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Chemistry: Amazing Experiments from Daily Life

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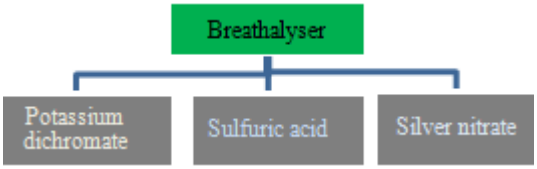
Abstract: ***Nothing in this world which is free from chemistry. Chemistry plays in all substances either it may living or non-living. In this way chemistry is a big part of everyone's life .It is very important because it helps us to know the composition, structure, and change of matter. All our three basic needs i.e. food, shelter, cloth are made by different chemicals and fiber. simply, chemistry is always present around us. The emotions that we feel are a result of chemical messengers, primarily neurotransmitters. The main aim of this study is to discuss some experiments with their chemistry from daily life. In our everyday life various chemicals are being used in various form, some of those are being used as food. Food rotten because of chemical reactions that occur between food molecules. Fats can become rancid. Bacteria grow that can make us sick. The human dependence on this natural science is increasing and to understand this, here are a few examples that highlight the importance of chemistry around us.***

Keywords: Polyphenoloxidase, Tautamerism, curcumin, free fatty acid, iodine value, enzyme, Retardents

1. Introduction

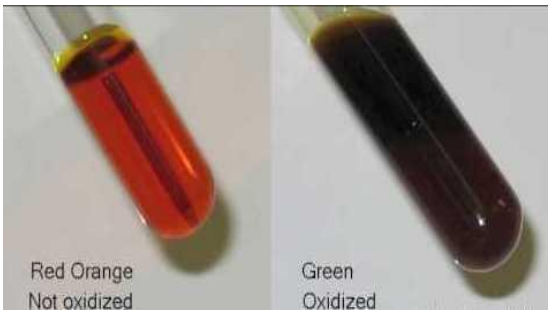
1.1 Breathalyzer Working

A breathalyzer or breath alyser is a device for estimating blood alcohol content (BAC) from a breath sample The chemical reaction inside the Breathalyzer includes both oxidation and reduction. The Breathalyzer contains a chamber with several compounds to support these reactions. They include:



$$3C_2H_5OH + 2K_2Cr_2O_7 + 8H_2SO_4 \longrightarrow 2\,Cr_2(SO_4)_3 + 3CH_3COOH + K_2SO_4 + 11H_2O$$

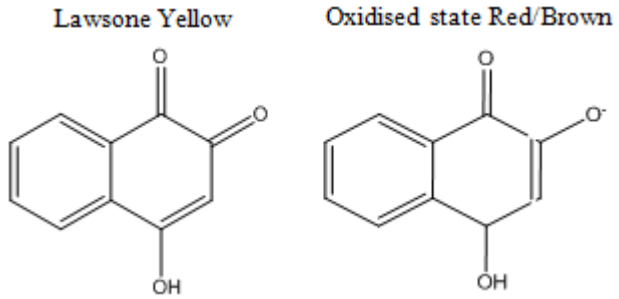
Ethanol — Potassium Dichromate — Sulfuric Acid — Chromium III Sulphate — Acetic acid — Potassium Sulphate — Water



In the Breathalyzer, ethanol participates in a redox reaction; it gets oxidized as it loses electrons (H atoms) and the potassium dichromate gets reduced as it picks up some electrons.

When the potassium dichromate solution in the Breathalyzer reacts with ethanol, the potassium dichromate loses an oxygen atom. The reduction converts orange potassium dichromate into a green solution containing chromium sulfate. At the same time dichromate ion gets reduced to chromium ion, ethanol gets oxidized to acetic acid. Silver nitrate serves as a catalyst for the reaction to increase the rate at which the dichromate gets reduced. Sulfuric acid in the test chamber helps to remove the alcohol from the exhaled air into the test solution and to provide the necessary acidic conditions.

1.2 Coloring Action of Henna



The active ingredient that enables henna to color hair is Lawsone- which is also known as 2-Hydroxy-1,4 Napthaquinone.

Lawsone is a weak organic acid that has a typical concentration of 1.3-1.5% in henna leaves. It is unique because of its structure. It's an extremely unstable negatively charged structure due to the presence of 2 carboxyl groups (C=O) and one acid group (OH).

It will ionize and then react (decompose) quickly, which makes it ineffective for hair coloring; therefore it needs to be preserved. The over abundance of protons from the citric acid make it less likely that the acid group or carboxyl groups on the lawsone molecule will ionize it's the release of lawsone in the henna leaves that gives henna its pigment.

Dried sour limes have the highest amount of citric acid as compared to lemons, oranges or tea. Thus sour limes are more effective at preserving (also known as acidic hydrolysis) the lawsone. The actual reaction mechanism of Lawsome molecule to hair keratin protein moleculeis as follows:

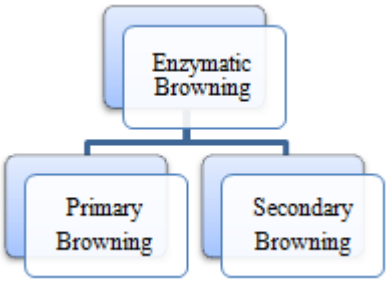
The carboxyl group from lawsone, which is negatively charged, reacts with the amide group from keratin's peptide bond, which is positive. This reaction attaches the lawsone molecule to the keratin protein in our hair, and thus, give our hair a permanent color

Lawsone Keratin Protein Reaction

$$\underset{\text{(Lawsone)}}{C_9H_5O_2 - C=O} + \underset{\text{(Free } NH_2 \text{ in Keratin)}}{H_2N - \text{Keratin}} \qquad \underset{\text{(Schiff's base)}}{C_9H_5O_2' - C=N - \text{Keratin}} + H_2O$$

1.3 Apple browning

Apples contain an enzyme called polyphenol oxidase (PPO), also known as tyrosinase. Cutting an apple exposes its cells to the atmospheric oxygen and oxidizes the natural phenolic compounds present in apples. This is called the enzymatic browning that turns a cut apple brown. It is also evident in bananas, pears, avocados and even potatoes.



1.3.1Primary browning

Fruit's phenolic compounds react with oxygen. This oxidation process is driven by an enzyme called polyphenol oxidase (PPO) .When an apple's cells are ruptured - for example, by bruising, biting or cutting. With the help of oxygen, which is in the air around the damaged cells, the polyphenol oxidase initiates a series of chemical reactions, transforming the polyphenols and eventually producing melanins: brown pigments.

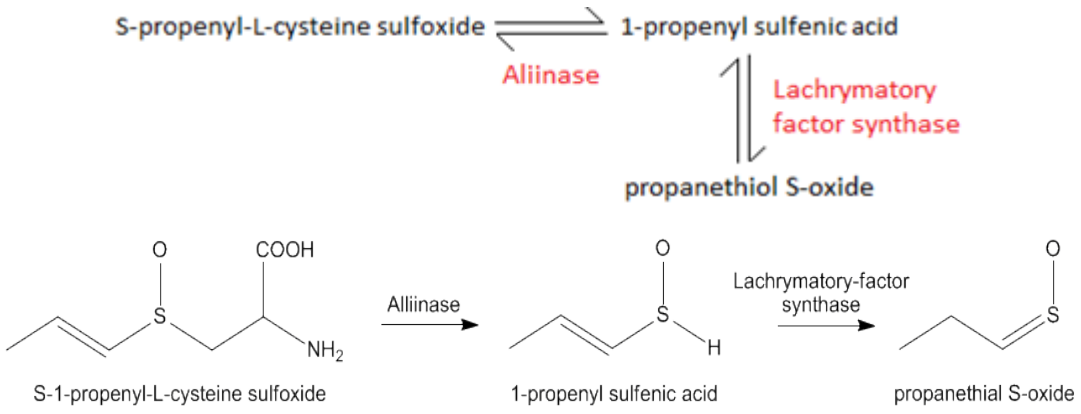
1.3.2 Secondary browning

The discoloration that occurs when an apple is beginning to decompose due to fungi and bacteria, i.e. rotten fruit. Examples of beneficial enzymatic browning:
Developing color and flavor in Coffee , Coca Beans, and tea.
Developing color and flavor in dried fruits such as figs and raisins.

1.3.4 Enzymatic Browning can be prevented by either reducing PPO oxidation activity or lowering the amount of substrate to which the enzyme can bind. Coating freshly cut apples in sugar or syrup can reduce oxygen diffusion and thus slow the browning reaction. Lemon or pineapple juices, both of which naturally contain antioxidants, can be used to coat apple slices. In addition, both fruit juices are acidic and the lower pH that they bring about causes PPO to become less active. Heating can also be used to inactivate PPO enzymes; apples can be blanched in boiling water for four to five minutes to nearly eliminate PPO activity.

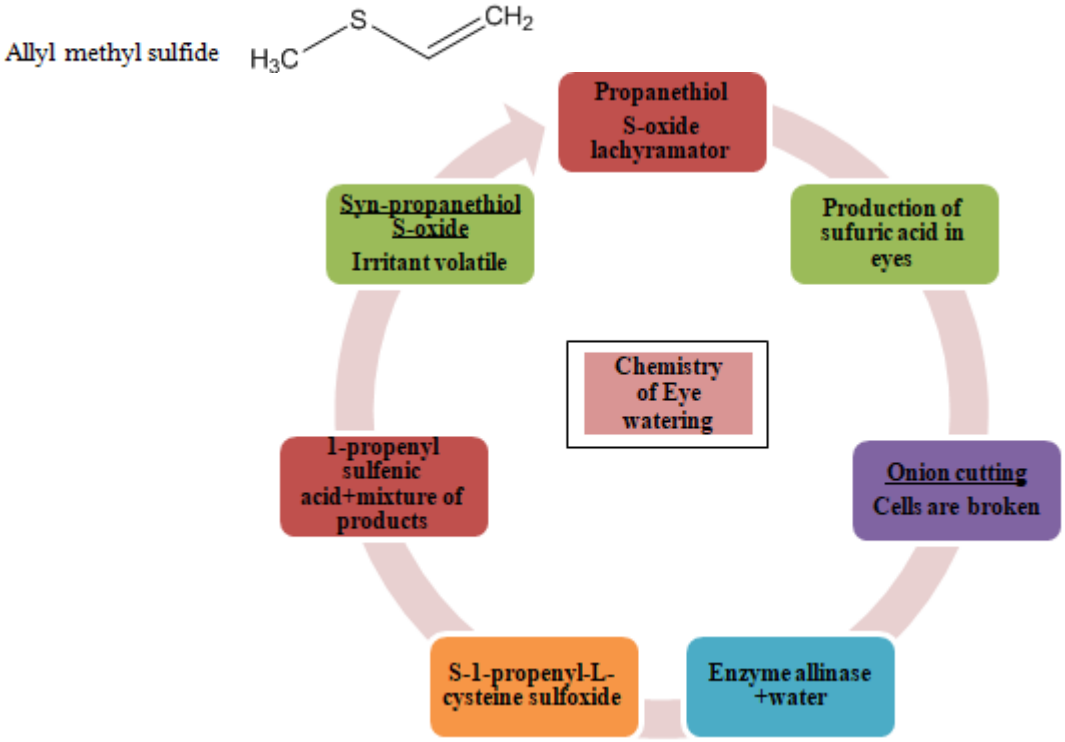
1.4 Eye watering chemistry of onions

Onions produce the relatively volatile chemical irritant known as syn-propanethial-S-oxide. It stimulates the eyes' lachrymal glands so they release tears .It is the product of a series of chemical reactions, shown below, that occur once the onion has been damaged.



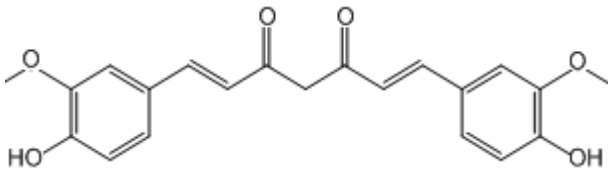
Reaction scheme for the production of propanethial

If the onion is ingested, these compounds are eventually broken down into allyl methyl sulfide, shown below, which can be removed from the body by exhalation – giving rise to the characteristic 'onion breath'

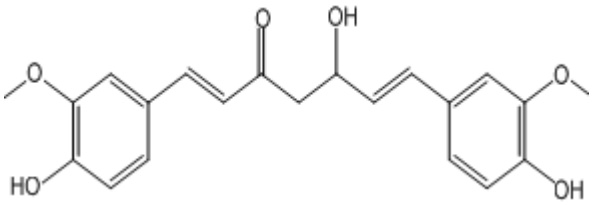


1.5 The Chemistry of Turmeric

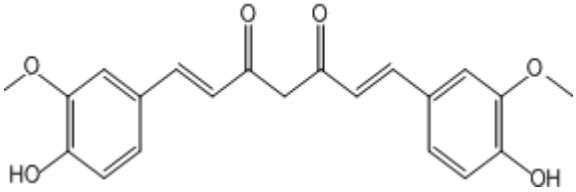
Turmeric is a mix of chemical compounds, the active ingredient is curcumin which is chemically a biphenol and also a 1,3 diketone. and exhibits a keto-enol tautomerism. The presence of tautomerism, extended conjugation and aromatic phenolic rings in it make curcumin appear yellow.



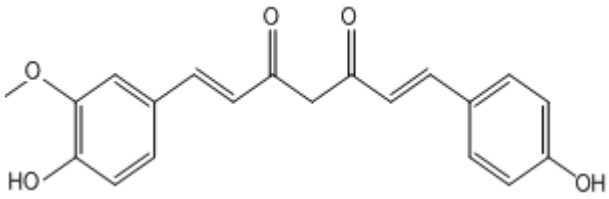
Curcumin (Yeilow color) pH3.7 ⇕ pH >8.0
Diketone form



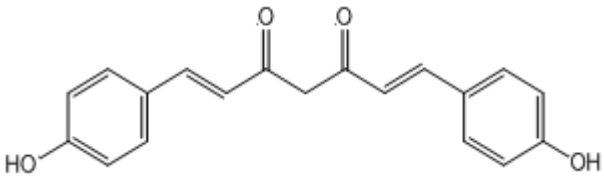
Curcumin (Red color) Keto-Enol form



Curcumin 77% (Curcumin I)



Demethoxycurcumin 13% (CurcuminII)



Bis-demethoxycurcumin 3% (Curcumin III)

Phenols are chemically acidic in nature and do readily lose their acidic proton in an alkaline medium, the loss of proton at any of the phenolic sites converts the phenolate ion from benzenoid structure into a quinonoid one. This means a change at the extended conjugation which would further disturb the tautomerism.

Whenever a benzenoid form goes into a quinonoid form, the species suffers a bathochromic shift in its optical property. Quicklime is chemically a strong alkali (base). Hence, exposure of turmeric powder or turmeric water to quick lime neutralizes any of the two phenolic protons and triggers the conversion of the original benzenoid structure with yellow appearance into a quinonoid structure with red colour. Red colour has higher wavelength than yellow.

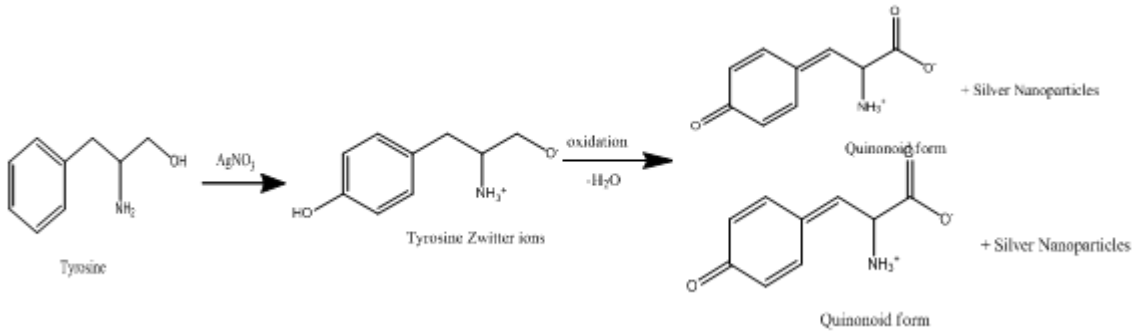
1.5.1 Chemistry of Turmeric as Fluorescence indicator.

This happens because electrons in the curcumin molecules absorb UV light from the UV torch, gaining energy as they do so. By gaining energy in ground state electron gets promotes to a higher energy level i.e.an ‘excited state’. This doesn’t last long though; they quickly lose some of this

energy as vibrational energy, before dropping back down to the ground state, emitting their excess energy as visible light, and giving us the fluorescence. Alcohol is used in experiments rather than just water. This is because turmeric is more soluble in alcohol than water, so the fluorescence is more visible.

1.6 Composition and Chemistry of Indelible Election ink in India

In case of election procedure this chemistry also plays a nice role in staining in finger tips by the reaction of silver nitrate on the melanin pigment of skin to produce stain which lasts for several days. Macromolecule melanin of skin pigment reacts instantly with silver nitrate of ink. Tyrosine and glutamine amino acids of melanin react with silver ion in presence of ultraviolet rays of sunlight to produce zwitter-ion which is responsible for production of silver nanoparticles at a time



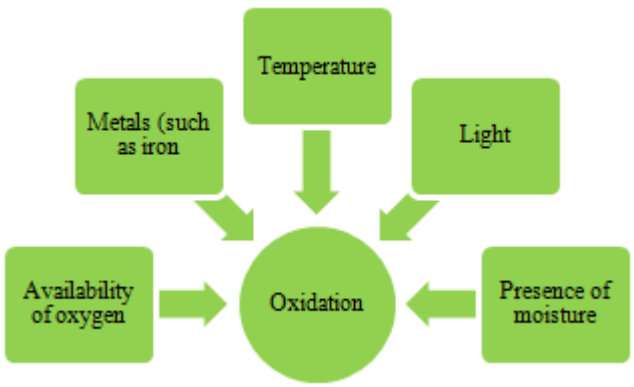
1.7 Oxidative Rancidity of fats and Oils

Oil oxidation is an undesirable series of chemical reactions involving oxygen that degrades the quality of oil. Oxidation eventually produces rancidity in oil, with accompanying off flavors and smells.

Oxidation is not one single reaction, but a complex series of reactions. Oxidation progresses at different rates depending on factors such as temperature, light, availability of oxygen, and the presence of moisture and metals (such as iron).

The type of oil also influences the rate of oxidation. The oxidative and chemical; change in oils during storage and heating at elevated temperature are charaterized by an increase in free fatty acid contents and a decrease in the total unsaturation of oils

Oil oxidation → Primary oxidation products
Peroxides, dienes, free fatty acids
↓
Tertiary oxidation products → Secondary oxidation products
Carbonyls, aldehyde, trienes



1.7.1 Acid Value- AV is a common parameter in the specification of fats and oil. It ia defined as the weight of KOH in mg needed to neutralize the organic acids present in 1 g of fat and it a measure of the free fatty acid present in the fat or oil

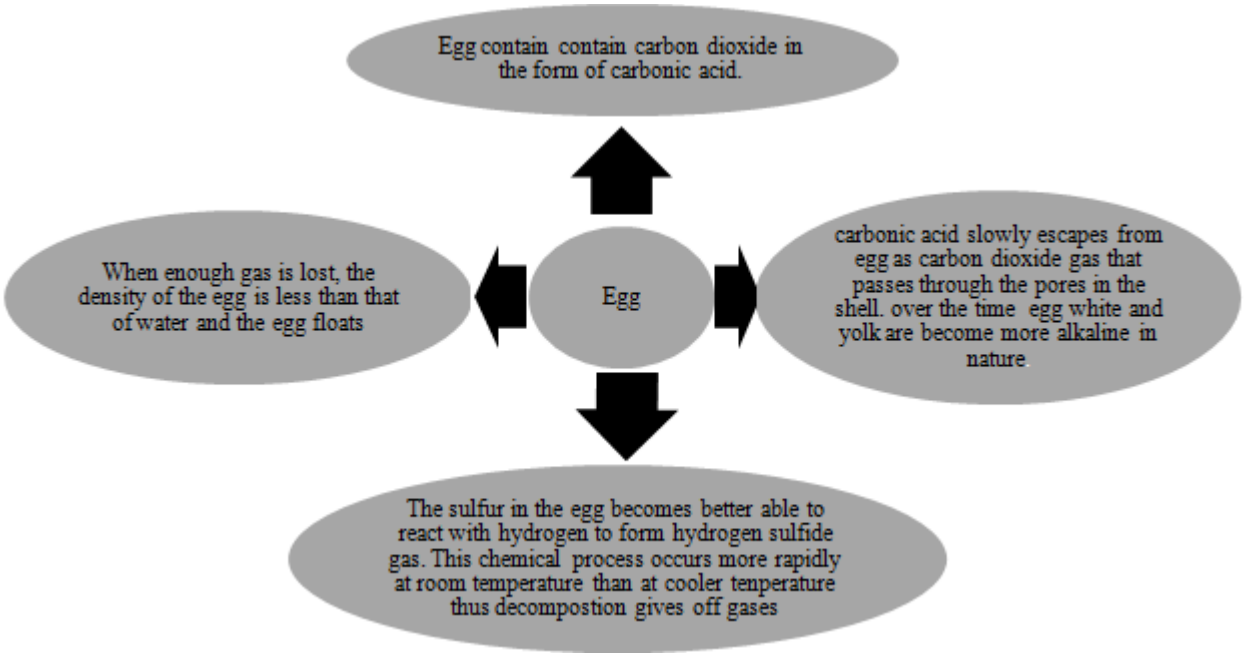
1.7.2 Iodine value also called Iodine Number /Iodine Index It is a measure of the degree of unsaturation of an oil .It is the mass of iodine in grams that is consumed by 100 gm of an oil .The higher the IV the more C=C bond present in the oil.

1.7.3 Peroxide Value : It is defined as the amount of peroxide oxygen per 1 Kg of fat or oil The best test for autoxidation (cxidative rancidity) determination of the peroxide value.It gives the measure of the extent to which an oil sample has undergone primary oxidation. Detection of peroxide gives the initial evidence of rancidity in unsaturated fats and oils.

Name of oil	Iodine Value
Coconut	8-10
Palm oil	37-54
Olive oil	75-95
Peanut oil	85-100
Cottonseed oil	100-117
Corn oil	115-130
Fish oils	120-150
Soybean oil	125-140
Safflower oil	130-140
Linseed oil	155-205

1.8 Rotten eggs floats

Fresh eggs sink because the egg yolk, egg white, and gases have enough mass that the density of the egg is greater than the density of water.. Basically, a fresh egg is heavier than water.



1.9 Fire Free pandals

A fire retardant is a substance that is used to slow or stop the spread of fire or reduce its intensity. This is commonly accomplished by chemical reactions that reduce the flammability of fuels or delay their combustion. Fire retardants may also cool the fuel through physical action or endothermic chemical reactions. Fire retardants are available as powder, to be mixed with water, as fire- fighting foam and fire- retardant gels. Fire retardants are also available as coatings or sprays to be applied to an object.

Bihar State fire service officer Clement Florian. "As per the standard ISI specification,

There are several ways in which the combustion process can be retarded

1.9.1 Physical action

By cooling: Some chemical reactions actually cool the material down. By forming a protective layer that prevents the underlying material from igniting.

By dilution: Some retardants release water and/or carbon dioxide while burning. This may dilute the radicals in the flame enough for it to go out.

1.9.2 Chemical action

Reactions in the gas phase: chemical reactions in the flame (i.e. gas phase) can be interrupted by fire retardants. Reaction in the solid phase: some retardants break down polymers so they melt and flow away from the flame.

Char Formation: For carbon-based fuels, solid phase flame retardants cause a layer of carboneous char to form on the fuel surface. This char layer is much harder to burn and prevents further burning.

Intumesents: These types of retardant materials incorporate chemicals which cause swelling behind the protective char layer, providing much better I insulation. They are available as plastic additives, and as paints for protecting wooden buildings or steel structures.

2. Conclusion

Chemistry is important because it helps us to identify toxic or dangerous substances and understanding basic chemistry is essential for understanding the effects of chemicals on the environment**.** All matter is made of chemicals, so the importance of chemistry is that it's the study of everything.

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