

CHEMICAL NATURE OF SILK and PROPERTIES OF SILK

Silk is a natural protein fibre secreted from the silk gland of silkworm to make their cocoon. These are commercially very important because human being use these fibres to make thread and fabric. The chemical composition as well as its properties has been reported by different workers.

Chemical composition/ Chemical nature of silk-

Silk is mainly composed of two important proteins- Fibroin and Sericin. The ratio of the two proteins slightly differs in different silk types. The compositions of the two proteins are-

Fibroin-(C₃₀H₄₆N₁₀O₁₂). It is yellow coloured fibrous protein. It is an insoluble protein forming the core of the silk thread. It is composed of two polypeptide chain –one heavy H-chain (MW. 350KD) and one light L-chain (MW.25KD). Its primary structure consist of repeated amino acid sequence (Gly-Ser-Gly-Ala-Gly-Ala)_n. The high Glycine content allows for tight packing and provides rigidity and tensile strength to the silk.

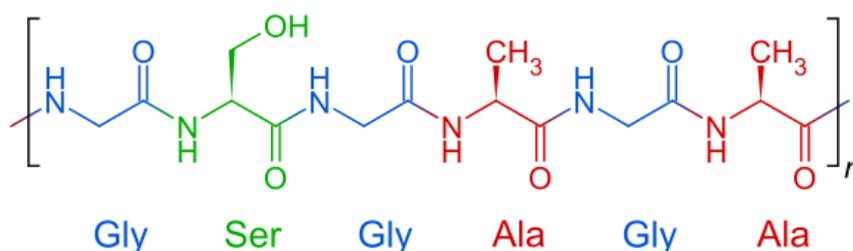


Fig- Structure of Fibroin

Sericin-(C₃₀H₄₀N₁₀D₁₆) – It is a gelatinous protein present in the outer covering of the silk fibre over the fibroin core. Sericin is composed of 18 different amino acids, of which 32% is serine. There are four types of sericin- Sericine –I.II.III.and IV. Sericin I, which is insoluble in water and contains approximately 17% nitrogen, along with amino acids such as serine, threonine, aspartic acid, and glycine. Sericine II contain tryptophan in addition to others and sericine –III contain Proline in addition to other amino acids. The basic sericine structure is



Fig- Structure of Sericine.

Apart from the fibroin and sericine silk also contain waxy material, carbohydrate, mineral and colouring substance. The golden silk contains xanthophylls, Yellow silk contain carotene and vialoxanthin, green silk has bombycin and bombycetin pigment.

	Mulberry silk	Tassar silk	Muga silk	Eri silk
Fibroin	70- 80 %	80- 90 %	80- 90 %	80- 90 %
Sericin	20-30 %	8- 10 %	8- 10 %	4-5%
Others	2-3 %	3-5%	3-5%	3-5%

Table- Percentage of proteins present in different silk.

Physical property of silk-

- i) Specific gravity- The specific gravity of silk is 1.25, which is less than cotton and wool or rayon fibre.
- ii) Density- The density of silk is less than cotton. The density of Raw and boiled silk is 1.33gm/cc and 1.25/cc respectively. (Density of cotton fibre is 1.54-1.56 g/cm³)
- iii) Tenacity- Silk is one of the strongest natural textile fibres. It is because of its linear polymers and crystalline nature. The tenacity of raw silk is 4.5-4.8gm/ denier and that of degummed silk is 3.3gm/denier. Fibres can be stretched from 15-20%.
- iv) Elasticity- Silk is considered to be not more elastic in nature. Because of crystalline nature, the silk polymer cannot withstand much stretching. Stretching may ruptures a significant number of hydrogen bonds. Therefore, after stretching the polymers do not return to their original position, rather there will be development of distortion and wrinkles in the silk material.
- v) Hydrosopic nature- The hydrosopic nature of silk is less than wool but more than cotton. In case of raw silk water regaining is 11%, where as in degum silk it is 9%.
- vi) Electrical property- Silk is poor conductor of electricity, but it can accumulate static charge by friction. It causes difficulties during processing in dry environment.

Chemical properties-

- i) Thermal properties- Being the silk contain fibrous protein, it can withstand higher temperature. Still, it is sensitive to heat due to lack of any covalent cross links in the polymer system.

- ii) Effect of sunlight- When exposed to UV ray of sun light, it causes the breakage of peptide bonds which causes polymer denaturation in the surface fibres.
- iii) Action with acid and alkali-Both strong acid and strong alkali destroy the natural property of silk. Strong acid leads to denaturation of protein, whereas dilute acid increases the lustre of silk. Mild nitric acid imparts yellow colour to the fibres.
- iv) Action with metallic salts- At the time of mordanting silk fibre can absorb some salt like stannic chloride, resulting in weight gain. Fibres are very much sensitive to oxidising agents. Salt like zinc chloride and sodium causes damage to silk by dissolving and tendering.