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Colourful nature in your clothes

Textile info sheet

All clothes and textiles that we use come from natural or synthetic sources. As you can see in figure 1, natural fibres are produced by plants or animals. These are often called 'bio-based materials', meaning that they have been produced by living beings. Plants, for example, use the resources of the environment, such as soil, water and sun energy, to create their structural support made of cellulose, a chain of sugar molecules. These chains build cellulosic fibres. Some of them are widely used in clothes and furniture, such as cotton, linen or hemp.[1]

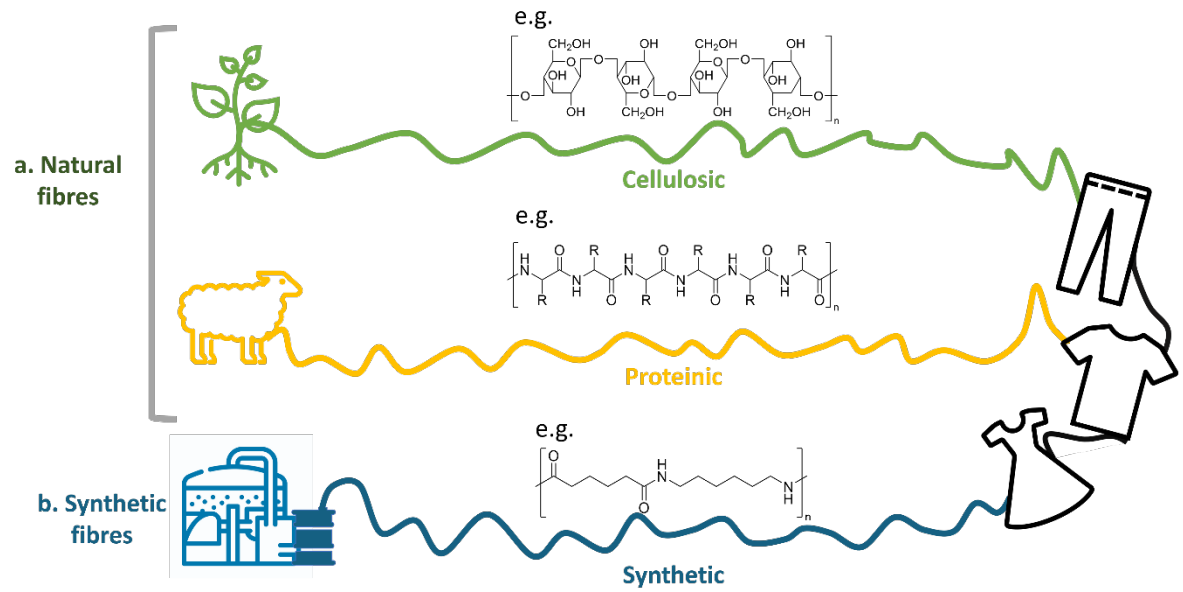

Figure 1: a) natural (cellulosic and proteinic) and b) synthetic fibres
Image courtesy of the authors

The basic structural components of animals are proteins, which are chains of amino acid units that form the building blocks of muscles, skin, hair and organs. Protein fibres are created by specimens through their metabolism using planetary resources. Different animals such as sheep and silkworms produce remarkable fibres that are used to make wool and silk textiles.[2]

Natural fibres, made of sugars and proteins, are compatible with water-based life, explaining their high affinity to water. They can therefore absorb humidity easily, giving a fresh and comfortable feeling. In flame tests, natural cellulosic materials such as cotton scorch and ignite quickly when brought close to a flame. The ignition process is homogeneous and maintains the original shape of the fabric when it turns to ash. The result residue is soft and easily breaks into loose ash, that can be dispersed and crushed between the fingers.[2]

Natural fibres are composed of biopolymers such as cellulose or proteins, making them easily degradable in nature. Under suitable environmental conditions, microorganisms can biodegrade these fibres into simple, non-toxic components that re-enter the carbon cycle, reducing their environmental impact at the end of their life cycle. In natural conditions, bio-based textiles are almost completely decomposed, producing mainly carbon dioxide and water vapor, with a small amount of carbonaceous residue remaining. While this degradability benefits the environment, it compromises the long-term durability of these materials.[3]

The process of obtaining bio-based materials is time-consuming and expensive, because the plants or animals need to be fed, grown and cared for to obtain the raw materials.[1] However, their breathability and softness make them the preferred option for making comfortable and potentially sustainable clothes.

In contrast, synthetic fibres such as polyester, nylon or acrylic are produced through chemical reactions using molecules that are often derived from fossil fuels. Their repetitive hydrocarbon composition makes them generally water-repellent, strong and resistant to wear and tear, making them very durable.[3] This is why they are preferred for technical clothing, such as waterproof or stretch fabrics for sports that dry easily. In flame tests, synthetic fibres can be recognised because, when approaching the flame, the material fuses and shrinks away from it. When the flame reaches the fabric, it burns through the textile, which melts and deforms, leaving behind a hard or rubbery black bead.

Although their production involves the use of toxic ingredients, especially solvents, the large-scale industrial fabrication is cheaper than the bio-based production of natural fibres. That's why synthetic fabrics are the most widespread type of textiles. Moreover, synthetic fabrics are derived from petroleum-based materials that are highly resistant to microbial degradation, meaning they can persist in the environment for hundreds of years. Despite not always being comfortable in direct contact with the skin, the wide range of possibilities they offers gives fashion designers a lot of space for creativity.

However, all kinds of fabrics will wear out over time.[4] Bio-based materials are the most prompt to degrade, as they can be eaten by moths or be home to different fungi. On the other hand, synthetic fibres, although less susceptible to degradation, constantly liberate small non-degradable pieces called 'microplastics',[5] that accumulate in the environment and in living beings. Microplastics can induce different diseases in humans, which are still being researched, since the impact of these small concentrations can only be determined after many years of exposure.

End of life

Now, let me ask you: have you ever wondered what happens to the clothes that you don't wear anymore? Whether they are damaged or they don't fit your lifestyle as before? Well, there are several routes that the garments can take. Under the traditional linear consumption model, people discard them, constantly increasing the pollution to worrying levels.

Recently, the circular fashion model has emerged (figure 2), promoting different practices for preventing used textiles from becoming waste, such as donating, reselling, repairing, upcycling and recycling discarded clothes as raw materials for new garments. In Activity 3, you will learn how to renew old garments using natural ingredients to refresh its colour, practicing an upcycling technique of the circular fashion model.

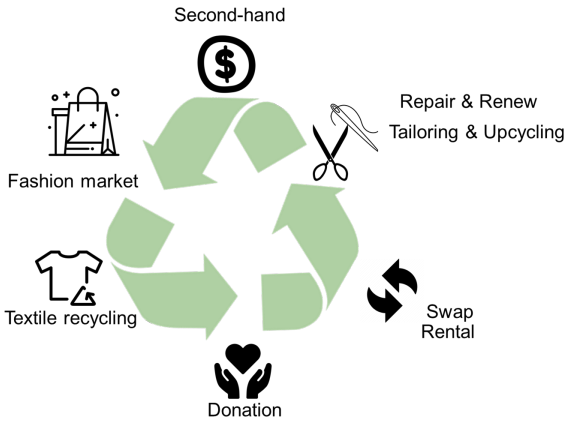

Figure 2: Circular fashion model
Image courtesy of the author

The mechanical recycling process, shown in figure 3, consists of shredding old garments (a) to obtain individual fibres (b). These fibres are then aligned and re-yarned (c), and mixed with pure, non-recycled material to obtain new textiles (d), that can be used to design new garments.[6] Although these recycled materials are more expensive than, for example, regular cotton, they

present an interesting alternative for saving clothes from ending up in landfill sites of global southern countries.

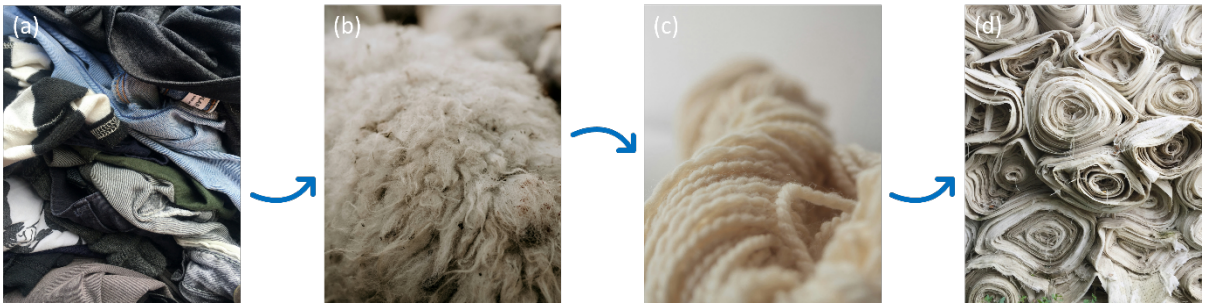

Figure 3: Mechanical recycling process of a) old garments (b) shred fabric c) re-yarned fibres d) recycled fabric
Images: a) Alejo Reinoso/Unsplash, CC0; b) Agnieszka Stankiewicz/Unsplash, CC0; c) Edo/Unsplash, CC0; d) Ethan Bodnar/Unsplash; CC0

However, this process can only be done with textiles made of a single type of fibre. The classification and removal of additional pieces are the major bottlenecks, since they require an excellent classification of the items and a lot of hand labour. This increases the price and limits scalability for recycled fabrics. Nowadays, less than 1% of total textile waste is recycled globally. Therefore, there is an increased interest in rethinking the fashion design process to incorporate recyclability from the beginning, with the aim of making recycled textiles more affordable in the future.

Unfortunately, mechanical recycling is not possible for elastic-synthetic fibres, since the presence of small amounts of elastane creates an enormous chewy ball of clothes that cannot be processed in the same way as non-elastic mono component materials. However, chemical recycling seems to be an alternative to exploit the potential reuse of multicomponent textiles.[7]

The ultimate destination for garments that cannot be reused, upcycled or recycled, is energy recovery, also known as thermal valorisation. When disposed of correctly, the non-recyclable waste is incinerated to recover thermal energy and transform it into usable energy, such as electricity, heat or biogas. However, this process comes with a cost that people don't usually consider and are not always willing to pay. So, what occurs more often is that the items that you don't use anymore end up in landfill sites, polluting the environment for ages after you have discarded them.

Here is where our opportunity as consumers comes in: by recognising the materials our clothes are made of, by learning about their production processes, by questioning the end-of-life of the items that we use every day, we can make conscious choices to reduce the environmental impact of everyday actions such as getting dressed.

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