chemical principles behind them. The focus will be on cases where science supports the folklore, showing how chemistry can explain and sometimes validate everyday wisdom.

Vinegar for cleaning mirrors and glass

One of the most common folklore remedies is that vinegar makes an excellent glass cleaner. Unlike many myths, this one has solid chemical backing. Vinegar is a dilute aqueous solution of acetic acid, or ethanoic acid (CH_3COOH), and its effectiveness comes from acid–base reactions (neutralisations).

Household dirt on glass often contains mineral deposits from hard water (limescale is mainly calcium carbonate, CaCO_3) or basic residues like soap scum (which is primarily magnesium and calcium stearate, $[\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2]_2\text{Mg}$ and $[\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2]_2\text{Ca}$). Ethanoic acid reacts with alkaline residues, such as carbonates, to form water-soluble salts, carbon dioxide and water. For example, reaction with calcium carbonate forms calcium acetate:



Calcium carbonate is only sparingly soluble in water because its ions (Ca^{2+} and CO_3^{2-}) are held together by very strong electrostatic attractions, giving it a high **lattice energy**. This energy cost is greater than the hydration energy released when water molecules surround the ions, so dissolution is unfavourable. In contrast, calcium acetate dissolves readily in water: its lattice is stabilised by weaker ionic interactions, as the acetate ion (or ethanoate ion, CH_3CO_2^-) has a lower charge density than the

doubly charged, compact carbonate ion. Consequently, the hydration energy of the Ca^{2+} and CH_3CO_2^- ions is sufficient to overcome the lattice forces, producing a salt that dissolves easily in water, and leaving glass streak-free.

Unlike **detergents**, vinegar leaves minimal residue because acetic acid is volatile and so it evaporates. However, it is important to note that many contemporary glass surfaces, such as frameless shower doors, are treated with protective coatings to repel water. The application of acidic substances like vinegar may gradually degrade these coatings, increasing the vulnerability of the glass to water spots, hard water stains and soap scum accumulation.

Conkers and spiders

The claim that conkers (horse chestnuts) repel spiders is widespread. Place a few conkers around the house, people say, and spiders will stay away. But does science support this? In 2010, the Royal Society of Chemistry (RSC) worked with primary school pupils to test the idea. The experiments compared spider behaviour in controlled environments with and without conkers. The results showed no significant repellent effect.

Conkers contain **glycosides**, such as aesculin (or esculin) (see Figure 1), which are produced to deter herbivores (e.g. caterpillars) and pathogens, as they make the seeds bitter and less palatable. This explains why conkers are rarely eaten by most insects. Also, many glycosides, including aesculin, are considered toxic if consumed by mammals because they can cause gastrointestinal upset, paralysis and bleeding disorders. However, there is no scientific research to show that aesculin, or similar glycosides, are harmful to spiders. So, while conkers contain bioactive chemicals, the folklore claim does not hold up under experimental scrutiny. This is a great example of how science can investigate and disprove a myth.

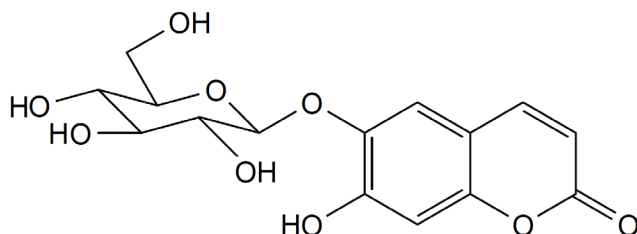
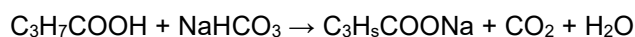


Figure 1 Aesculin is a coumarin glycoside, in which the sugar component (glucose) is bonded to a coumarin derivative (called esculetin). Coumarins contain a benzene ring fused to a cyclic ester (lactone)

Eliminating odours with bicarbonate of soda

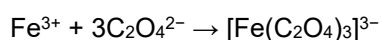
If you have ever been told to leave an open pot of bicarbonate of soda in the fridge to get rid of bad smells, then you have come across one of the most reliable traditional remedies. This claim is explained by chemistry. Sodium hydrogencarbonate (sodium bicarbonate, NaHCO_3), or baking soda, is a weak alkali that reacts with various acids in neutralisation reactions. Many unpleasant odours in the home, from spoiled food to dirty laundry, are caused by volatile acidic molecules. This includes butyric acid (butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$) from rancid butter. Sodium hydrogencarbonate neutralises these odorous molecules, forming non-volatile salts and reducing the smell. For example, it reacts with butyric acid, to form sodium butyrate (sodium butanoate), carbon dioxide and water:



The key point is that baking soda does not 'absorb' odours in a passive sense, it actively neutralises them through acid–base reactions, making it a sound household deodoriser.

Potatoes and rust removal

Another commonly held belief is that rubbing a rusty knife or pan with a potato assists in removing rust. This assertion is supported by scientific evidence. Rust, which is mainly hydrated iron(III) oxide ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$) is insoluble in water. Potatoes contain oxalic acid (ethanedioic acid, $\text{HOOC}-\text{COOH}$), which helps to remove rust. In aqueous solution, oxalic acid (a dicarboxylic acid) dissociates to form oxalate ions ($\text{C}_2\text{O}_4^{2-}$). These ions act as ligands and bind strongly to Fe^{3+} ions from the rust, forming soluble iron-oxalate complexes. The simplified reaction can be represented as:



This breaks down the insoluble oxide layer, forming the water-soluble trioxalatoferrate(III) complex ion, and allowing the rust to be lifted away. As a result, the visible rust is removed, revealing the underlying metal surface, although it may not be fully restored to its original condition. Other vegetables containing oxalic acid can be used to remove rust, including rhubarb leaves. The key point is that potatoes genuinely can remove rust, because their oxalic acid acts as a natural chelating agent – this uses the same chemical principle as many industrial rust removers.

Walnuts and olive oil for scratches

Furniture polish can be expensive. But some people claim that rubbing a walnut or a little olive oil onto scratched wooden surfaces works just as well. Perhaps surprisingly, chemistry supports this.

Walnuts are rich in unsaturated **triglycerides**, particularly those containing polyunsaturated **fatty acids** such as linoleic acid (Figure 2). In contrast, olive oil is composed mainly of triglycerides rich in monounsaturated fatty acids, such as oleic acid ($(Z)\text{-CH}_3\text{-(CH}_2)_7\text{-CH=CH-(CH}_2)_7\text{-COOH}$). When these oils are rubbed into a scratch, they penetrate the porous wood fibres and fill tiny gaps, reducing light scattering and making the scratches less visible. Over time, oxidation of polyunsaturated fatty acids generates free-radical intermediates (e.g. $\text{R}^\bullet$) that react with fatty acid chains, leading to cross-linking between fatty acid chains and **polymerisation**, which helps the repair to 'set'.

The key point is that this method does not truly repair the wood at a structural level, but it does disguise scratches through clever use of oils and light refraction – chemistry in action on your coffee table.

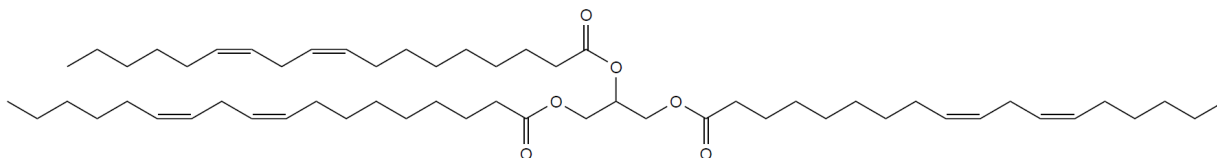


Figure 2 Linolein (tri-*O*-[(9*Z*,12*Z*)-octadeca-9,12-dienoyl]glycerol) is a triglyceride made by the esterification of glycerol [$\text{HOCH}_2\text{CH(OH)CH}_2\text{OH}$] with three molecules of linoleic acid ((9*Z*,12*Z*)-octadeca-9,12-dienoic acid). Unsaturated triglycerides are oils because the *Z*- (*cis*-) $\text{C}=\text{C}$ double bonds in their fatty acid chains create bends, which prevent the molecules from being closely packed together

Final thoughts

These household remedies might sound unscientific, but they provide fantastic opportunities to spark curiosity and connect chemical principles with daily life. Some, like vinegar cleaning mirrors or bicarbonate of soda eliminating odours, are strongly supported by chemistry. Others, like conkers repelling spiders, turn out to be more myth than reality. But in every case, there is an opportunity to apply chemical thinking, explore the evidence, and deepen understanding.

For students, the message is clear: chemistry is not confined to labs or exam papers. It is in the fridge, under the sink, in the garden, and even in the scratches on your furniture. By looking beyond the folklore, we can see that the real magic is science, and that is more powerful than myth.

Glossary

Detergent A water-soluble surfactant (with a water-attracting head and a water-repelling tail) that helps oils and grease disperse in water by reducing surface tension and forming micelles.

Fatty acid A carboxylic acid with a hydrophobic hydrocarbon chain (tail) comprising at least 12 carbon atoms and a carboxyl group (-COOH) at one end.

Glycoside A type of compound, found widely in plants, formed when a sugar molecule binds to a non-carbohydrate molecule (R). In doing so, an -OH group on the sugar becomes -OR .

Lattice energy The enthalpy change when 1 mole of the substance is formed from its individual gaseous ions.

Polymerisation The joining together of many small molecules (monomers) to form a large, long chain molecule, called a polymer.

Triglycerides Esters of glycerol (propane-1,2,3-triol) and long-chain carboxylic acids.

Practice exam questions

- 1 Why might baking soda reduce irritation from some insect bites? (2 marks)
- 2 Why is it unsafe to eat rhubarb leaves, even though the stems are edible? (2 marks)
- 3 How does the degree of unsaturation in a triglyceride affect its melting point? (3 marks)
- 4 Why does aesculin fluoresce under ultraviolet (UV) light? (3 marks)

Answers are on the next page

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Answers

- 1** Insect bites are often acidic. Baking soda is a weak alkali, so applying it as a paste can neutralise some of the acid, reducing irritation and the stinging sensation.
- 2** Rhubarb leaves contain significant amounts of oxalic acid, which can irritate the skin and eyes and interfere with calcium metabolism if ingested. This makes the leaves toxic, whereas the stems have much lower oxalic acid levels and are safe to eat.
- 3** Triglycerides that contain a greater proportion of unsaturated fatty acids, especially those with *cis* double bonds, display hydrocarbon chain kinks that hinder close molecular packing. This results in weaker intermolecular van der Waals forces and a lower melting point, so these triglycerides are typically liquid at room temperature. Conversely, triglycerides composed mainly of saturated fatty acids have straight chains which pack efficiently, increasing intermolecular interactions and resulting in a higher melting point, making them solid at room temperature.
- 4** Aesculin fluoresces under UV light because the substituted coumarin (aglycone) part contains a conjugated aromatic system. The conjugated double bonds allow the molecule to absorb UV light, which excites electrons to a higher energy level. When these electrons return to their ground state, the energy is emitted as visible light, producing fluorescence. The glucose (glycone) part of aesculin does not contribute to this fluorescence; it primarily affects the molecule's solubility. Thus, the fluorescence of aesculin arises from the electronic structure of its coumarin core.