

Influence of wool fiber structure on sensory perception and sensation

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ABSTRACT

Wool is a natural fiber with a three-layered structure (i.e., epidermis, cortex, and medulla) composed mainly of keratin. The scales on the surfaces of the fibers provide water repellency and felting properties, while the double-layered interior "cortex" creates crimping of the wool fiber that provides excellent elasticity and moisture absorption properties. However, a prickly sensation is caused by thicker wool fibers ($>30\ \mu\text{m}$) when they pierce the skin. In addition, the scales themselves may cause skin irritation. Despite its excellent moisture absorption properties, wool is not used for undergarments but instead for outerwear (e.g., sweaters) owing to its unpleasant prickly feel. In this study, we treated wool fabrics to reduce their prickliness and compared their properties with those of untreated wool when used as undergarments. To reduce the prickliness of the wool fabric, we used thinner wool fibers and applied a prickliness-reducing chemical treatment. Standard ($19.5\ \mu\text{m}$) and thin ($17.5\ \mu\text{m}$) wool fibers were compared, and both treated and untreated fibers were used to experimental sample fabrics. The mechanical properties of the sample fabrics were examined using the KES method. Comfort during wearing has traditionally been evaluated using human touch. However, the tactile sensation of clothing touching a person's skin can also be evaluated using their brain activity owing to changes in oxyhemoglobin (Oxy-Hb), which is present in the cerebral blood flow. The experimental participants in this study were 10 healthy women in their 20s. Their brain activities were analyzed using near-infrared spectroscopic brain imaging, which measured cerebral blood flow at five locations around the frontal and temporal lobes. When the participants wore the wool fabrics, their cerebral blood flow increased as the degree of prickliness increased. The participants' Oxy-Hb levels increased in the following order: $17.5\ \mu\text{m}$ treated wool $<$ $19.5\ \mu\text{m}$ treated wool $<$ $17.5\ \mu\text{m}$ untreated wool $<$ $19.5\ \mu\text{m}$ untreated wool. The samples with thinner fibers and those treated to suppress prickliness also had lower bending and shear stiffnesses, which resulted in less prickliness. These results suggest that cerebral blood flow could be a new indicator for evaluating prickliness sensations. Furthermore, it is expected that thinner wool fibers and chemical processing could lead to the development of comfortable underwear.