

Seaweed Fabric Research and Application for the Field of Elderly Clothing Technology

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ABSTRACT

As a kind of new sustainable biopolymer fiber, seaweed fiber boasts a wide development and application space. The fabric made from that fiber drew a great attention in the textile field as soon as it came into being due to its strong biocompatibility and completely degradable absorbability. The new textile fabrics produced by extracting natural seaweeds (*Ecklonia Kurome*, kelp, *Sargassum*, etc.) are high in keeping warm, air permeability and very light in weight, with a promising application prospect for the elderly crowd (older than 60) involved in this paper. It perfectly meets the requirements of that crowd for daily clothing fabric performance.

Keywords: *Seaweed Fiber, Sustainable Bio-fabrics, Clothing Fabrics, Elderly Clothing, Health Care.*

1. INTRODUCTION

Seaweed fiber fabrics belong to bio-fabricated textiles, which are processed from the fibers extracted from natural seaweeds by spinning. Because the raw materials coming from natural seaweeds are subject to a special treatment in the spinning process, they have such excellent characteristics as naturally eco-friendly, strongly antibacterial, highly flame-retardant, high water absorption, etc. As a new kind of textile fabric, this biopolymer material as can be used in clothing production is currently in the stage of research and development worldwide instead of being introduced in the textile industry for mass production. The physical and chemical properties of such fiber fabrics have been further demonstrated and explored as relevant technologies achieved breakthroughs year by year. And

because of their specific performance advantages, they can meet the special requirements of the elderly group for the performance of textile fabrics.

This research summarizes the key properties of the known seaweed fibers and the fabrics made therefrom and the experimental research stage which that field is in, and creatively proposes by focusing on the application prospect of these new fabrics that they can be used in the elderly clothing technology design. Based on the theories of previous scholars, the application of the emerging fabrics to the clothing technology for specific groups of people is developed from the literature dimension, with the effective function of such fabrics acting on the bodies of the

elderly group expounded. In comparison with previous researches on seaweed fibers and their fabrics, this research, as a result of bridging the effective direction and route for putting the materials into market for production in future, is conducive to the commercial transformation after the emerging fabrics leave laboratory.

2. ANALYSIS TO EFFECTIVE PERFORMANCE OF SEAWEED FIBER FABRICS AND CURRENT RESEARCH STAGE

2.1. Analysis to Effective Performance of Seaweed Fiber Fabrics and Current Research Stage

The modern scientific exploration on whether seaweed fibers making seaweed fiber fabrics as modern bio-fabricated textiles can be spun originated from World War I [1]. The textile manufacturers and scientists at that time experimented with a large number of natural materials for fiber or dye extraction to meet the demands of textile materials short of supply during war. Due to historical limitation, the immature chemical technology resulted in the seaweed yarn dimension being irregular and the properties being different for the textile field at that time, so they were unable to promote clothing fabric revolution. With the explosive development of the textile technology in the 1990s, the in-depth research into seaweed fibers has led to their excellent fiber properties being tapped.

The most important performance advantage of seaweed fibers as biopolymer fibers are in the following aspects: Excellent heat and thermal insulation property, good elasticity, strongly antibacterial, strong air permeability, complete material degradability. In comparison with the traditional synthetic fibers based on the petroleum technology, the seaweed fibers do not have the problem of non-sustainability caused by the exhaustion of petroleum resources [2][3]. Here, take the SeaCell® seaweed fiber fabrics produced by Alceru Schwarza in Germany as an example. Currently, the SeaCell® seaweed fiber fabrics are at the forefront in the seaweed fiber research field. The new fabric types developed by the team of that company by taking advantage of the carbohydrates, proteins (amino acids), fat, cellulose and rich mineral substances contained therein have possessed a very good performance. Figure 1 for the fiber extraction technology disclosed by Alceru Schwarza shows that the seaweed fiber production method is based on the addition of finely ground seaweed powder or suspended matter to the spinning solution for drawing yarns. The raw seaweeds are derived from phaeophyta, rhodophyta, chlorophyta

and cyanophyta. Especially, phaeophyta and rhodophyta are the most ideal materials for extracting seaweed fibers. In the process from production to degradation, their fabrics are dictated by their physical and chemical properties without exception, so it is a completely sustainable recycling structure.

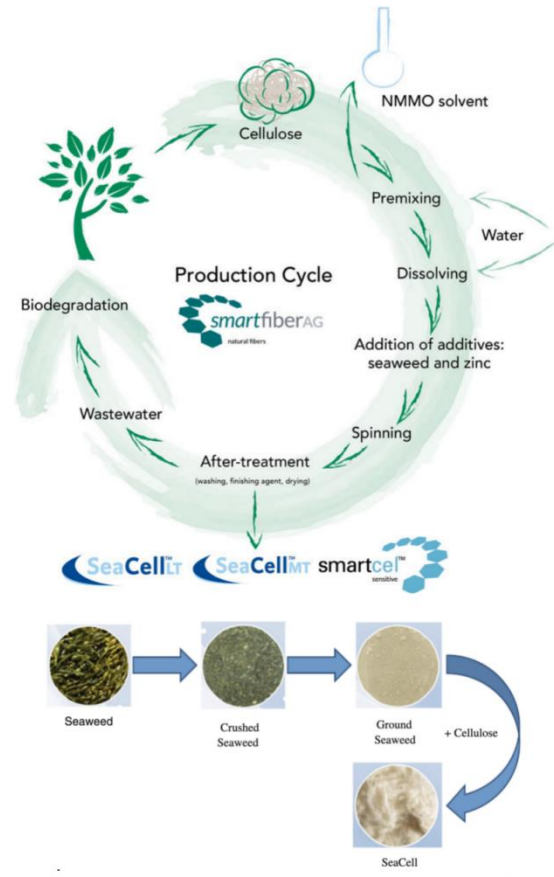


Figure 1: SeaCell® seaweed fiber extraction process [16]

2.2. Superior Advantage of Seaweed Fiber Fabrics Suitable for Human Bodies

In the fiber physical structure table for the SeaCell® fabrics as shown in Figure 2, the seaweed fibers typically represented by SeaCell® have the superior properties over other natural fibers or synthetic blend fibers. Their good plasticity can be used for processing into staple fibers or filament of any length and fineness, and can also be blended with other fibers. This feature greatly improves the comfort and elasticity of the fabrics after acting on human body and it is easier to fit human curve [4].

According to experiments, as long as 25% seaweed fibers are mixed in textiles, the effective value of the

seaweed ingredients in the seaweed fibers can be clearly demonstrated, that is, the moisture absorption, air permeability and antibacterial performance of the fabrics can be effectively improved [5][6][7]. And through contact with skin, the seaweed ingredients stored in the fabrics are released actively, so that the skin of the wearer absorbs continuously the vitamins and mineral substances released from the fabrics. In the process of dehydration and fibrosis, seaweeds basically retain calcium and magnesium and other major mineral substances as well as essential vitamins. In the research about the contact of the seaweed fiber fabrics with skin, it is shown that the mineral substances and vitamins contained in the seaweed ingredients are good for skin without causing any allergic reaction, and can provide an antibacterial function for a longer time [8][9]. The good natural skin-friendly, anti-allergic and antibacterial properties make the fabrics made from the seaweed fibers usable in such clothing design as having certain medical value and antibacterial properties.

Another important feature of the seaweed fiber fabrics is its excellent thermal insulation performance [10]. Based on the flame-retardant and thermal stability experiments to the seaweed fiber fabrics (as shown in Figure 3), it is known that the seaweed fiber fabrics, by relying on the particularity of their raw materials, have an effect of keeping temperature constant and holding temperature far beyond cotton and linen or chemical fiber fabrics, and belong to such fabrics as being of a high value of far infrared radiation rate that are able to increase the temperature in human body substantially when acting on it in a cold environment, having an obvious property of cold resistance [11][12][13]. This new type of heat-insulating, flame-retardant, constant temperature-keeping textile fabrics can not only be applied in the production process of such special clothing as fire clothing, rescue clothing, but can also be applied in the clothing design for special groups of people under ideal conditions. In comparison with the production of the traditional thermal insulation fabrics, the advantage of the seaweed fiber fabrics lies in that they get rid of the man-made damage to the ecological environment caused by cotton, linen and chemical fiber textile production activities, with the fabrics being lighter in weight and stronger in heat storage capacity [14].

At present, although the seaweed fiber fabrics still being in the stage of continuous research and exploration have not been put into large-scale commercial production, related concept clothing has come into existence as of 2021. Zegna Baruffa Lane Borgosesia, an Italian textile company, has launched Thalassa, a silk thread containing certain seaweed ingredients, and used it in clothing production. A kind of seaweed fabric developed by China Qingdao

University, as the pioneer in the field of seaweed fiber research, has been used in the production of medical textile fabrics, which has a very strong bacteriophagic and hemostatic performance [15]. The seaweed fabrics, due to having a lot of advantages, are bound to have a strong commercial value and application market in the field of future clothing industry.

Properties	SeaCell fiber
Fiber fineness (dtex)	1.7
Strength (cN/tex)	≥35
Wet strength (cN/tex)	≥30
Elongation (%)	13
Dry elongation (%)	17
Wet modulus (cN/tex)	≥180

Figure 2: Physical structure of SeaCell® seaweed fibers [3]

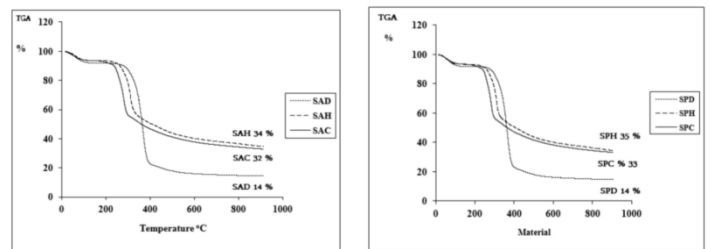


Figure 3: Testing to flame resistance and thermal stability of SeaCell® seaweed fiber fabrics [11]

3. APPLICATION OF SEAWEED FIBER FABRICS TO CLOTHING OF ELDERLY GROUP

3.1. Current Demand of Elderly People for Clothing Fabrics

This research is mainly designed to explore the possibility of application to the special group of people, that is, the elderly people older than 60, by being based on the effective properties of the above new fabrics, that is, the seaweed fiber fabrics.

With Liaoning, China functioning as an area for sample taking, this project team used random sampling survey with 1,000 questionnaires issued with regard to the requirements of the elderly group for clothing fabric performance. There were 1,000 effective questionnaires

and the survey period lasted for 30 days. For the contents of the questionnaire, please refer to Figure 4. Whether the physiological and psychological requirements of the elderly group are satisfied is the key to judging the clothing product design quality [17].

Through collecting and making statistics of the questionnaire results, this research has found that the following five major indicators are required: warm-keeping, comfort, anti-bacteria, air permeability, environmental sustainability. The number of people fully in favor of fabric performance accounts for 87.5%. This discovery substantially substantiates that the seaweed fiber fabrics meeting the above five major indicators fully comply with the design requirements in this field as elderly clothing and there is a promising application prospect in the commercial transformation stage of the new fabrics in future.

With the population ageing phenomenon becoming more and more prominent globally, the future important camp in the clothing production and design sector will be bound to incline to the R&D of elderly clothing products. At the same time of meeting the demands of the elderly people for products, the seaweed fiber fabrics should also give full play to their special fabric properties for the development of such products as suitable for the elderly physiological structure from the perspective of clothing appearance. With the growing of age, immune abnormalities lead to a large number of elderly people suffering rheumatism, arthropathy or skin diseases for a long time. The seaweed fiber fabrics being naturally antibacterial and good in elasticity are very suitable for this group of people due to certain inhibition and therapy against these diseases [7][18]. In addition, due to the strong plasticity and tensile properties of seaweed fiber fabrics, the elderly clothing products developed by being based on such fabrics can meet the requirements of ergonomics satisfactorily and eliminate

as far as possible the problem that as the skeleton and body shape of elderly people become deformed with age, the original clothing profile is affected. It is believed that such clothing design products will be more friendly to the elderly group.

Figure 4 :The content of the questionnaire for the performance needs of garment fabrics of the elderly over 60 years old is displayed

3.2. Elderly Clothing Appearance Conceiving Developed from Seaweed Fiber Fabrics

Based on the unique performance of the seaweed fiber fabrics, this research, from the perspective of protecting the bones and joints of elderly people, preventing and treating elderly skin problems, moisture protection and keeping warm and combining with the future commercial application of the seaweed fiber fabrics for the elderly clothing design, proposes the following elderly clothing appearance concept of applying the seaweed fiber fabrics.

As shown in Figure 6, there includes a warm-keeping structure provided in clothing body, elbow joint and a support structure provided in the knee joint. The said clothing is divided into jacket and pants, consisting of a total of 14 clothing patches. The jacket is provided with removable elbow section (5). The elbow warm-keeping structure consists of elbow pad and hook & loop fastener, through which the warm-keeping structure is connected with the corresponding lining of the elbow section (5). The hook & loop fastener is provided with elbow pad made of the seaweed fiber fabric (6); the back of the jacket (2) is also made of a highly warm-keeping seaweed

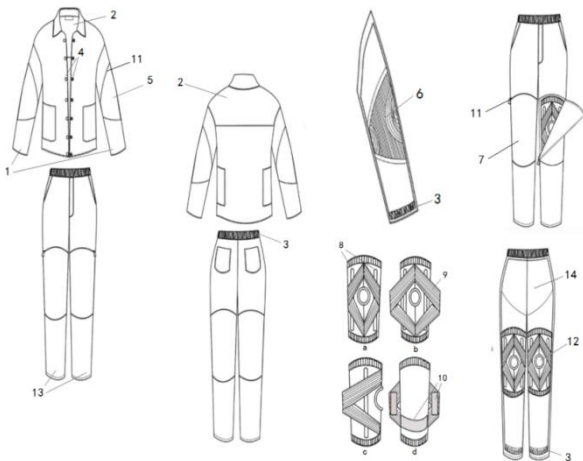
QUESTIONNAIRE ON PERFORMANCE REQUIREMENT OF GARMENT FABRICS FOR THE ELDERLY OVER 60 YEARS OLD

Hello! We are conducting a survey on the performance preference of clothing fabrics for the elderly. I hope you can spare a few minutes to answer the following questions.

1. Do you have any demand for the thermal insulation / heat preservation function of clothing fabrics?
 Required Not required
2. Do you have any demand for the comfort and elasticity of clothing fabrics?
 Required Not required
3. Do you need the antibacterial function of clothing fabrics?
 Required Not required
4. Do you need the air permeability of clothing fabrics?
 Required Not required
5. Do you want the clothing fabric to be natural and environmentally friendly and not allergic to skin?
 Required Not required
6. What is your age?
 60-70 70-80 80-90 90+

fiber fabric, and the upper arm part (1) of the jacket is made of the seaweed fiber fabric with waterproof coating; the jacket is provided with magnetic buckle (4) for putting on and taking off the jacket easily; The said pants are provided with removable knee joint section (4) made of a seaweed fiber fabric and secured to the pants through zipper (11); the said support structure consists of knee pad, V-shaped elastic rope (9), spring for support (8) and hook & loop fastener, the two V-shaped elastic ropes (9) forming a diamond shape are encapsulated on the outer side of the knee pad, a hook & loop fastener is provided on the diagonals of the V-shaped elastic rope (9) respectively to facilitate tightness adjustment to and removal of the same, a hook & loop fastener is provided on the bottom of the knee pad for the support structure to connect with the pant lining; a spring for support (8) is provided on each of the both sides of the support structure to reduce the load on the joint in moving. An O-shaped gasket for protecting patella (12) is provided on the support structure to secure the patella joint against rubbing the knee part due to patella joint movement; The shank part (13) below the knee joint part (7) is made of the seaweed fiber fabrics with waterproof coating, while the pant pelvis part (14) is also made of highly warm-keeping seaweed fiber fabrics. Further, elastic bands are provided in jacket cuff inside, pant bottom mouth inside and pant waist part (3).

By studying the changes of the skeleton and body shape of the elderly group older than 60, this design concept makes a R&D to the warm-keeping structure and support structure for shoulder, elbow, crotch and knee in a reasonable and non-burdensome manner, and enlarges



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the advantage of the seaweed fiber fabrics to the highest degree through the clothing appearance design guided by ergonomics. The elbow and knee pads developed from the seaweed fiber fabrics have overcome the shortcomings of traditional knee pads as stuffy and airtight due to the fabric characteristics, and are lighter in weight, with a warm-keeping and supporting role, good wearability and corrosion resistance simultaneously. The use of hook & loop fastener, magnetic buckle, elastic band improves the easiness to put on and take off the clothing. As there is no redundant design outside the clothing and the overall version is in line with the aesthetics of elderly people, it is highly accepted by the elderly group.

Figure 6: Elderly clothing appearance design using seaweed fiber fabrics

4. CONCLUSION

This research tries to explore the possibility of seaweed fiber fabric suitability for elderly clothing design and manufacturing by taking advantage of the new fabric research direction, that is, seaweed fiber fabrics in the field of textile science, in combination with the requirements of elderly people for textile fabric performance due to their physiological structure characteristics and psychology, and make the kind of clothing using such fabrics have certain medical auxiliary function and commercial value.

Based on the previous case study on seaweed fiber fabrics, an in-depth discussion is made about the significance of contemporary research into seaweed fiber fabrics. According to the random sampling survey results for the requirements of the elderly group over older than 60 for clothing fabric performance, the appearance of clothing made of seaweed fiber fabrics is boldly conceived, with their design value and the market value of such fabrics acting on the elderly group expounded. The research on the clothing of special crowds whom the new textile fabrics represented by the seaweed fiber fabrics act on is far beyond this. How to have the subsequent fabrics combined with clothing more closely needs constant R&D, improvement and supplementation, so as to expand the possibility that the seaweed fiber fabrics are widely used by the clothing manufacturing industry eventually.

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