

Unsung Chemistry Heroines – Alice Ball (1892-1916)

Alice Augusta Ball (1892 – 1916) was an African American chemist who, at the age of 23, developed the only effective treatment for leprosy until the discovery of antibiotics in the 1940s. She was the first woman and the first African American to obtain a Master's Degree from the College of Hawaii, now the University of Hawaii. She died at the age of 24. Her Head of Department published her findings without including her name in the paper and it is only recently that her work has been fully recognised.



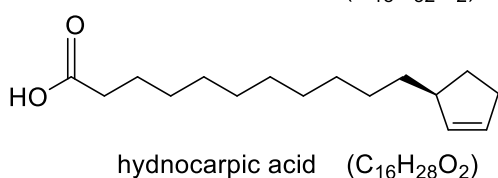
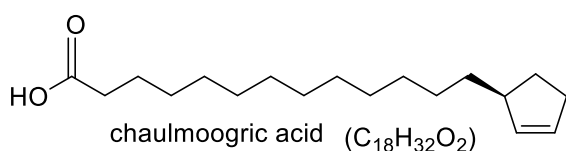
Fig. 1: Alice Augusta Ball

Alice was born in Seattle (Washington State) to middle class parents. She excelled in the sciences and was awarded a degree in pharmaceutical chemistry (1912) and a Bachelor's in pharmacy (1914) at the University of Washington. She then won a scholarship to the University of Hawaii where she studied for a Master's in chemistry. Her thesis was on the chemical constituents of the kava plant (*piper methysticum*), a member of the pepper family, used in the South Pacific to relieve pain, stress and insomnia.



Fig 2: *Piper methysticum* leaves

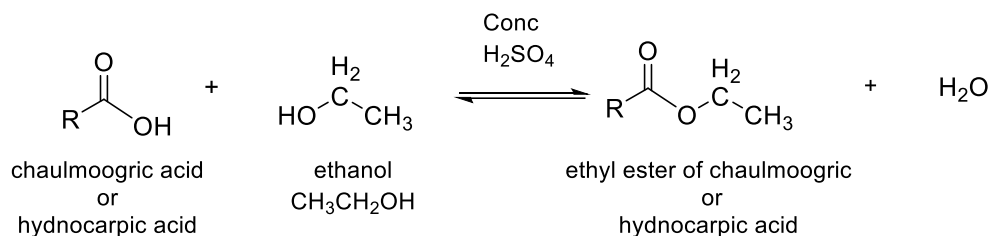
Alice stayed on at Hawaii as a teaching fellow and, at the age of 23, was the first woman and African American to become Assistant Professor at the University. During this time, she began to work on Chaulmoogra oil which was known to have some benefit in the treatment of Hansen's disease, also known as leprosy. Leprosy is a very unpleasant and highly contagious skin condition that can affect many other critical organs. It had been known for over 4000 years and there are frequent mentions of sufferers in the Bible. Those afflicted were forced out of their communities to live in 'leper colonies'. Chaulmoogra oil was the main ingredient in formulations used for over 400 years to treat the disease in China and India. When applied directly to the skin it had little effect. If injected it was more effective but resulted in a lot of pain and caused abscesses due to its high density and low solubility in water. Chaulmoogra oil is composed of long chain fatty acids of which the active ingredients were believed to be chaulmoogric acid ($C_{18}H_{32}O_2$) and hydnocarpic acid ($C_{16}H_{28}O_2$).



Long chain fatty acids have very poor solubility in water due to their extended hydrophobic non-polar hydrocarbon chains. If water soluble salts of the acids could be made, it was thought they could be introduced into the blood stream more effectively. Harry Hollmann, a surgeon in the Public Health Service in Hawaii, suggested Alice should work on extracting and analysing oil from seeds of the chaulmoogra tree as they were known to contain the two fatty acids. Previous attempts to produce salts of the acids with greater water solubility had been successful, but

the ionic species formed reacted with lipids in cell walls leading to hemolysis – the destruction of red blood cells.

Alice used a different approach based on techniques refined in her Master's degree. This involved producing esters of the fatty acids. She eventually developed the "Ball Method" which separated the chaulmoogra oil into four fractions, followed by esterification of the acids in alcohol using a catalyst such as sulfuric acid. This was a lengthy process initially involving saponification, to produce potassium salts, followed by treatment of the salts with hydrochloric acid and extraction with alcohol. The pure solid fatty acids formed were then recrystallised from alcohol and converted to the ethyl ester as represented in the equation below.



Formation of the ethyl ester of chaulmoogric or hydnocarpic acids

The ethyl esters formed were less viscous than the acids and could be injected and absorbed more easily by the body. Many sufferers of Hanson's disease benefited from this drug, going on to enjoy a reasonable quality of life in the community with good life expectancy. This treatment was used until the 1940s when sulfone drugs and antibiotics became available.

Alice Ball died in 1916 at the age of 24. She may have suffered chlorine poisoning while demonstrating the use of gas masks in the teaching laboratory. However, her death certificate was altered and tuberculosis given as the cause of death. Alice Ball did not receive recognition for her part in this discovery until much later. The Director of the University of Hawaii, Arthur Dean, continued her work and published papers outlining the process but named it the "Dean Method" and failed to note Alice's involvement. Hollmann tried to put the record straight but, despite this, it took 85 years for Alice's contributions to be recognised. She is one of only three female scientists commemorated on the façade of the London School of Tropical Medicine; the others are Marie Skłodowska-Curie and Florence Nightingale. The remaining 23 innovators named are men. 28th February is celebrated in Hawaii as "Alice Augusta Ball Day".

Fig 1: Image Alice Augusta Ball: AnonymousUnknown author, Public domain, via Wikimedia Commons

Fig. 2: Image kava plant: Forest & Kim Starr Creative Commons Attribution

Bibliography: S.S. Weigel Gomes and W.E. Francisco Junior, *Journal of Chemical Education* 2024, 101, 12, 5231-5239 [Alice Ball: An African-American Woman to Foster Education in Chemistry | Journal of Chemical Education](#) (accessed 22nd February 2026)

G. Ferry, *The Lancet*, Vol 402, 2023 www.thelancet.com (accessed 22nd Feb 2026)

PUZZLE CORNER - Organic Compounds Connect Four

Arrange the 16 compounds named in the grid below into four sets as in the TV programme "Only Connect". Think about types of compounds, similar structural features and functional groups. You may find it helpful to check the structures of unfamiliar molecules.

hexane
glucose
benzene
phenol

ethyl ethanoate
propanoic acid
ethane
propylamine

cyclopentene
nitrobenzene
ethanamide
2-methylpropane

cyclopentane
ethane-1,2-diol
benzoic acid
phenylamine

One Solution: Set 1: 2 oxygen atoms-ethyl ethanoate, propanoic acid, ethane-1,2-diol, benzoic acid; Set 2: Saturated hydrocarbons: hexane, cyclopentane, ethane, 2-methylpropane; Set 3: 1 nitrogen atom - nitrobenzene, propylamine, ethanamide, phenylamine; Set 4: Cyclic compounds - phenol, benzene, cyclopentene, glucose. [You may find a different way of organising the compounds into sets. If so - please let us know!]