

Visualization of Helical Structure of Cotton Cell-Hairs

Adkham Paiziev and Viktor Krakhmalev

Arifov Institute of Electronics, Academy of Sciences of the Republic of Uzbekistan, F.Khodjaeva str.33, Tashkent 100125, Uzbekistan

It is known that microfibrils of cellulose are deposited on a surface of hair's plasmalemma. As a result of cellulose biosynthesis, a plasmalemma of a cell begins to rotate, involving the microfibrils into the process of continuous lengthening of hair apex (Fig.1). The addition of rotary and translational motions inside a hair forms the spiral structure of deposited layers of cellular wall. As the primary wall of cotton hairs is rather thin (slightly less than 0.1 mkm), then the fibrillar beams of secondary wall, which have significant diameter (about 0.2-0.3 mkm), are displayed on a surface of hairs as the folds. The structural fragment of secondary wall demonstrates the distribution of crystalline and amorphous parts along microfibrillar beams. As a result of chemical treatment the amorphous parts of microfibrils are removed, and the crystalline parts are visible as fine spherical particles having nanodimensions. It is clearly seen, that the crystalline parts of microfibrils are located along the line of microfibril packing and have the dimensions from 150 to 250 nm.

Spiral structures of cotton hairs are well revealed in result of chemical processing. The spiral structures can be placed as in surface layers of the hairs, and they can occupy all the thickness of cellular wall. As cotton cell-hair performs spiral rotation on its axis during its growth (Fig.1) after drying it takes corkscrew-like form. These structures consist of separate fibrillar beams of cellulose with the diameters of 1.5-2.0 mkm. Depending on the features of growth, cotton sort, the spiral structures can take the form of very close packed spirals, which are slightly separated from each other, but grouped in the wisps, and also they can be as ribbons-spirals. Finally, the cytoplasmic membrane-plasmalemma of a hair has the ribbon-like, spirally twisted structure (Fig.1).

Thus, the submitted material shows, that the longitudinal cotton hairs are classical example of the biological objects with clearly expressed spiral architecture. High-molecular polysaccharides, linear -1, 4- glucan ($C_6H_{10}O_5$)_n serves as building material. For cellulose of cotton hairs the degree of primary cellular wall polymerization is 2-6 thousand, for secondary cellular wall it is 13-14 thousand. The structure of single cellulose filament-microfibril is believed to include 60-70 molecular chains of cellulose. The microfibrils form larger submolecular formations with characteristic dimensions of the order of 0.2 mkm. The fibrillar beams with the cross sections of 0.1 mkm² are most numerous and typical. We have calculated, that cotton fibril consists on the average of 2300 cellulose beams which form strong spiral structure along all length of a cell (Krakhmalev, Paiziev 2006).

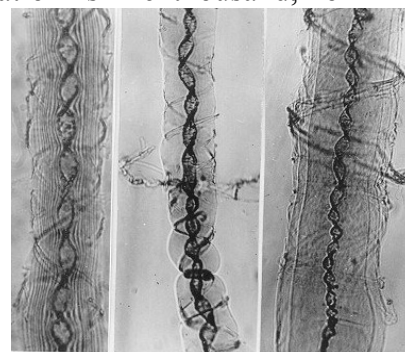


Fig.1. Spiral structure of cotton

Reference

- [1] Krakhmalev V., Paiziev A. 2006. Spiral Structure of Cotton Fibers. *J.Cellulose*, cell 13/1, 45-52.