Elements of Flair and Fashion

by Marielle Agbahoungbata

Let us start with a simple question: what allows you to read this article? Your eyes, the light? Whatever your answer is, you are right. But now, please, keep your eyes open and the light on, and imagine that this text is written exactly in the same colour as the paper. Would you be able to read?

Colour, of course, plays an important role. Colour has always had a huge impact on our lives. It has generated many human tragedies in history such as slavery and colonialism, and yet saves the world from disasters every day through traffic lights and other vital means of communication. From the clothes we wear, to the food we eat, and the cars we drive, colour is an essential feature which guides our choices, reveals our emotions and structures our life. Gaining more insight into colour matters is an important issue that goes far beyond simple curiosity. What does colour mean?

This question brings us back to our first question. Indeed, whatever the quality of your eyes and the colors used for printing this text, you cannot read it without light. As an electromagnetic radiation, light has frequency. The frequency of light that our eyes can detect is called colour. Color is the characteristic of human visual perception described with names such as red, orange, yellow, green, blue, purple, or pink. When light shines on an object, some frequencies (colours) are reflected whereas others are absorbed. The substance responsible for this phenomenon within objects is called colorant. The absorption of electromagnetic radiation in the ultra violet (UV) and visible regions by these coloring substances induces electronic excitation and a shift to higher energy levels. Next, the excited electron relaxes to its ground state by emitting a quantum of light called a photon. Our eyes detect this light as a color. For instance, we can see a lipstick is red because it absorbs all frequencies in the visible light except the one that corresponds to red color. White paper reflects all frequencies in the visible light (no absorption) while black ink absorbs all of them (no reflection). A covalently unsaturated group responsible for absorption in the UV or visible region is known as a chromophore (C=C, C≡C, C=O, C≡N, N=N, NO_2). Colorants are understood to include both pigments and dyes. The key distinction between them is that dyes are soluble in water and/or an organic solvent, while pigments are insoluble in both types of liquid media. The majority of natural colorants are derived from plants (roots, berries, bark, leaves, wood, fungi and lichens), minerals (oxide, silicate, carbonate, etc.) and animals (snails, mollusk, insect). However, a significant number of colorants were artificially synthesized as soon as color became important in our need to improve our environment and clothing.

Indeed, ever since pre-historic times, humans were fascinated by the ability of coloring objects of their daily lives. From Ancient Egypt, a civilization of ancient North Africa that coalesced around 3100 BC, to now, the world has enjoyed a ground-breaking history as far as the use of dyes and pigments is concerned. Several different types of natural dye were used by Ancient Egyptians in the field of fashion [1]: *Archil or orchil*, a purplish blue dye obtained from lichen and known as "poor man's purple." Its chemical constituents are essentially carbon (C), hydrogen (H), oxygen (O) and nitrogen (N) in a quite complex structure. *Alkanet* or dyers' bugloss (chemical constituents C, H, and O) is a perennial low growing herb (*Anchusa tinctoria*) with bright blue flowers. Its red dye was obtained from the

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roots. *Madder dye* (composed of C, H and O) was usually obtained from common madder (*Rubia tinctorum*), an evergreen plant growing up to 1.5 m tall and having five yellow petals, producing blue to black berries. This dye is obtained from its long roots, and chalky soils produce the best quality. It was used to dye wool, cotton, silk and leather.

A dye from the animal kingdom, *Kermes dye* (C, H, and O), was obtained by boiling the bodies of female insects of the Kermes family (*Coccus ilicis*) until dry and then ground. It was applied to fibers with an alum mordant. It takes 150 000 insects to produce 1 kg of dye.

Indigo dye (C, H, O and N) is among the oldest dyes used for textiles. The oldest known fabric dyed indigo dates to 6 000 years ago, and was discovered in 2009 at Huaca Prieta, Peru. Many Asian countries, such as India, Japan, and Southeast Asian nations have used indigo as a dye (particularly silk dye) for centuries. This dye was also known to ancient civilizations in Mesopotamia, Egypt, Britain, Mesoamerica, Peru, Iran, and Africa. A variety of plants have provided indigo throughout history, but most natural indigo was obtained from those in the genus Indigofera.

Another dye, *Henna* (C, H, O) was prized in Egyptian and Greek mythology as a cosmetic. The Egyptians ground the leaves then pasted them on the skin in order to decorate fingers and toenails. It could be used to colour hair and by men to dye their beards, moustaches, and even the manes and tails of their horses. Henna is widely used still in most West African countries for the same needs.

Similarly, the Egyptians were very familiar with a number of mineral pigments obtained from natural ores as well as oxides [1]: the *orpiment* pigment is lemon yellow in colour, its formula is As_2S_3. A small bag containing the pigment was found in Tutankhamun's tomb (1325 BC), apparently as a cosmetic. *Realgar* pigment has been found at several Egyptian sites, including a 14th century BC tomb, where it appears to have been used as a cosmetic. It can be a reddish yellow to orange with formula often depicted as AsS, but better represented as As_4S_4 which can exist in different crystalline structures.

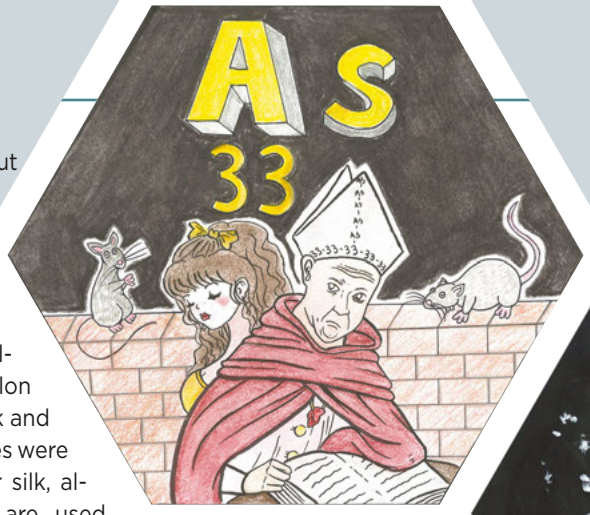
Vermilion is a pigment obtained from the mineral cinnabar and designated HgS. This pigment can be obtained by heating sulfur and mercury above 580 °C, when the vermilion sublimes, condenses and is collected as bright red crystals, giving an intense shade. *Malachite green* is an organic compound that is used as a dye for materials such as silk, leather, and paper. The Egyptians used it as a cosmetic as far back as the Badarian period (5000 BC). Formally, *malachite green* refers to the chloride salt $[C_6H_5C(C_6H_4N(CH_3)_2)_2]Cl$, and it was also found in Tutankhamun's tomb (1325 BC). *Azurite* has the same structure as green malachite. Although it does not fade, it slowly changes color to green malachite.

The Egyptian blue pigment is considered to be the oldest synthetic pigment. It is made by heating together silica, malachite $Cu_2CO_3(OH)_2$ (not to be confused with malachite green), $CaCO_3$ and soda or potash at 900 °C. The resulting product has a composition $CaO{\cdot}CuO{\cdot}4SiO_2$. Apart from all these famous dyes and pigments, there are medieval dyes and pigments such as *Brazil wood* from Asia, notably Sri Lanka and the East Indies, *logwood* from Central America, *Cochineal* from Aztecs, *Lapis lazuli* from Afghanistan but used for the gold mask found in Tutankhamun's tomb, *Indian yellow* from India, *Prussian blue*, etc.

If colour has had a huge impact on fashion in the past, contemporary fashion is still governed by colour. From hair to toes, color plays an important role. Hair colouring is the practice of changing hair color in order to cover gray or white hair, to change to a colour regarded as more fashionable or desirable, or to restore the original hair colour after it has been discoulored by hairdressing processes or sun bleaching. Depending on the goal (permanent, semi-permanent, demi-permanent or temporary hair coloring), several dyes are used. Their main components are ammonia, ethanolamine, sodium carbonate, hydrogen peroxide, and paraphenylenediamine. Several dyes and pigments (ultramarine blue, iron oxide, titanium dioxide, carmine, eosin, and others) are also used to produce lipsticks, skin-care creams, eye and facial makeup.

As far as our body is concerned, the possibility of using colour to control food consumption is attractive for weight-loss programs and even for the treatments of eating disorders [2]. There is an interesting study that shows that serving dishes on red plates could reduce food consumption. Indeed, subtle red color cues significantly reduced the consumption of soft drinks and salty snacks compared to blue or white color cues.

Decidedly, color plays a significant role in the field of fashion. When talking about clothes, it is estimated that over 10 000 different dyes and pigments are used industrially and over $7{\times}10^5$ tons of synthetic dyes are annually produced worldwide. Selection of the appropriate dye is important because any given dye is not suitable on every type of fiber. Furthermore, resistance to washing, rubbing and light differ among dyes. The choice of dye depends on the objective in dyeing and which material is to be dyed. Azo dyes make up over half the dyes classified in the Color Index, covering



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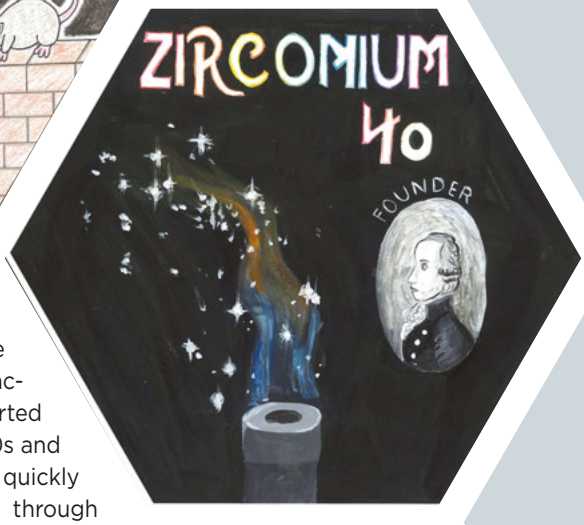

the whole spectrum, but mainly yellow, orange and red dyestuffs. They are characterized by one or more azo groups (—N=N—). Acid dyes are used mainly for the coloration of wool and nylon and, to a lesser extent, silk and acrylics whereas basic dyes were originally used mainly for silk, although nowadays they are used for acrylic fibers, where they provide good fastness. Direct dyes were used on cellulose and disperse dyes were developed for cellulose acetate but now their main application is for polyester. Reactive dyes are known to be able to achieve the whole gamut of colors. Others dyes such as malachite green, mauveine ($C_{26}H_{23}N_4^+X^-$), Congo red ($C_{32}H_{22}N_6Na_2O_6S_2$) are widely used in the dyestuff industry.

The development of fashion in Africa has impacted the development of some traditional dyes workshops. Especially in West Africa (Mali, Guinee, Senegal, Benin, and Cote d'Ivoire) textile dyeing activities started in the 1960s and has been quickly developed through the 1990s into today. For instance, in Benin, the approximate amount of dyes used per day in a small workshop can reach 50 kg [3].

Group of periodic table	Examples of elements in colorant	Colorant	Colour	Main applications
1	Sodium (Na)	Azo dyes	Red, blue	Textile
2	Magnesium (Mg) Calcium (Ca)	Magnesium carbonate Egyptian blue	White Blue	Cosmetics Art
3	-	-	-	-
4	Titanium (Ti) Zirconium (Zr)	Titanium dioxide Zirconium oxide	White White	Cosmetics Jewellery
5	-	-	-	-
6	Chromium (Cr)	Azo dyes	Violet	Textile
7	-	-	-	-
8	Iron (Fe)	Idian red	Red	-
9	Cobolt (Co)	Cobolt blue	Blue	Coating
10	Nickel (Ni)	Nickel salts	Several	Dye mordant
11	Copper (Cu)	Azo dyes	Blue	Cosmetics
12	Zinc (Zn)	Zinc white	White	Art
13	Aluminium (Al)	Carmin	Red	Textile
14	Carbon (C)	Organic dyes	Whole spectrum	Textile, cosmetics
15	Nitrogen (N)	Azo dyes	Whole spectrum	Textile, cosmetics
16	Oxygen (O) Sulfur (S)	Azo dyes Azo dyes	Whole spectrum	Textile, cosmetics
17	Chlorine (Cl)	Azo dyes	Green, red	Textile
18	-	-	-	-

These dyes/pigments are powdered in different colors: green, blue, red, yellow, brown, black, orange, pink, purple, and more, and contain, in addition to organics, some metallic elements such as Cr, Pb, Zn, Cd, and Hg.

However, the dyeing activity is likely going to be gradually industrialized in West Africa since fashion has become one of the biggest sectors within the continent. The famous Lagos Fashion Week (LFWNG) is an excellent illustration. It is an annual multi-day event founded in 2011 by Omoyemi Akerele, a Nigerian fashion designer. LFWNG is a fashion platform that drives the Nigerian and ultimately, the African fashion industry; by bringing together buyers, consumers and the media to view the current collections of designers in the fashion capital of Lagos, Nigeria. The fashion and exhibition event includes: Runway shows featuring new season collections from the best talents in the fashion industry; exhibitions featuring fashion products and accessories, textiles, design elements, photography; and art installations workshops and master classes facilitating knowledge transfer, information exchange, and networking opportunities across the board. The next Lagos Fashion Week will be held from 23-26 October 2019 in Lagos, Nigeria.

Like dyes and pigments, there are also others important ingredients in use for thousands of years in the field of flair and fashion: gold and gemstones. Gold (Au) is a chemical element, the most malleable of all metals, with a slightly reddish-yellow color used as jewelry since the ancient Egyptians. Nowadays, the consumption of gold produced in the world is about 50% in jewelry. As opposed to gold, a gemstone is a piece of mineral crystal, a solid chemical compound that occurs naturally in pure form, used to make jewelry or other adornments in its cut and polished form. Since the beginning of time, people have been fascinated by the beauty and purity of gemstones such as diamond (a solid form of element carbon), ruby (aluminum oxide), emerald ($Be_3Al_2(SiO_3)_6$), sapphire (α-Al_2O_3), and others. Their exceptional beauty is generally due to their color. As previously explained, a gemstone's color comes from its interaction with light. However, a gemstone which is mostly the same can exhibit different colors. For example, ruby and sapphire have the same primary chemical composition (both are aluminum oxide) but exhibit different colors because of impurities: *i.e.* an atom in the primary structure of the mineral is replaced by a completely different atom, sometimes as few as one in a million. Another example is beryl. It is colorless in its pure mineral form but becomes emerald with chromium impurities. If manganese is added instead of chromium, beryl becomes pink morganite, and with iron aquamarine.

As you could notice, the history of color in the field of fashion and flair has been with us for millennia. As we review the periodic table of elements, we see that almost all the eighteen groups of the table have been mentioned by talking about elements of color. The table on the previous page shows that at least one element in most groups is used in the field of fashion. Moreover, most periodic tables themselves use color. Some use colors to distinguish metals, non-metals, metal-like, noble gasses, and rare-earth elements from each other. The history between fashion and the elements of the periodic table is surprisingly amazing. Let's keep an eye on them.

Acknowledgements

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Marielle Yasmine AGBAHOUNGBATA <hounmar@gmail.com> is the Coordinator of X-TechLab, a platform dedicated to X-Ray Techniques in Africa. She holds a PhD degree in inorganic chemistry from University of Abomey-Calavi in Benin. Her research focus on the development of titanium dioxide based photocatalyst materials for wastewater purification. In 2019, celebrating IYPT and the 100th anniversary of IUPAC, she was awarded element 12, magnesium, on the IUPAC100 Periodic Table of Younger Chemists, https://iupac.org/100/pt-of-chemist/#marielle-yasmine-agbahoungbata.