Application of New Waterproof Quick-drying Sports Green Material in Clothing Design

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Abstract. In order to provide a theoretical basis for the study of moisture-absorbing and quick-drying clothing, this paper selects 6 kinds of knitted fabrics (6 types of moisture-absorbing and quick-drying fabrics, 1 type of pure cotton fabrics and 1 type of pure polyester fabrics) and makes them into garments for comparison. A liquid water dynamic transfer performance tester (MMT) and a moisture permeable cup were used to evaluate the wet transfer performance of the samples. The sweat dummy and subjective evaluation methods were used to study the thermal and wet comfort of the clothing samples. This paper studies the application of green materials for waterproof and quick-drying sports in apparel design.

1. Introduction
In recent years, with the improvement of people's living standards, moisture-absorbing and quick-drying clothing has gradually attracted people's attention and recognition, and has the functions of moisture absorption, ventilation, and perspiration during the wearing process. Especially in sports brands, it is more commonly used. Many international clothing brands such as Prada, Armani, BMW, HugoBoss, Escada, RalphLauren, Polo, etc. have successfully applied moisture-absorbing and fast-drying functional fabrics to their own clothing designs [1]. Due to the socio-economic development, consumers' functional requirements for fabrics have increased, and research on moisture-absorbing and quick-drying fabrics is still ongoing. Researchers at the Institute of Military Equipment Research proposed the evaluation index of the fabric's heat and moisture transfer performance under human sweating, which provided a basis for comprehensive evaluation of the fabric's heat and moisture transfer performance [2]. ChenYaping et al. [3] selected two kinds of fibers, analyzed the three influencing factors based on orthogonal experiments, and used the gray approximate optimal comprehensive evaluation method to obtain the fabric with the best comprehensive performance. When French scholars developed new dentist's work clothes, they used infrared cameras to record and determine the spraying areas of saliva, water, and debris in the laboratory, and chose to configure different functional fabrics in these areas [4]. The development of fabric evaluation indicators, comprehensive evaluation of fabric performance, and fabric functionality play an important role in apparel design.

At present, researches on moisture absorption and quick-drying fabrics at home and abroad are mainly focused on the field of fiber development, or evaluation research on unidirectional performance indicators of fabrics, and relatively few studies on evaluation of fabrics' comprehensive moisture absorption and quick-drying properties. In the market, moisture-absorbing and quick-drying
fiber materials are used to achieve the functionality of fabrics. Common fiber materials include COOLMAX and polypropylene. Some manufacturers also use fabric finishing to achieve moisture-absorbing and quick-drying functions. In terms of fabric development, the research on knitted and woven moisture-absorbing and quick-drying fabrics has achieved results. These fabrics mainly achieve their moisture-absorbing and fast-drying needs through the combination of yarn raw materials, yarn combination methods, and textile technology [5]. Generally, the evaluation of moisture absorption and quick-drying performance of textiles includes two aspects of hygroscopicity and quick-drying. Hygroscopicity includes water absorption, dripping time, and wicking height; quick-drying characteristics include evaporation rate and moisture permeability. Breathability is also an important factor that cannot be ignored in absorbent and quick-drying clothing. Based on this, this paper analyzes and evaluates the six major properties of fabrics, based on the analysis of individual evaluation indicators of moisture-absorbing and quick-drying fabrics, and adopts a fuzzy comprehensive evaluation method to optimize the moisture-absorbing and quick-drying fabrics with better comprehensive performance for moisture-absorbing and quick-drying clothing. Provide the basis for design and development.

2. Experimental materials and methods

2.1. Experimental fabric

In order to comprehensively evaluate the wearing comfort of moisture-absorbing and quick-drying fabrics, this paper selects six knitted fabrics with different fiber components and different tissue structures. The fabric parameters are shown in Table 1.

| Number | Fabric weave | Detailed | Gram weight (g/m²) |
|--------|--------------|----------|--------------------|
| 1      | Double-sided mesh | 8.33 tex / 72 F Cool ever70% + 8.33 tex / 36 F Cool dry 30% | 183 |
| 2      | Double-sided pad | 11 tex / 36 F PET 57% + 11 tex / 48 F Cool dry 43% | 216 |
| 3      | Double-sided cotton cover | 10 tex / 78% + 8.33 tex / 72 F Cool dry 22% | 158 |
| 4      | Double-sided mesh | 53% PET + 47% Cool dry | 168 |
| 5      | Single-sided mesh | 100% Cotton 23 tex | 180 |
| 6      | Polyester single-sided weft flat needle | 100% PET15 tex | 110 |

In order to exclude the influence of factors such as styles and specifications on the experimental results, the experimental clothing in this article uses the experimental fabrics in Table 1 to cut the front zipper long-sleeved T-shirts with the same style and specifications by professionals. One piece of each type of experimental clothing is made, a total of 6 pieces. During the experiment, the subjects wore experimental clothing on the top, full polyester sports trousers for the experiment, and mid-leg cotton sports socks on their feet. Control the environmental conditions of the artificial climate bin: temperature (21 ± 3) °C, humidity (65 ± 10) %.

2.2. Test method

According to the national standard GB / T21655.1-2008 "Assessment of moisture absorption and quick-drying of textiles-Part 1 of a single combination test method" and GB / T5453-1997 "Determination of the permeability of textile fabrics", the fabric dripping area test was performed. Moisture permeability test, water absorption test, wicking height test, evaporation test, air permeability test. The fabric dripping diffusion area experimental test instrument uses a burette and a scale; the
moisture permeability test instrument is a SDZF-60 vacuum drying box, a balance, and a moisture permeability cup; the water absorption rate experimental test instrument uses a balance, a sample suspension device, and a water tank; a fabric core Suction height test instrument adopts sample suspension device, scale, timer; evaporation rate test instrument is balance, burette, timer, sample suspension device; fabric permeability test instrument uses YG461E-III automatic breather. All tested samples could stand for 24 hours in a standard environment. Test conditions: temperature (25 ± 2) °C, humidity 65.0% ± 5.0%, wind speed 1.00m / s.

3. Results

3.1. Objective evaluation of thermal and wet comfort of moisture-absorbing and quick-drying clothing

The subjects wearing 4 # clothing during the exercise recorded the temperature of the back-clothing surface significantly higher than that of 2 # clothing. From the subjective evaluation of the subject's thermal sensation throughout the experimental period, it can be seen that the sultry feeling of 4 # clothing is much better than that of 2 # clothing, mainly because the proportion of moisture-absorbing and quick-drying fibers contained in 4 # clothing is in the measured clothing. The highest, in addition, its tissue structure is a honeycomb cloth with a larger mesh, so heat is released faster, so the clothing surface temperature is higher. During the entire experimental period, the feeling of sweltering changes greatly, and the subjective feeling of the subject is the most uncomfortable. Although 2 # clothing also contains a high proportion of moisture-absorbing and quick-drying fibers, it is relatively heavy and has a tight structure, which results in poor ventilation and heat dissipation performance, and the surface temperature of the clothing is relatively low. Therefore, the temperature of the surface of the back of the 4 # clothing is higher than that of the surface of the 2 # clothing.

When sitting and resting for 15 minutes after exercise, 4 # clothing contains higher liquid sweat than 2 #. It can also be seen from the MMT test results that the maximum wetting radius, liquid water diffusion speed, and one-way transmission index of the upper and lower surfaces of 4 # fabric And the dynamic index of liquid water is better than 2 # fabric, especially the one-way transmission capacity is far better than 2 # fabric, which shows that 4 # is better at absorbing and transmitting liquid sweat than 2 # fabric. Reflected in the clothing made from it, subjective evaluation results show that wearing 4 # clothing has the fastest increase in wetness and the most significant wetness during heavy exercise. During the rest period after exercise, 4 # Clothing ratio 2 # Absorbs more liquid sweat. It can also be seen from the image taken by the infrared camera that when sitting and resting after exercise, 4 # clothing has a better ability to absorb liquid sweat than 2 # clothing. As shown in Figure 1.
3.2. Objective evaluation of comfort

Through the analysis of the test results of the sample, it can be seen that among the 8 fabrics tested, fabric 1 # and 4 # have good liquid water dynamic transmission ability and unidirectional transmission ability, and the performance is that sweat can easily and quickly pass from the fabric The side that is close to the skin is passed to the other side, keeping the skin dry. In addition, these two fabrics also have a fast diffusion speed on the upper and lower surfaces and a large wetting radius, which is manifested in the fact that sweat can quickly diffuse and dry on the upper and lower surfaces. The reason why the 1 # and 4 # fabrics have good liquid water dynamic transmission capacity and unidirectional transmission capacity is because these two fabrics contain relatively high moisture-absorbing and fast-drying fibers, such as Cool dry, and the square weight is relatively small. 5 # and 6 # are polyester fabrics that have been hydrophilically treated. They also have good liquid water dynamic transmission capacity, one-way transmission capacity, and large liquid water diffusion speeds on the upper and lower surfaces. All 10 indicators of the MMT test are good. This is mainly because after the fabric is subjected to hydrophilic treatment, on the one hand, the surface energy of the fabric increases, which enhances the adsorption of water molecules, and on the other hand, hydrophilic groups are added to improve the capillary water absorption effect, so 7 # and 8 # fabrics It has better liquid water dynamic transfer performance, which indicates that the surface properties of the fabric have a greater impact on the liquid water dynamic transfer performance in the fabric, as shown in picture 2.

4. Correlation between comfort and actual conditions of different types of clothes

4.1. Correlation between wet resistance and subjective evaluation results of wet sensation

An important factor affecting the comfort of clothing is the resistance of clothing to moisture permeability. Before the human body sweats, the water vapor emitted by the human body is transferred in a way that does not show sweat (latent heat). In the state of vigorous exercise, once the heat dissipation of the human body cannot be balanced with the heat output of the human body, the human body must radiate heat in the form of sweat. A very important factor that affects the evaporation and heat dissipation is the wet resistance of clothing. From the test results of the sweating dummy, the moisture resistance and moisture permeability are basically negatively correlated, that is, the greater the clothing moisture resistance, the smaller the moisture permeability of the clothing, and the moisture permeability and moisture resistance are both clothing comfort. Wet transfer indicator.
The smaller the moisture resistance and the greater the amount of moisture permeability, the better the moisture permeability and quick-drying performance of the garment, and the less subjective the evaluation of the wet sensation is. The larger the amount of moisture, the more obvious the subjective evaluation of the wet sensation. Professor Hollis, a well-known expert in clothing comfort, found in research that at room temperature 35 °C, the moisture content of the fabric inner layer has a significant correlation with subjective comfort. When the moisture content of the garment inner layer reaches 4%, the human body is obvious discomfort, and at this time the moisture content is not enough to cause capillary wicking of the fabric, so he believes that the transmission of water vapor to the fabric is an important factor affecting the thermal comfort of the fabric.

In the experiment, the Pd3 and pd4 stages belong to the meditation and rest stage of the subject after heavy exercise, especially during the pd3 stage, due to the vigorous exercise of the human body, the human skin is still sweating continuously, and a large amount of liquid sweat is present on the skin. At the pd2 stage, due to the large amount of human body movement and the human body sweating a lot, in this experiment, the clothes we selected have hygroscopic and quick-drying properties and good hygroscopic properties. After the clothes contact the human body, the clothes are soaked. It can be seen from the subjective evaluation results of the wet sensation that the clothing is soaked by liquid sweat, and this phenomenon still exists and is more serious at the pd3 stage. During the meditation and rest phase after exercise, the sweat on the skin surface is mainly transmitted to the surface of the garment through wicking in a liquid manner, and evaporates on the surface of the garment to reach the air, so the comfort of the garment will be reduced. Mainly because, due to the large amount of liquid sweat in clothing, the moisture content of clothing increases. When the wet clothing surface contacts the skin, it is perceived by the skin's sensory nerves, which causes a greater decrease in human skin temperature, and the more obvious the subjective wet feeling is. In addition, after moisture fills the voids in the fabric, the static air is no longer stored in the voids, which significantly reduces the thermal insulation capacity of the fabric. In addition, the thermal conductivity of the water-containing fabrics increases, and the thermal insulation capacity decreases, making people feel that the clothes feel wet and cold.

4.2. Correlation between thermal resistance and sweating subjective evaluation results
Sweating dummy test and subjective test subjects differed in motion and posture. Different postures, even if it is the same clothing, the thermal resistance will change. Usually, the thermal resistance of the clothing is measured by standing position. The basic thermal resistance of the clothing is reduced by about 15% when sitting. Figure 3 shows the change in the thermal resistance of the basic dress when sitting in two positions with different skirts. It is because the clearance of the clothes is reduced in the sitting position, the air layer under the clothes is reduced, and the total thermal resistance is reduced, but the thermal resistance of the air layer is nude when naked. It will increase, and the result of the comprehensive effect is still the thermal resistance of the basic dress, which decreases [6]. There is also a difference in the amount of heat generated during quiet periods and during activities. Therefore, clothing that feels comfortable during quiet periods will feel uncomfortable during activities. When you continue to exercise vigorously, you still feel hot and even sweat. According to research, if you wear 2.7clo clothing at a quiet time, if you walk at 3.6km/h, the Kro value of the clothing you wear can be reduced to 1.6clo. If running at a speed of 9.7km/h, the clothing can be reduced to 1.2clo. The sweating dummy used a static standing posture in the sweating dummy test. In the subjective test, the subject took a dynamic exercise on the treadmill with a large amount of exercise. As shown in Figure 3.
5. Conclusion
In this paper, the subjective evaluation of thermal and wet comfort of a moisture-absorbing and quick-drying garment under a large amount of exercise is performed. The results showed that during the exercise, the subjects did not have much difference in the wet sensation of different garments, and during the rest period after exercise, the subjects had a significant evaluation of the wet sensation of the absorbent and quick-drying clothing, pure polyester and cotton clothing. The difference is that the moisture-absorbing and quick-drying fibers have significant advantages in terms of moisture transmission. In terms of evaluation of heat, stuffiness and stickiness, the exercise stage and the stationary stage after exercise have significant differences in the evaluation of different garments by the subjects. There are obvious advantages in the evaluation of hot, stuffy and sticky feeling of dry clothing. After 15 minutes of resting after exercise, except for the poor evaluation of the tacky feeling of the fabrics with a high proportion of cotton fibers, the subjects did not have significant differences in the evaluation of the heat and stuffiness of these experimental garments.

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