Analysis of the Status of Skin-Friendly Textiles

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Abstract. In order to help consumers properly understand skin-friendly textiles, the research status of skin-friendly textile products was summarized. This paper expounded the skin-friendly textiles from the aspects of material, finishing, and analyzed the characteristics of skin-friendly textiles. It is pointed out that skin-friendly textiles perform well in terms of breathability, anti-static properties, moisture absorption, quick-drying, human safety and tactile feel. In addition, the five performance indexes are summarized and analyzed in order to provide reference for the objective evaluation of skin-friendly textiles. Finally, skin-friendly textiles are proposed as one of the trends in functional textile products.

1. Introduction
With the increasing demand for health and quality of life, people have higher and higher requirements for clothing. Stakeholders such as manufacturers and retailers are taking advantage of this situation to introduce many new products to meet consumer demand. In the slogan, "skin-friendly textiles" are described as skin-like fabric products that are more comfortable, more natural and give people a sense of closeness. In particular, category A textiles in the GB 18401-2010 " National general safety technical code for textile products ", such as infant clothing, underwear, etc., businesses often use the concept of "skin-friendly" to promote sales. However, there is no clear and uniform concept of "skin-friendly textiles" at home and abroad, nor are there any relevant evaluation standards or certification methods. For this reason, a generalized study can help consumers to understand these textile products correctly.

Although the concept of skin-friendly textiles is subjective, it is also an objective feature of fabrics, just like the concepts of stiffness, smoothness, and fullness. This paper introduces the current status of research on skin-friendly textiles and describes the characteristics that should be possessed by skin-friendly textiles, which will serve as a reference for future research on quantitative evaluation of skin-friendly textiles.

2. Status of Skin-Friendly Textiles
At the present stage, the study of skin-friendly textiles is mainly based on cotton fibers or regenerated cellulose fibers as a substrate for weaving, finishing, in order to obtain good skin-friendly performance of textile products. However, there is not yet an evaluation system and certification method for skin-friendly textiles. Some researchers [1] proposed a preliminary concept of skin-friendly textiles. Skin-friendly textiles that are comfortable to the touch, breathable and moisturizing, and have specific requirements in terms of materials and processing technology. And they summarized the general...
classification of skin-friendly fabrics from the aspects of material and finishing. This paper expounded the skin-friendly textiles from the aspects of material and finishing.

2.1. Application of new fiber

There was study [2] showed that the Lotus® protein fiber had good moisture absorption and UV performance; and the fabric was rich in amino acid molecules, which could emit negative oxygen ions, with moisture nourishment, and be skin-friendly. Some researchers used optoelectronic functional skin-friendly fibers blended with cotton and modal to develop skin-friendly knitted underwear products [3]. The products' skin friendliness was tested in terms of moisture permeability, warmth preservation rate and air permeability, and the test results showed that the underwear products all meet the requirements of ecological textile standard and the performance reached the international advanced level. Some researchers [4] developed a warm skin care knitted underwear fabric by interweaving Viloft, cotton blended yarn with moisture-conducting and quick-drying fibers. Some studies [5] used a pearl blended regenerated cellulose fiber and Coolmax to improve the skin-friendliness, moisture absorption, and comfort of sportswear while maintaining the original moisture-wicking function, and at the same time adding UV protection, far-infrared emission and other skin care functions. There were researchers [6] studied the preparation and properties of collagen-modified cotton fabrics, which were skin-friendly, moisturizing and emollient, and anti-allergic.

In summary, the application of new fibers in skin-friendly textiles focuses on new natural fibers and regenerated cellulose fibers, and is attention to breathability and air permeability of the product.

2.2. Skin-friendly finishing

There were studies using cotton fabric as a substrate, with PFOTES coated titanium dioxide particles pretreated to give it superhydrophobic; then modified by plasma treatment technology to create a porous gradient of wetting channels in the hydrophobic layer, as a "sweat gland", in order to achieve "skin-like" (see Figure 1). It is said that the inner layer of the fabric can be directed to wick away perspiration, the outer layer can repel water, with excellent breathability [7]. Moreover, there are studies using natural dyes from grape skins to dye cocoon silk fabrics [8], or using natural pomegranate skin extracts to dye wool fabrics [9], or using licorice extracts to perform antibacterial finishing on fabrics [10] and so on.

![Figure 1. A skin-like fabric with both directional water transport and water repellency](image)

This indicates that the research direction of skin-friendly finishing is twofold: one is to give skin-like properties to the finished fabric, and the other is to use natural dyes to perform functional
finishing on the fabric. At the same time, the skin-friendly nature of the product is characterized in the literature mostly in terms of breathability, moisture absorption and other indicators.

3. Evaluation methods for skin-friendly textiles

Although there is no evaluation method for skin-friendly textiles, we can know from comprehensive literature analysis that skin-friendly textiles should have good breathability, moisture absorption and quick drying, comfort, anti-static and human safety performance, see Figure 2.

![Figure 2. Characteristics of skin-friendly textiles](image)

3.1. Human safety

As can be seen from the above, in order to obtain good skin-friendly performance, new fibers or new finishing agents and finishing process would be used to fabric finishing. However, the effect of new materials or new processes on the human body is often unknown, so human toxicity, skin sensitization, etc. should be the primary assessment items [11,12].

3.2. Antistatic properties

The hazards of electrostatic discharge have been widely recognized [13,14], such as causing human heart disease, causing an explosion. As we all know, the fabric in the wearing process due to friction, extrusion and other physical effects, will accumulate charge on the surface of the fabric, generate static electricity and will produce discharge phenomenon, to stimulate the human skin to produce a sense of electric shock, causing human discomfort. Therefore, the anti-static properties of skin-friendly textiles should be excellent.

3.3. Breathability

Analysis of the literature shows that breathability has a significant impact on the skin-friendly properties of fabrics. The breathability of the fabric refers to the ability of gas molecules to pass through the fabric under the condition that there is a certain pressure difference between the two sides of the fabric. Good breathability allows the heat and moisture generated by the human body to circulate rapidly through the fabric and the external environment, so that the fabric obtains good heat and moisture transfer performance [15-16]. The heat and moisture transfer performance of the fabric directly affects the feeling of the fabric, which is expressed as cold and wet feeling, hot and sultry feeling, etc., as shown in Figure 3 [17]. Skin-friendly textiles should have good breathability.
3.4. Quick-drying and moisture absorption

Quick-drying and moisture absorption performance of the fabric not only affects the stickiness of the fabric to the human body \cite{18}, wet and cold feeling \cite{19,20}, but also affects the friction performance between the fabric and the skin. Some research shows that fabric moisture absorption is positively correlated with the influence of dynamic friction between the fabric and skin \cite{21}, which means that the fabric in the wearing process, such as not well the sweat discharged and keep dry, the human body would produce such as wet and cold feeling, itchy feeling and other discomfort feeling. Skin-friendly textiles should have good moisture absorption and quick-drying properties to avoid the discomfort of the human body during the wearing process.

3.5. Fabric touch

Fabric touch related indicators is the most direct feeling of the human body to the fabric, is also an important indicator to evaluate the skin-friendly textiles. The contact between skin and fabric will produce various sensations, such as itching, roughness and so on. The objective evaluation of tactile indicators is generally referred to the principles of fabric style testing. Some authors \cite{22} have used the KES-FB style instrument to describe the contact comfort of intimate apparel by selecting 16 mechanical parameters of a specimen. In addition, the evaluation of fabric touch using the Fabric Touch Tester (FTT) has been recognized by scholars \cite{23,24}.

The FTT measures simultaneously 15 fabric indices related to four categories of fabric physical properties, namely bending, compression, thermal, and surface properties. These fabric indices are subsequently used by the FTT software to predict three primary comfort indices (i.e. smoothness, softness, warmth) and total passive touch feel. The primary comfort indices are calculated based on statistical models developed by the FTT manufacturer SDL Atlas after correlating the fabric indices with the comfort indices assessed by a hand panel. Tactile characteristics of skin-friendly textiles could be measured with FTT.

4. Conclusions

The research and development of skin-friendly textiles meet the needs of people pursuing a comfortable and healthy life, which is one of the trends of functional textile products. By analysing the characteristics of skin-friendly textiles, it is possible to objectively evaluate the quality of skin-friendly textiles to a certain extent and provide assistance to those who require them. Furthermore, the establishment of evaluation systems and certification of skin-friendly textiles could standardize the market behaviour of manufacturers and other interested parties, enhance industrial efficiency, and protect the rights and interests of consumers. It is believed that as research continues, product standards about skin-friendly textiles will be promulgated in the future.

Figure 3. Physiological curve of temperature and humidity of human skin surface
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