Natural Fibres

Introduction

Museum staff who care for textiles should have a basic understanding of the characteristics of fibres.

This Note provides an introduction to four natural fibres: cotton, flax, silk, and wool. Cotton and flax are vegetable fibres composed of cellulose. Silk and wool are protein fibres that are made up of various amino acids.

A burn test can provide basic information on fibre group, i.e. cellulose or protein, but a good light microscope is required to make a more definitive identification of a fibre.

Cellulose Fibres

Cellulose fibres are found in stems, leaves, and seed bolls of plants. Many varieties of plant fibre have been used throughout history. Hemp, jute, ramie, sisal, and coir are regularly used in various parts of the world. Cotton and flax are the most common vegetable fibres found in Western museum collections. Table 1 lists some of the properties of undegraded cellulose fibres. However, the characteristics of cellulose are altered by ageing and degradation, which is manifested in many different ways; for example, fibres are more vulnerable to light, and can weaken and change colour.

Cotton

Origin
Cotton fibres come from the seed heads or bolls of the cotton plant (genus *Gossypium*), a member of the Malvaceae or mallow family. The quality of cotton depends on the variety and the climatic conditions under which it is grown.

Physical characteristics
Cotton fibres are almost pure cellulose and are between 1 and 6 cm long. A cotton fibre consists of an outer cuticle, a primary and secondary wall (the bulk of the fibre), and a central core or lumen (Figure 1). Mature cotton fibres have thick walls and a small, discontinuous lumen. Mercerization (a process using caustic soda and tension) causes the fibre to swell, straighten, and become more cylindrical, thus promoting lustre, dyeability, and increased strength.

Flax

Origin
Flax is a fibre obtained from the stem of the plant *Linum usitatissimum*. A considerable amount of processing is required to extract the useful fibre from the rest of the stem. After it is processed into threads and fabrics, it is called linen. The quality of flax depends on the growing conditions, the age of the plant, and fibre processing.

Physical characteristics
Though high in cellulose content, flax is not as pure a fibre as cotton and contains lignin, pectin, fat, and wax. Its fibre length can reach over 30 cm. The main parts of a flax fibre are the outer layer, fibre bundles or fibrils (the bulk of the fibre), and a central lumen (Figure 2).
Table 1. Properties of undegraded cellulose fibres

<table>
<thead>
<tr>
<th>Strength</th>
<th>Absorbency</th>
<th>Elasticity</th>
<th>Fabric handle</th>
<th>Resistance to acids and bases</th>
<th>Resistance to light</th>
<th>Resistance to mould and bacteria</th>
<th>Resistance to insects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton fibres</td>
<td>• strong</td>
<td>• good absorbency</td>
<td>• fairly inelastic</td>
<td>• conducts heat so feels cool to the touch</td>
<td>• weak acids damage cotton and flax</td>
<td>• will turn yellow when exposed to sunlight, and more severe degradation will occur with prolonged exposure; this process can be accentuated by heat, moisture, and certain dyes</td>
<td>• the larvae of clothes moths and carpet beetles will not attack clean cellulose fibres, but dirt on textiles serves as a food source for most insects, and can result in damage</td>
</tr>
<tr>
<td></td>
<td>• stronger when wet</td>
<td></td>
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</tr>
<tr>
<td>Flax fibres</td>
<td>• very strong</td>
<td>• very good absorbency</td>
<td>• poor elasticity</td>
<td>• absorbed moisture evaporates quickly</td>
<td>• good resistance to light, but degradation will occur with prolonged exposure</td>
<td></td>
<td>• silverfish will eat cotton and flax if the fabric is starched</td>
</tr>
<tr>
<td></td>
<td>• stronger when wet</td>
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</table>

Other causes of cellulose deterioration

- Wetting and slow drying of cellulosic textiles will cause a characteristic brown line staining, which is an area of weakness.
- Cotton and linen textiles tend to retain creases and folds. These areas may become brittle with time, requiring care in handling and storage.
- Manufacturing and finishing processes such as bleaching and dyeing may weaken cotton and linen fabrics.

Protein Fibres

Protein fibres are animal in origin. These multicellular fibres are obtained from coats of mammals or are secreted by larvae of insects such as the silkworm. Hair from indigenous species of animals has been used worldwide to make textiles and garments. It can be spun into yarn, or converted directly into a non-woven textile by felting. There are many varieties of protein fibres. Silk and sheep’s wool are the most common animal fibres in most parts of the world. Table 2 lists some of the properties of undegraded protein fibres. However, these properties are altered by ageing and deterioration.

Silk

**Origin**

Silk is a continuous protein filament produced by the silkworm when forming its cocoon. The principal species is *Bombyx mori* (cultivated silk). Tussah silk (produced by *Antheraea mylitta* and *Antheraea pernyi* moths) is darker in colour and is sometimes referred to as uncultivated or wild silk.

**Physical characteristics**

Silk fibres can be more than 2 km long. Unprocessed silk consists of two fibres of the protein “fibrin” held together with a soluble silk gum called “sericin”. Sericin accounts for 10–20% of the weight of silk. Once the sericin is removed, silk separates into two filaments (Figure 3).

Figure 3. a, Silk fibre, longitudinal view; b, cross section of silk fibre.
Wool

Origin
Wool is a protein fibre forming the protective coat of sheep. There are over 200 grades of sheep that produce varying qualities of wool. Merino is the finest quality of wool.

The fleece from some other animals is also used, e.g. the Angora goat (mohair), the Cashmere goat, the Angora rabbit, and members of the Camelidae family (alpaca, llama, vicuna, and camel).

Physical characteristics
Wool fibres are sorted into various lengths for processing. Typically wool fibres are between 4 and 15 cm long, but can be as long as 38 cm. Sheep’s wool consists mostly of keratinous proteins; all mammalian hair and wool fibres are similar in this respect. A wool fibre consists of a cuticle or outer layer that includes scales characteristic of the wool fibre; a cortex, which is the bulk of the fibre substance; and a medulla, the hollow central canal that may be lacking in very fine and immature fibres (Figure 4). The outer scales are important for fibre identification, and for making felt, a non-woven fabric. Often the scale pattern is altered or destroyed in very degraded fibres.

Other causes of protein fibre deterioration

- Deterioration of silk is accelerated by heat and moisture. When wool fibres are subjected to heat, moisture, and friction, the overlapping scales will interlock and cause irreversible matting and shrinkage (i.e. felting). Felting is considered to be a form of damage to wool fabrics if it occurs accidentally.
- Weighted silk is treated with metallic salts such as tin chloride. This process is used to compensate for...
for the weight lost when sericin gum is removed before dyeing, and to give added body to the fabric. Weighted silk is more vulnerable to accelerated deterioration from light and air pollutants than unweighted silk. Similar deterioration can occur when silk is mordanted with metallic salts in the dyeing process.

- Both wool and silk are particularly vulnerable to damage by chlorine.

Bibliography


