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Application of Activated Carbon Fiber in Functional Clothing

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The development and health performance of multi-functional activated carbon fiber materials are mainly studied. Based on the special biological effects of functional health fiber materials, the product is designed. From the pathogenesis of female breast lobular hyperplasia and Chinese medicine therapy, multifunctional activated carbon fiber material is used to develop a health care bra, which has the function of preventing and treating breast lobular hyperplasia. Its health performance is evaluated. The design and development of functional health bra and the verification of its health effect are the focus of this research.

1. Introduction

Functional fibers have been developed in the last two or three decades (Kebede et al., 2017; Boulaoued et al., 2016; Li et al., 2017; Olofin and Liu, 2016). Its development is a symbol of modern fiber science progress. Functional fiber is a general term for a large class of fibers, which has the functions of adsorption, separation and biodegradation (Liang, et al., 2013). There are 21 kinds of functional fiber varieties: hollow fiber separation membrane, activated carbon fiber, ion exchange fiber, anion fiber, superabsorbent fiber, far infrared heat storage fiber, forest bath fiber, antibacterial deodorizing fiber and nanofiber (Li et al., 2017). The development of functional fiber is the technological innovation of the traditional textile industry, which creates favorable conditions for the transformation of high-tech industry, and contributes to the improvement of living standards (Ma et al., 2016).

Bra is a kind of underwear, and it is a necessity of modern women. Its basic function is to gather the breast, prevent the dairy drooping, and protect the nipple from scratches and so on. With the change of people's consumption concept and the development of textile technology, women's pursuit of bra is no longer limited to its basic functions (Balanay et al., 2015). They pay more attention to environmental protection, comfort and health. Therefore, far infrared bra, magnetic therapy bra and anion bra are rapidly developing. In view of the special biological effects of multifunctional activated carbon fiber materials, this functional fiber material is used in the design and development of female bra. This allows the bra to effectively promote the body's local blood circulation, increase the body's metabolism, massage the breast, so as to achieve prevention and adjuvant treatment of breast lobular hyperplasia and other breast diseases (Yuan et al., 2017).

2. Methods

2.1 The principle of experiment

(1) Infrared thermal imager

Infrared thermal imager is an infrared detector and optical imaging objective to accept the measured target of the infrared radiation energy distribution pattern reflected in the infrared detector photosensitive element, so as to obtain the infrared thermal image. This thermal image corresponds to the thermal distribution of the surface of the object. In ordinary language, the infrared thermal imager transforms the invisible infrared energy emitted by an object into a visible thermal image. The different colors of the thermal image represent the different temperatures of the measured object. There are two main purposes, namely, thermal imaging and temperature measurement (Peng et al., 2015). The temperature measurement accuracy is 0.1 °C.

(2) Effects of far infrared on local skin temperature of human body

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The mechanism of far infrared rays produce thermal effects on the skin is spectral matching, that is, when the radiation wavelength of the radiation source is consistent with the absorption wavelength of the radiation object, the object can absorb the infrared radiation energy, thereby increasing the molecular motion, and achieving the effect of heating temperature. The human body is an organism with the characteristics of far infrared absorption and high conductivity. The activated carbon fiber material can absorb the infrared radiation of human body efficiently, and is also a far infrared radiation source. When this material is made into the garment, the fiber material molecules can absorb the energy released by the infrared radiation in the resonance process. It can absorb the wavelength of 4μm~14μm infrared radiation energy, which is needed by the human body. At the same time, the energy is released to the human body with the same frequency as the heat release of the human body, resulting in the physiological heat effect, so that the tissue temperature is increased, and the local blood circulation is improved (Reis, 2016; Tracada, 2016).

To sum up, the thermal effect of far infrared fiber material can increase the skin temperature in a certain range. When wearing a far infrared fiber material, the infrared camera can measure changes in the local temperature of the human body.

2.2 The process of the experiment

(1) The purpose of the experiment

To verify the self-heating effect of multifunctional activated carbon fiber material in contact with skin.

(2) The contents of the experiment

Under the laboratory condition, the infrared thermal image of the human body is used to obtain the infrared thermal image of the human body before and after the local contact function fiber material. During the experiment, the average temperature of the local infrared image at different stages is compared. Thus, the thermal effect of the functional fiber material and the human skin is analyzed.

(3) The instruments of the experiment

Equipment name: infrared thermal imager

(4) Laboratory conditions

The laboratory temperature is controlled at 25 °C (In the range of 20 °C~32 °C, the body is in the effective temperature regulation state, the skin surface temperature value is almost no external temperature changes.), and the relative humidity is 98%.

(5) Experimental steps

Step 1: choose a physical and mental health as the object of observation;

Step 2: adjust the internal temperature and humidity of the laboratory, so that it is controlled within the specified range. 30 minutes later, start the experiment;

Step 3: after 30 minutes, the experimental participants entered the lab to start the experiment. In the first 30 minutes, the experimenter was in normal working condition, no strenuous exercise, and no part of the body of any functional fiber material;

Step 4: select the left hand side of the experimenter as the object of observation. After the experimenter entered the lab for 30 minutes, the first infrared image of the dorsum of the left hand was obtained;

Step 5: place the functional fibrous material on the left hand side of the experimenter, and the material area is equivalent to the size of the back of the hand. In order to make the experimental effect obvious, the activated carbon fiber fabric double layer placed on the back of the hand, with a single layer of cotton plain thin cloth wrapped;

Step 6: the experimenter continues to be in a normal state of office, and after 30 minutes, the second infrared image of the left hand was obtained.

Step 7: repeat step 6, continue the experiment, get the left hand back third infrared thermal image;

Step 8: using the infrared thermal image analysis software to read and analyze the data;

Step 9: repeat the experiment five times with the same experimental participant as the subject.

2.3 Acquisition and data analysis of infrared thermal image

(1) Acquisition of infrared thermal image

Through the infrared camera, the infrared thermal image of each stage of the experiment process was obtained, and the infrared thermal image was obtained by analyzing the infrared information system. The regional temperature value was obtained.

The average temperature of a fixed area in the left hand of the left hand was taken as the observation object of the five experiments. Figure 1 shows the rectangular area of activated carbon fiber material wrapped parts. Figure 2 shows the average temperature measurement site. The results of the five experimental data are shown in Table 1.

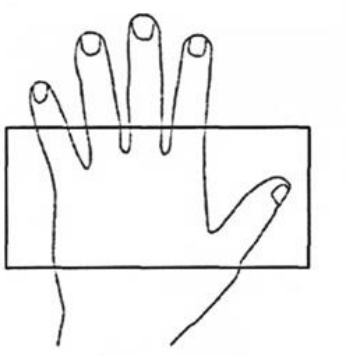

Figure 1: Functional fibrous material wrapped parts

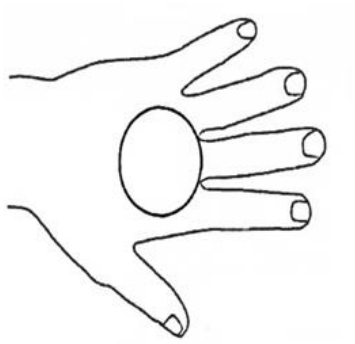

Figure 2: Measuring point of mean temperature

Table 1: Experimental data (°C)

Experimental participant	The first regional average	The second regional average	The third regional average
First experiment	18.30	21.00	21.60
Second experiment	17.50	20.90	21.40
Third experiment	18.80	21.20	22.90
Fourth experiment	17.30	20.70	21.30
Fifth experiment	17.50	21.20	22.80
Mean	17.88	21.00	22.00

(2) Data analysis

The average temperature change of the three stages of the experiment is represented by a simple linear graph, as shown in Figure 3. It can be seen that the temperature change of the first phase to the second phase of the experiment is obvious. The average change value is +3.12 °C (21.00-17.88=3.12). At this stage, the effect of room temperature (21.5 °C) on the skin temperature (below 20 °C) is relatively large. The temperature range of the second stage to the third stage of the experiment is small. The average change value is +1.00 °C (22.00-21.00=1.00). At this stage, the room temperature (21 °C) has little effect on the skin temperature (above 20 °C). The effect of its temperature change is mainly from functional fiber materials (Saetia et al., 2014).

It can be seen that the functional fiber material can increase the body temperature a certain range. It is verified that the activated carbon fiber material can produce some warming effect when it comes into contact with the skin.

Figure 3: The change trend of the mean temperature

3. Comprehensive evaluation of the performance of functional health bra

3.1 Results and discussion

To study the health care function of this function, 27 cases of breast lobular hyperplasia were collected and analyzed. They are in line with the experimental "inclusion criteria". The time interval for breast examination was one month. During the experiment, the patient did not have any treatment, and they mainly rely on their own relief. Table 2 shows the comparison of disease recovery status between the treatment and control groups. The total effective rate was 88.89% in the experimental group, which was significantly higher than that in the control group (55.56%).

Table 2: Comparison between the experimental group and the control group

Group	Number of cases	Recovery	Effective	Getting better	Invalid	Total efficiency
Test group	27	0 (0%)	2 (7.41%)	22 (81.48%)	3(11.11%)	88.89%
Control group	27	0 (0%)	2 (7.41%)	13 (48.15%)	12 (44.44%)	55.56%

3.2 Comparative analysis on the purchase intention of patients before and after the trial

Before and after the trial, we conducted a questionnaire survey of 30 patients on the user satisfaction survey. The questionnaire is mainly aimed at two problems: before and after the trial, the patient's willingness to purchase similar functional health bra, and after the trial, the patient's subjective evaluation of functional health bra. According to the results of the survey, 3.3% of the 30 patients considers that the price of functional health care bra is too high, so they do not buy it. 16.7% of women think that there will be no obvious effect, so they will not go to buy it. 20.0% of women know this bra, but the effect is not obvious, so they will not consider buying it. 53.3% of women know this bra, which works, so they will consider buying it. 3.3% of women say they believe in science, they will buy it. 3.3% of women said that health is very important, they will buy it. The above survey data show that women who want to buy and try functional care bra is 6.6%. 40.0% of women are not willing to consider buying because of lack of trust in the bra. 53.3% of women are hesitant and cannot decide whether to buy it or not.

According to the survey, 3.3% of the 30 patients said that the price may be much higher than the ordinary bra, so they will not continue to wear it. 6.7% of women feel that the effect is not very good, so they will not continue to wear it. 13.3% of women will continue to wear during illness. After the disease is completely restored, they will not continue to wear it. 60.0% of women believe that even if they return to health, they will continue to wear it. 16.7% of women will continue to focus on such functional health bra, and they cannot decide whether to continue to wear it. The above survey data show that 73.3% of women who wish to buy and continue to wear functional care bra. 3.3% of women are not willing to consider buying because of lack of trust in the bra. 16.7% of women are hesitant and cannot decide whether to buy it or not.

As can be seen from the analysis results in Figure 4 and Figure 5, the purchase intention of patients has changed after try on. This experiment has changed the patient's skeptical attitude towards functional care bra. The function of health care and auxiliary treatment of functional textile products is being accepted by patients.

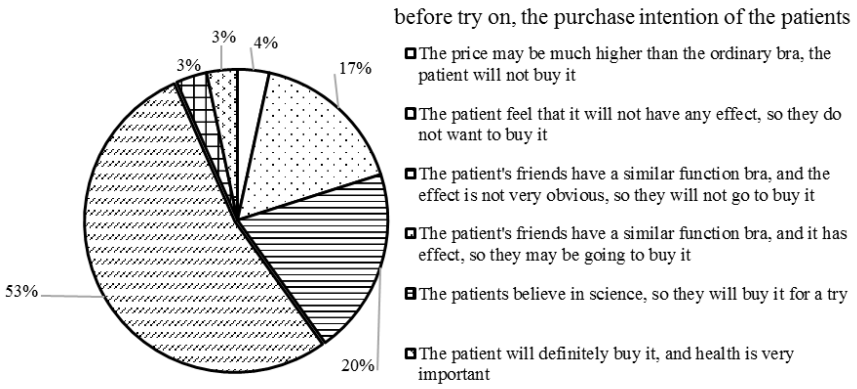

Figure 4: Purchase intention of patients before try on

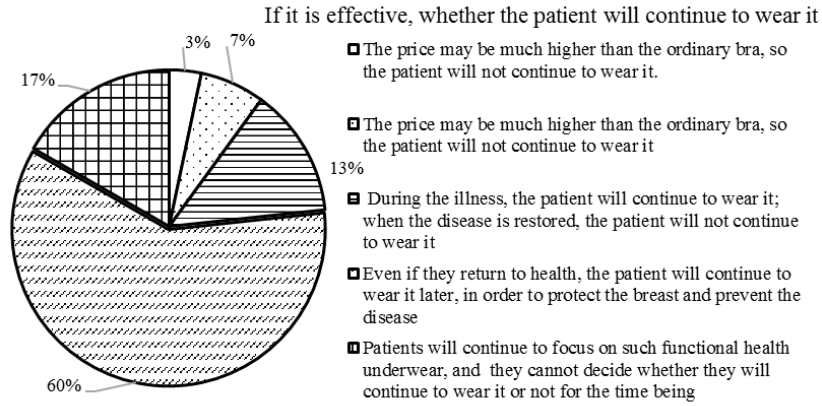

Figure 5: Purchase intention of patients after try on

4. Conclusions

In this paper, the application of multifunctional activated carbon fiber material in functional care bra is studied. The effectiveness of the functional bra was verified. The results showed that the total effective rate of functional bra was reached 88.89%. This experiment has changed the patient's skeptical attitude towards functional care bra. The function of health care and auxiliary treatment of functional textile products is being accepted by patients. In addition, this article only selected 30 low-educated women as the respondents. In later studies, we can select more women with different occupations and different qualifications as respondents, increasing the reliability of the experiment.

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