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Developing Comfort Enhancing of Knitted Sportswear Collection by Synthetic Fibers with Different Properties

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Abstract

This study demonstrates our effort in examining to improve the performance of activewear and provide subjective comfort in activewear. Functional properties such as elasticity, cool keeping, breathability, quick drying etc. in activewear products increase the comfort performance characteristics of the garments. The paper focus on the textile materials and product which is designed specially by company for activewear. Comfort properties of fabrics such as capable of breathing, quick dry, flexible etc. were reproduced. The fibres, yarns, fabrics and special finishing treatments used for activewear in order to enhance performance and properties of activewear were discussed. In addition, it was explained where the fabric is used, and which performance characteristics are important for designing the product. Within the scope of the study, the development of an alternative comfort enhancing knitted activewear collection with different synthetic fibres was examined. The results of the literature studies have shown that there are various parameters to ensure comfort. Moreover, design studies were made with fabric at different stages in this study. As a result, prototype tests were made considering the physical and chemical properties of the developed fabrics. These studies formed the basis for the development of raw materials. The use of these products in the prototypes of recycled pet yarns collected from the sea shows the contribution of this study in terms of sustainability.

Keywords: activewear; breathability; functional design; recycled yarn; technical textiles

1. Introduction

Nowadays, different applications and usage areas have emerged for textile products as a result of the development of new fibers, new production technologies and increasing human needs. Especially the growth in the sportswear market has significant effects in the textile industry. The global sportswear market is highly competitive, and it is one of the most heavily branded areas in the global apparel market (Tong, et al., 2009), (Su &Tong, 2015). The

sportswear brands are dedicated to creating strong brand equity and build brand loyalty through creating strong and distinctive brand personality. Sportswear brand personality enhances the effectiveness of marketing communications efforts (Su &Tong, 2015), (Arora & Stoner, 2009), (Brakus, et al., 2009). The people' demand in all areas of textile fabrics and garments are going up because of the increasing standard of the worldwide. Consumers demand high levels of comfort, design and easy care, not only in daily used garments, but also in sportswear (Ozdil & Anand, 2014). This study demonstrates our effort in examining to improve the performance of sportswear and provide subjective comfort in sportswear. Functional properties of fabrics such as elasticity, cool keeping, breathability, quick drying etc. in sportswear products increase the comfort performance characteristics of the garments (Chaudhari, et al., 2004).

The paper focus on the textile materials and product which is designed specially by company for sportswear. Comfort properties of fabrics such as capable of breathing, quick dry, flexible etc. were reproduced. The fibres, yarns, fabrics and special finishing treatments used for sportswear in order to enhance performance and properties of sportswear were discussed. In addition, it was explained where the fabric is used, and which performance characteristics are important for designing the product.

2. Materials and Methods

Single jersey and interlock knitted fabrics with different weights and yarn counts mixed with 95% polyethylene terephthalate (PET) and 5% Elastane (Lycra) as synthetic fibers were used in this study. The polyester yarn used in fabrics is recycled and produced from PET bottles collected from the sea. The trade name of the recycled PET is SeaQual. The properties of the fabrics summarised in Table 1.

Table 1: Properties of TYH fabrics

Properties of Fabrics	Fabric-1	Fabric-2	Fabric-3	Fabric-4
Type Knitting	Single jersey	Single jersey	Single jersey	Interlock
Unit Weight (gr/m^2)	235	215	200	210
Colour	Living Coral	Living Coral	Turquoise	Turbulence
Pantone	16-1546 TCX	16-1546 TCX	15-5519 TCX	19-4215 TCX
Detail	SeaQual	SeaQual	Bi-Strech	Mono-Strech

In addition to materials, Ecocert, Ruca-bac, Ruco-fresh and Feran EPV chemicals were used. Chemicals that give antibacterial, antistatic and wicking (breathability) properties to these fabrics were applied during the finishing processes. In finishing processes, it is aimed to reveal the differences between fabrics by using the same chemicals (finishes) during the finishing process. The application of chemicals on fabrics was carried out by the impregnation method. Material development studies were conducted in accordance with the specified criteria by empirical. These studies were repeated until the expected criteria were ensured. The studies were tested with physical and chemical tests.

In order to ensure compatibility between the fabrics, the structural properties of the developed fabrics were first evaluated. Fastness to washing, rubbing fastness (dry and wet), colour fastness to water, perspiration fastness, pH tests, ICI Pilling Box and Pilling Martin Dale were applied. In addition, quick dry, vertical wicking, thermal resistance, water vapor

permeability, moisture management, antibacterial activity determination tests were performed on the required fabrics. Test sample fabrics were conditioned under standard conditions. (21 ± 1 °C, 65 ± 2% relative humidity)

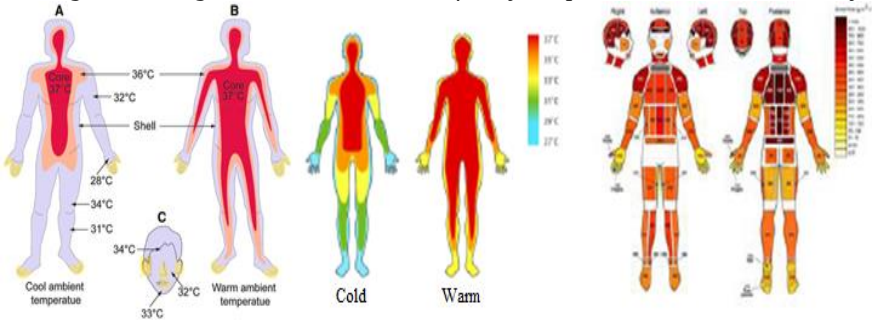
In this study, these tests applied to the fabrics have been conducted in accordance with certain standards. Tests and standards are presented in Table 2.

Table 2: Tests and Standards

Test	Standard
Fastness to Washing (Gyrowash)	ISO 105 C06 AIS
Rubbing Fastness (Dry-Wet)	EN ISO 105 – X12
Colour Fastness to Water	EN ISO 105 – E01
Perspiration Fastness	EN ISO 105 – E05
pH	ISO 3071 – 1980
ICI Pilling Box	ISO 12945 – 1
Pilling Martin Dale	EN ISO 12947
Thermal Resistance/ Water Vapor Resistance	TS EN ISO 11092:2014
Vertical Wicking	AATCC 197:2013
Determination of the Activity to Antibacterial	ISO 20743:2013
Quick Dry	AATCC 199
Moisture Management	AATCC 195:2017

Within the scope of the study, different types and characteristics of fabrics were used together in the prototype designs of this study, in contrast to the use of similar fabrics in equivalent products. It has been observed that the fabric used in equivalent products has a single type and specific performance feature. Thus, fabrics of different types and features were used by combining them and it was determined after scientific and literature researches where these featured fabrics will be used and where their performance properties are important. Figure 1 shows the distribution of body temperature of human anatomy in hot and cold environments. It also shows the regions where the body temperature rises, and perspiration occurs as an active sport. As it can be seen from Figure 1 that A shows cold environments, the area preserved at 37°C contracts and the shell area expands; B shows the body volume preserved at 37°C expands; yellow areas in a, b, and c illustrate the "acral" regions that help control body temperature by constricting blood vessels when the body temperature falls (White et al., 2011). As a result of these examinations, sportswear product design was made considering these features.

Figure 1: Diagrammatic illustration of body temperature in the human body



Source: (White et al., 2011)

3. Results and Discussion

3.1 Physical Test of Fabrics

Fastness is the strength of a textile product to withstand the factors encountered during both its production and use. Fastness is an important quality feature in dyed textile products. Knowing the fastness of the textile material is important for the preparation of care labels (Tolek & Kadem, 2016). Thus, fastness to washing, rubbing fastness (Dry and Wet), colour fastness to water, perspiration fastness and pH tests were applied. Table 3 shows the results of these testing. These tests were carried out in the company's laboratory.

As can be seen from Table 3, wet rubbing fastness values were observed as 3/4 and 4, dry rubbing fastness values were observed as 4 and 4/5. Washing (Gyrowash) fastness values were determined as 4 and 4/5 according to ISO 105 C06 AIS standard, colour fastness to water according to EN ISO 105-E01 standard was 3/4 and 4, and perspiration fastness was determined as 4 and 4/5 according to EN ISO 105-E05 standard. Thus, it was determined that the fastness test results of the developed knitted fabrics showed good results. Test results were evaluated according to the company's acceptance value and customer criteria.

In addition, the pilling problem is one of the most important problems in textile, disturbing both the producer and the consumer and affecting the fabric quality. Test devices and methods used together with the factors affecting pilling are also very important in terms of evaluating the pilling performance of fabrics (Okur, 1998). In this context, as a fabric pilling analysis, Martin Dale test according to EN ISO 12947 standard and ICI Pilling Box test according to ISO 12945-1 standard were performed on the developed knitted fabrics can be seen in Table 3. Martin Dale test results were determined as 3/4 and 4, ICI Pilling Box test as 4. These results have been accepted as valid according to standards.

Table 3: Physical Tests of the fabrics and results

Structural Test	Fabric-1	Fabric-2	Fabric-3	Fabric-4
Fastness to Washing	4	4/5	4	4
Dry Rubbing Fastness	4	4	4/5	4/5
Wet Rubbing Fastness	3/4	4	4	4
Colour Fastness to Water	3/4	4	4	3/4
Perspiration Fastness	4	4	4/5	4
pH	6.8	6.9	6.9	6.8
ICI Pilling Box	4	4	4	4
Pilling Martin Dale	3/4	4	4	3/4

3.2 Performance Test of Fabrics

The performance tests of the fabrics were made in the relevant parts of the product based on the comfort behaviours targeted for functional properties. In this context, the performance tests of the fabrics are presented in Table 4.

Table 4: Performance tests of the fabrics and results

Performance Test	Fabric-1 Living Coral	Fabric-2 Living Coral	Fabric-3 Turquoise	Fabric-4 Turbulence
Thermal Resistance, (R_{ct}), m^2K/W	0.00627	0.0079	0.0044	0.00803
Water Vapor Resistance, (R_{et}), m^2Pa/W	0.4486	0.4892	0.3168	0.578
Vertical Wicking, Length, cm/15 min.	6.4	5.4	10.7	4
Vertical Wicking, Width, cm/15 min.	6.5	5.5	11.6	4.9
Antibacterial Activity Value, A	3.71	3.71	-	-
Quick Dry, min.	-	-	331.6	-
Moisture Management, OMMC	-	-	0.8262	-

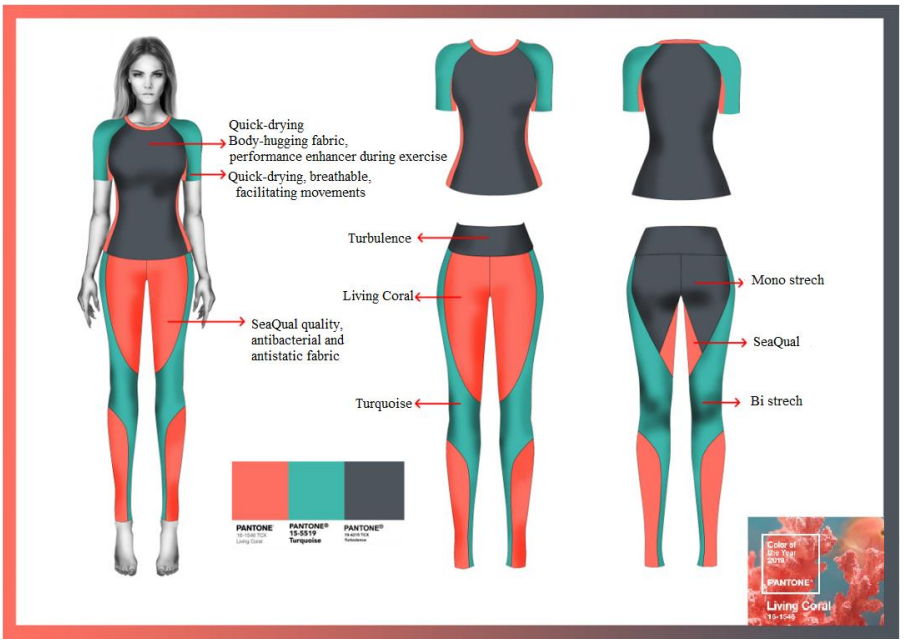
In order to maintain thermal balance, the perspiration secreted from the body must be transferred to the atmosphere. Providing thermal balance is a desired feature in sportswear products. In particular, this situation is directly effective with the properties of knitted fabrics such as quick dry, vertical wicking, water vapor resistance, thermal resistance, moisture management. Tests were carried out in this context and these results are good performance of features according to standards. As can be seen from Table 4, total liquid moisture management performance (OMMC) as 0.8262. According to AATCC 195 method, if OMMC > 0.80 is strong performance. Fabric-3 is a moisture management fabric. It can manage moisture (mainly perspiration) by moving it from the skin to the outer surface of the garment or by absorbing it. As the body movement increases in sports activities, the body warms and perspiration. This causes the back transfer of body fluid that is in close contact with the garment wall. In terms of comfort, it is very important that the skin remains dry and moisture evaporates (Senthilkumar et al., 2013). It is observed from these test results that the developed knitted fabrics reflect these properties. In addition, antibacterial activity value was tested as A = 3.71. According to ISO 20743 method; If $2 \leq A < 3$, there is sufficient effect, if $A \geq 3$ is strong effect.

3.3 Activewear design of fabrics with different properties

As a result of the examinations made (White et al., 2011), the product design was made by taking these features into consideration. Antibacterial properties are preferred in the armpit and inner leg areas. Mono-Strech fabric was preferred in the hip and abdomen, so a tight-holding structure was designed. Antistatic properties were preferred in various places on the arms and legs, it was used mostly in mobile areas.

The colours preferred in the design phase of the products were chosen by Pantone in 2019, and fashion was taken into consideration. Pantone 19-4215 TCX – Turbulence as a dark colour was preferred on the hips, breast and abdomen, and a design that is easy to use and does not show interior. 'Living Coral' pantone colour (16-1546 TCX) fabrics knitted from recycled polyester from the sea are preferred for the armpit and inner legs. 15-5519 TCX pantone Turquoise colour was used on arms and legs and matched with breathing. As can be seen from Figure 2, activewear design studies have been developed based on scientific foundations and functionality is prioritized.

Figure 2: Activewear design of fabrics with different properties



3.4 Developing prototype textile products of knitted sportswear collection

In this context, the casting and physical properties of the fabric were used in the relevant parts of the product based on the targeted comfort behavior, and the created design product formed the output of this study in accordance with the targets. Various prototypes have been developed with samples of the developed fabrics. The fit of these prototypes was checked using both living and non-living (dummy) mannequins, and the measurements were revised accordingly. In this context, the casting and physical properties of the fabric were used in the relevant parts of the product based on the targeted comfort behavior, and photographs of the created design t-shirt and tights products are given Figure 3.

Figure 3: Prototype textile products of knitted sportswear collection

4. Conclusion

Within the scope of the study, the development of an alternative comfort enhancing knitted sportswear collection with different synthetic fibres was examined. The results of the literature studies have shown that various parameters to ensure comfort. In addition, design studies were made with fabric at different stages and prototype tests were made considering the physical and performance properties of the developed fabrics in this study. In this context, the properties of the fabric were used in the relevant parts of the product based on the comfort behaviour targeted. These studies formed the basis for the development of raw materials. As a result of this study, it was determined where the featured fabrics are used in t-shirt and tights products developed and which performance characteristics are important. Within the scope of the study, an alternative comfort-enhancing knitted sportswear collection with different synthetic-based fibers, raw materials, has been developed. Moreover, the use of these products in the prototypes of recycled pet yarns collected from the sea shows the contribution of this study in terms of sustainability. At the same time, in line with the Intellectual and Industrial Property Rights management policy of the company, design registration was applied for the final product and the design registration was obtained by the Turkish Patent Institute for the products.

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