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Evaluation of Thermal Comfort and Moisture Management Properties of Polyester–Spandex Yoga Sportswear

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ABSTRACT

Thermal and moisture management properties are important considerations in the selection of fabrics for yoga apparel because they influence the wearer's physiological comfort during physical activity. This study evaluated the thermal comfort characteristics of four commercially available polyester-spandex yoga sportswear fabrics with different fiber compositions and fabric construction properties. Air permeability, liquid moisture management, thermal resistance (Rct), and water-vapor resistance (Ret) were evaluated using standardized testing methods. Moisture management characteristics were assessed using a Moisture Management Tester, while Rct and Ret were determined using a sweating guarded hot plate. The results showed differences in thermal and moisture management characteristics among the investigated samples. The fabric containing 86.06% polyester and 13.94% spandex exhibited favorable moisture management performance, achieving Grade 5 for the accumulative one-way transport index (AOTI) and overall moisture management capacity (OMMC). Meanwhile, the 91.13% polyester–8.87% spandex sample exhibited the highest air permeability and comparatively low thermal and water-vapor resistance. These findings demonstrate that the thermal comfort performance of yoga sportswear should be evaluated through multiple fabric properties rather than fiber composition alone. The study provides material-level evidence that can support the selection and development of polyester-spandex fabrics for thermally comfortable yoga apparel.

Keywords: polyester -spandex, yoga sportswear, moisture management, thermal comfort.

1. Introduction

The comfort and performance of yoga practitioners are significantly influenced by their choice of yoga sportswear (Zhao & Wang, 2022). Given that yoga involves activities ranging from gentle stretches to intense movements, the thermal comfort provided by sportswear is crucial (Lee et al., 2020). The fabrics utilized in yoga attire are essential for regulating body temperature, managing moisture, and ensuring overall comfort during practice. Polyester and spandex are two synthetic materials commonly employed in sportswear due to their elasticity, lightweight properties, and capacity to enhance movement comfort (Kundu & Chowdhary, 2020). Polyester is valued for its moisture resistance and absorption capabilities, while spandex is known for its exceptional elasticity, enabling garments to conform to the body's shape and facilitate dynamic movements typical in yoga.

The combination of these materials is anticipated to produce clothing that not only provides comfort but also supports athletic performance, including thermal comfort (Handbook of Textile Fibre Structure, 2009). Thermal comfort is defined as the degree to which an individual experiences temperature-related comfort when wearing clothing (Tesinova & Atalie, 2022). In sports contexts, body temperature increases

due to physical exertion, resulting in perspiration. Consequently, the fabric utilized in sportswear must effectively regulate body temperature and manage moisture to maintain comfort without causing overheating or chilling (Zhang & Wang, 2020). Garments that fail to regulate body temperature can lead to discomfort, potentially impacting concentration and performance during yoga sessions. There is a notable paucity of research on thermal comfort in yoga sportswear specifically utilizing polyester-spandex blends. While previous studies have examined thermal comfort in sportswear generally, investigations focusing on polyester-spandex materials for yoga activities are lacking. This gap underscores the need for more comprehensive research into how material composition affects thermal comfort in yoga apparel.

The evolution of the fashion and sports industries has driven the continuous improvement of yoga sportswear design, with the aim of enhancing user comfort (Wang et al., 2021). The selection of suitable materials for yoga attire involves considering not only aesthetics and flexibility but also thermal comfort factors, which are influenced by the material's physical properties such as moisture wicking, air flow, and heat insulation capabilities (Yang et al., 2019). Consequently, understanding how material composition affects thermal comfort is crucial for developing optimal yoga sportswear. This research focuses on the impact of polyester-spandex blends on thermal comfort in yoga clothing. The primary objective is to determine the material composition that offers the optimal thermal comfort by examining physical properties such as elasticity, moisture absorption, and temperature regulation.

This study aims to evaluate the thermal comfort and moisture management characteristics of commercially available polyester-spandex yoga sportswear with different fiber compositions. The evaluation focuses on air permeability, liquid moisture management, thermal resistance (Rct), and water-vapor resistance (Ret), together with selected fabric construction properties. The findings are intended to identify the fabric sample exhibiting the most favorable combination of thermal and moisture management properties for yoga apparel. (Tesinova & Atalie, 2022). Garments that fail to manage body temperature effectively can result in discomfort, either from overheating due to sweat accumulation or from excessive cooling. Factors influencing thermal comfort include the material's moisture-wicking properties, air circulation, thermal insulation, and temperature change resistance (Wardiningsih & Troynikov, 2019).

Polyester, a synthetic material frequently utilized in sportswear, is characterized by its moisture-wicking and quick-drying properties. It can draw sweat away from the body and distribute it across the fabric's surface, maintaining the wearer's dryness. However, polyester's limited thermal insulation capacity suggests it may exhibit increased warmth when worn in high-temperature environments (El-Newashy et al., 2019). In contrast, spandex offers excellent elasticity, allowing it to stretch significantly and return to its original shape. This characteristic renders spandex suitable for sportswear requiring flexibility and unrestricted movement, such as yoga attire. Nevertheless, spandex has limitations in terms of body temperature regulation. Its poor moisture absorption capabilities can result in garments retaining sweat and creating a damp sensation on the skin (Kundu & Chowdhary, 2020).

The combination of polyester and spandex aims to address the limitations of each material individually. While polyester offers effective moisture management, spandex contributes elasticity and ease of movement (Ahmad et al., 2020). This research seeks to determine the optimal polyester-spandex ratio for maximizing thermal comfort in yoga attire. The composition of polyester-spandex fabrics can be adjusted based on the intended use and functionality of the garment. Previous research has explored various material compositions in athletic wear to assess their impact on comfort and performance. For yoga apparel specifically, the ratio of polyester to spandex is crucial in achieving ideal thermal comfort (An et al., 2016).

Research conducted by Central Michigan University et al. (2018) demonstrated that sportswear incorporating an appropriate mixture of polyester and spandex can enhance thermal comfort by effectively regulating body temperature and facilitating optimal air flow.

Additionally, Lee et al. (2020) found that a fabric composition of 80% polyester and 20% spandex provides a balanced combination of comfort and flexibility, effectively managing body moisture during exercise. This study focuses on polyester-spandex compositions, as they are expected to offer a balance of thermal comfort, moisture management, and elasticity suitable for yoga apparel.

The findings aim to provide a clearer understanding of how material composition affects thermal comfort. The physical properties of fabrics significantly influence the thermal comfort of athletic wear (Di Domenico et al., 2022). Moisture absorption capacity is the most influential physical property affecting thermal comfort. Fabrics with high moisture absorption maintain skin dryness and minimize sweat-induced discomfort. Air circulation also impacts thermal comfort, as proper ventilation allows for free airflow, helping maintain a stable body temperature. Material elasticity is another crucial factor, particularly in yoga wear, where diverse body movements require high flexibility (Omrani et al., 2017). Research by Xiaofei (2021) demonstrated that materials combining good elasticity and moisture absorption provide superior thermal comfort during physical activities. Fabrics excelling in both ventilation and elasticity not only enhance comfort during movement but also mitigate the effects of extreme temperatures that may cause discomfort.

This study significantly enhances the understanding of how polyester spandex composition affects thermal comfort in yoga apparel. While previous research has explored various aspects of comfort in athletic wear, this study uniquely combines material physical properties with composition assessments specific to yoga. The findings are anticipated to guide the development of yoga clothing that improves comfort, efficiency, and the overall yoga experience.

2. Research Method

2.1 Materials

This investigation examined thermal comfort in yoga attire utilizing sportswear comprising two primary components: upper and lower garments. The apparel was specifically designed for yoga practice, emphasizing comfort, flexibility, and the capacity to regulate body temperature and moisture during physical activity. The yoga attire employed in this study is commercially available and widely utilized in various settings, including fitness facilities, yoga studios, and private residences for individual practice. For a visual representation, refer to Figure 1 and Table 1 below.

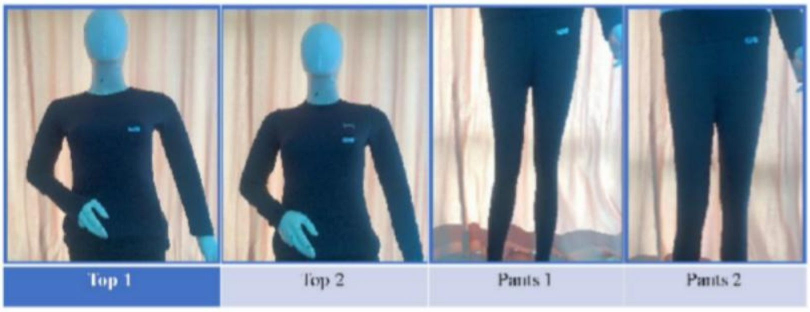

Figure 1. Sample of Yoga Sportswear Material that already exist in Society

Table 1. Technical specification of yoga sportswear

No	Sample	Yarn Count (Tex)	Filament	Stretch course (%)	Stretch wale (%)	CPI (cm)	WPI (cm)	Fiber composition
1	Top1	13,59	96	43,45	44,37	29,66	17,19	Poliester 91,13 % Spandex 8,87%
2	Top 2	12,93	96	40	45,52	33,86	17,59	Poliester 86,06 % Spandex 13,94 %
3	Pants 1	6,538	72	90,28	26,21	26,38	26,12	Poliester 82,71% Spandex 17,29 %
4	Pants 2	5,97	72	70,07	37,33	28,87	26,31	Poliester 79,51% Spandex 20,49%

2.2 Methods

a. Fabric composition and construction

Testing was conducted at the Physical and Chemical Evaluation and Testing Laboratory, Politeknik STTT Bandung. Fiber composition was determined in accordance with SNI ISO 1833-12:2010. Knitted-fabric construction was characterized by courses per inch (CPI), wales per inch (WPI), yarn linear density, filament count, and stretchability in accordance with SNI 0458:2013.

b. Air permeability

The air permeability test determines the volume of air that can traverse a fabric in a given area at a specified pressure. Air permeability is defined as the quantity of air (cm^3) that flows per unit time (second) through a specific fabric surface area (cm^2) at a specified air pressure differential across the fabric surface. This test is conducted in accordance with the SNI 08-3910-1995 standard utilizing a textile air-permeability tester.

c. Liquid moisture-management properties

The moisture management properties of fabrics were evaluated using the SDL Atlas Moisture Management Tester and AATCC 195-2009 protocol. This device functions based on electrical conductivity and resistance when a fabric sample comes into contact with liquid moisture (Matusiak, 2019). An 8 × 8 inch sample from conditioned fabric is placed in the MMT tester, which uses concentric sensors to assess liquid movement on both fabric sides. Synthetic sweat is applied to the fabric's top surface, initiating the measurement of moisture properties as sensors detect electrical conductivity. The following indices are calculated and graded:

- Wetting time (WT): The time for the fabric surface to become wet after liquid application, calculated separately for top and bottom surfaces.

- Absorption rate (AR): The rate at which the fabric absorbs liquid, calculated separately for top and bottom surfaces.
- Spreading speed (SS): The speed at which liquid spreads to its maximum wetted radius, calculated separately for top and bottom surfaces.
- Maximum wetted radius (MWR): The furthest extent of liquid spread radially from the liquid source, calculated separately for top and bottom surfaces.
- Accumulative one-way transport index (AOTI): The difference in moisture accumulation between the top and bottom surfaces.
- Overall moisture management capacity (OMMC): The overall capability of the fabric to manage moisture.

d. Thermal and water-vapor resistance

A sweating guarded hot plate (SGHP) was used to determine thermal resistance (Rct) and water-vapor resistance (Ret). Measurements followed ISO 11092. For Rct, the ambient temperature was maintained at 20°C, relative humidity at 65%, and air velocity at 1 m·s⁻¹. Measurements were recorded after steady-state conditions were reached.

$$Rct = \frac{A(Ts - Ta)}{H} - Rct0 \quad (1)$$

where Rct is the thermal resistance of experimental workwear fabric (m² °C/W), $Rct0$ is the thermal resistance of the boundary water layers (m² °C/W), Ta is temperature of ambient water (°C), Ts is the surface temperature of the plate (°C), A corresponds to area of the test section (m²), and H is amount of electrical power (W).

To evaluate the water-vapor resistance, environmental conditions were established to replicate a hot, humid climate analogous to that encountered during yoga exercises with contemporary attire. The ambient temperature was maintained at 35 °C, with relative humidity regulated at approximately 40%, and air velocity at 1 m/s. Upon system stabilization, the steam cloth's resilience was assessed utilizing a specific equation.

$$Ret = \frac{A(Ps - Pa)}{H} - Ret0 \quad (2)$$

where Ret is the vapor resistance of experimental workwear fabric (m².Pa/W), $Ret0$ is vapor resistance provided by boundary air layer (m².Pa/W), Pa is water vapor pressure of the water (Dad), Ps is water vapor pressure at hot plate surface (Dad), A corresponds to area of the test section (m²), and H is amount of electrical power (W).

Data were analyzed descriptively to compare the four commercial fabric samples. Air permeability, Moisture Management Tester grades, thermal resistance (Rct), and water-vapor resistance (Ret) are presented in figures to show between-sample patterns. Inferential statistical tests were not applied because the available dataset did not provide independent replicate-level observations required for valid analysis of variance or regression modelling.

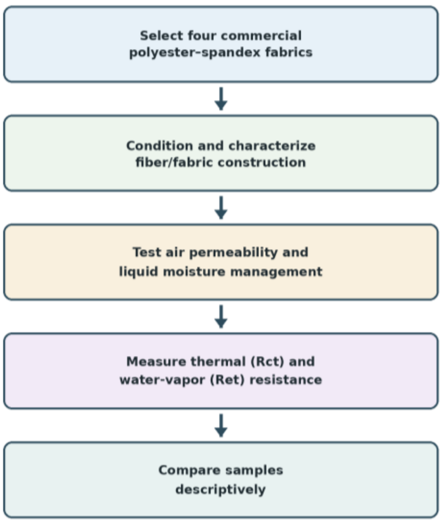

Figure 2. Research methodology flowchart

3. Result and Discussion

3.1. Results

The four fabrics showed distinct performance profiles (Figures 3–9). Top 1 (91.13% polyester/8.87% spandex) recorded the highest air permeability (53.86 $cm^3 \cdot s^{-1} \cdot cm^{-2}$) and comparatively low Rct and Ret. All samples received Grade 3 for top- and bottom-surface wetting time. Top 2 (86.06% polyester/13.94% spandex) showed the most favorable overall liquid-moisture behavior, including Grade 5 for both the accumulative one-way transport index (AOTI) and overall moisture management capacity (OMMC). Figures 5–7 further show between-sample differences in absorption rate, maximum wetted radius (MWR), and spreading speed (SS) on the two fabric surfaces. These descriptive patterns are interpreted in Section 3.2 in relation to fiber composition and fabric construction; no inferential significance is claimed.

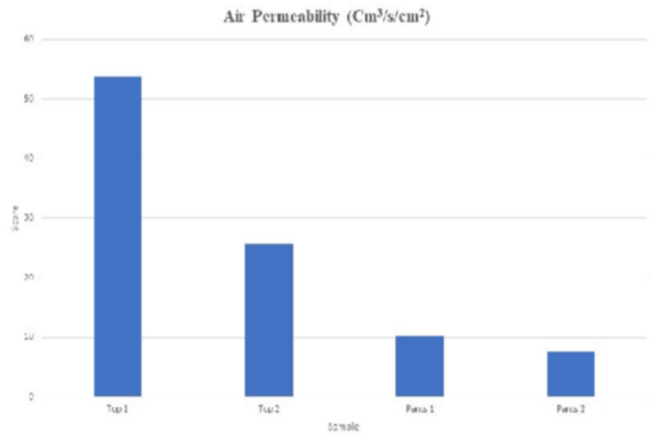

Figure 3. Air permeability value of yoga sportswear

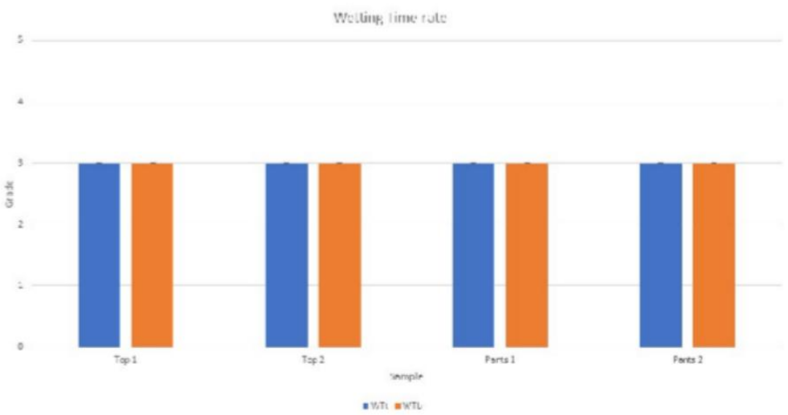

Figure 4. Wetting time of the top and bottom surface of the yoga sportswear

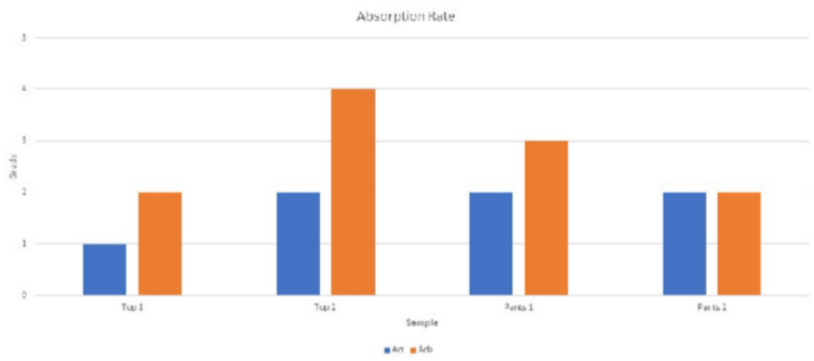

Figure 5. The absorption rate of the Top and Bottom Surfaces of the yoga sportswear

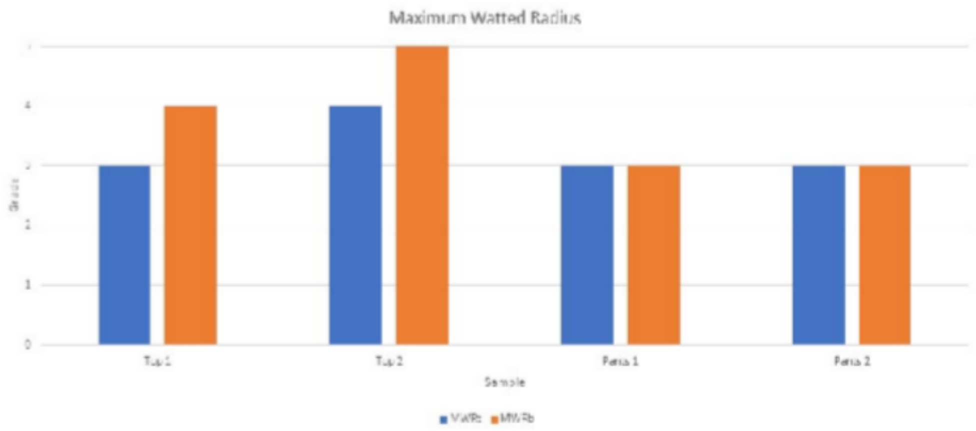

Figure 6. The maximum wetted radius of the top and bottom surfaces of the yoga sportswear

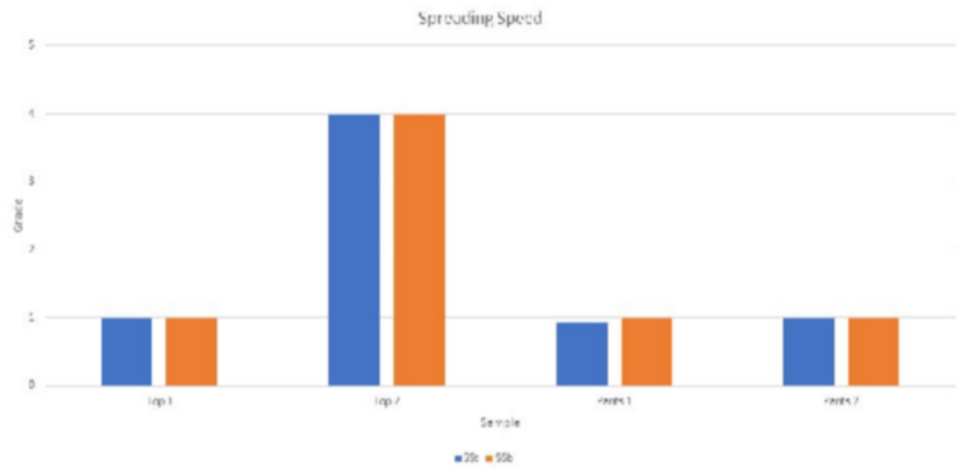

Figure 7. Spreading speed of the top and bottom surfaces of the yoga sportswear

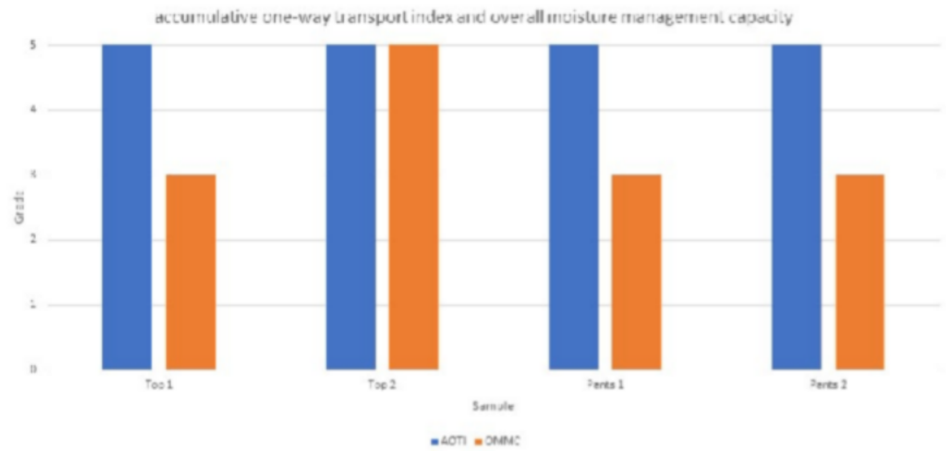

Figure 8. Accumulative one-way transport Index and Overall moisture management capacity of the yoga sportswear

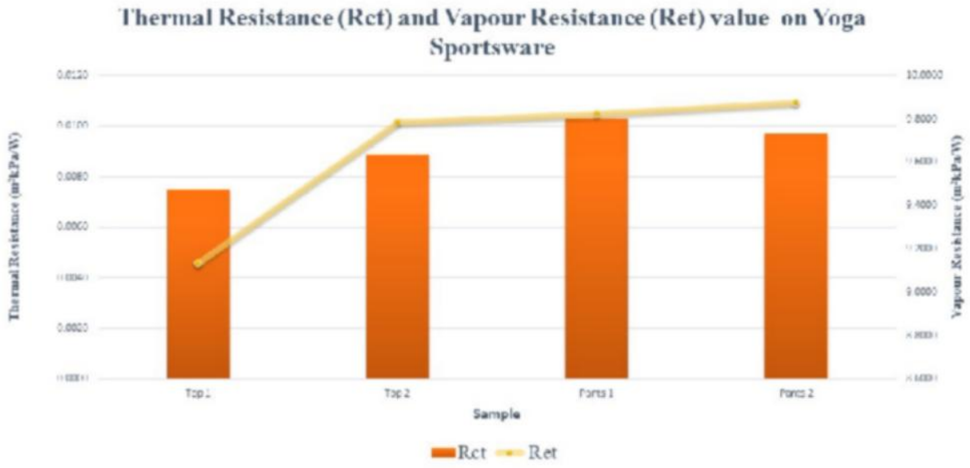

Figure 9. Thermal Resistance (Rct) and Vapour Resistance (Ret) Value on Yoga Sportswear.

3.2. Discussion

a. Physical properties of yoga sportswear

The assessment of physical attributes in yoga sportswear ensures materials and construction meet users' comfort, performance, and durability expectations. Physical tests on fabric samples include measurements of Course per Inch (CPI) and Wale per Inch (WPI), thread count analysis, filament quantity evaluation, and examination of material elasticity. Table 1 shows the test outcomes. Results from examinations of yoga attire for upper and lower body components are as follows:

- The CPI and WPI measure the density of knitted fabrics, with CPI indicating horizontal paths and WPI indicating vertical paths per inch (Wang et al., 2021). Studies on yoga apparel showed the highest CPI and WPI in the upper section for garments with 86.06% polyester and 13.94% spandex and in the lower section for garments with 79.51% polyester and 20.49% spandex. The higher CPI and WPI in fabric A suggest denser material, hindering airflow and potentially raising body temperature, although yoga’s low intensity may mitigate this effect. Lower CPI and WPI fabrics offer greater flexibility, aiding the range of motion required for yoga (Jansen, 2020).
- Thread count, indicating thread thickness in fabric construction, shows that higher counts indicate finer threads (Ul Hoque et al., 2022). The Top 1 upper clothing sample, with 91.13% polyester and 8.87% spandex, had a thread count of 13.59 Tex. A high thread count results in smoother and more comfortable fabrics. While thicker threads enhance durability, they may also reduce comfort. Yoga practitioners prefer soft, flexible attire to thicker garments.
- The filament count in the yarn affects the fabric texture, with higher counts yielding smoother surfaces. The top one and top two upper garment samples for yoga had the highest filament counts. Yarns with more filaments had greater surface areas, aiding sweat evaporation and comfort during yoga. Higher filament counts provide smoother textures, thereby reducing skin friction and irritation during yoga postures.
- Stretchability denotes the ability of a material to extend under stress and revert to its original shape. Elastic fibers such as spandex in stretched materials enable expansion without permanent deformation. In yoga, which involves various postures and extensive stretching, highly stretchable attire is crucial. Such garments permit unrestricted movement, enhance flexibility, and facilitate complex positions, such as splits or backbends. Conversely, low-stretch clothing can cause discomfort, rigidity, and limited movements (Tadesse et al., 2021). The tests showed high stretchability in the pant material, with pants 1 and 2 at 90.28% and 70.07%, respectively. Pant 1 comprised 82.71% polyester and 17.29% spandex, whereas pant 2 had 79.51% polyester and 20.49% spandex. This indicates that highly stretchable materials provide a comfortable fit without excessive skin pressure, snugly fitting without looseness, preventing wrinkles or friction during movement, and minimizing clothing displacement. Moderate to high stretch attire also offers mild muscle compression, aiding blood circulation and reducing muscle fatigue (Shishoo, n.d.). In yoga, this support aids in posture maintenance and stability during poses.

Appropriately stretchable clothing reduces injury risk by accommodating extreme movements without undue joints or muscle pressure. Physical property tests suggested that a balanced fabric density (CPI and WPI) with fine yarn (Yarn Count and Filament) yields comfortable yoga clothing, ensuring optimal softness, breathability, and flexibility.

b. The effect polyester – Spandex fibers on air permeability properties of yoga sportswear

Air permeability is essential to clothing comfort. Figure 2 shows the air permeability test results for four yoga clothing samples. The results indicate that sample Top 1, made of 91.13% Polyester and 8.87% Spandex, had the highest air permeability at 53.86 $cm^3/s/cm^2$. Air permeability measures the ability of a textile to allow airflow, with higher values indicating better airflow through the material, suggesting adequate porosity for air exchange. Fabrics with high air permeability enhance air circulation between the skin and the environment. Polyester and spandex fibers improve clothing air permeability. Although polyester, a synthetic fiber, typically has a compact structure and lower air permeability than natural fibers such as cotton, specialized technologies (e.g., microfibers and microventilation) can enhance its breathability. Properly processed polyesters can significantly improve airflow and maintain the body temperature (Gurarda et al., 2018). Spandex, which is highly elastic and capable of stretching up to five times its length, has low air permeability but adds shape and flexibility to garments without significantly hindering breathability. In yoga clothing, the spandex allows better "breathing" by not restricting movement, despite its lower breathability in larger quantities (Zhao & Wang, 2022).

c. The effect polyester – Spandex fibers on moisture management properties of yoga sportswear

In the current era, the comfort aspect has become a critical consideration in clothing design. The Moisture Management Tester serves as an instrument for evaluating comfort by analyzing the transmission of water and air through fabric materials. Yao et al. (2006), in their research article "An improved test method for characterization of the dynamic liquid moisture transfer in porous polymeric materials," elucidate several key factors to be taken into account when conducting moisture management assessments on porous substrates:

1. Wetting time (WT): The Moisture Management Tester (MMT) evaluates fabric wetting characteristics, focusing on a material's capacity to absorb, distribute, and evaporate moisture. The fabric's inner and outer surfaces serve distinct functions in this process. The exterior is influenced by environmental factors such as air and humidity, while the interior must efficiently absorb and disperse moisture, frequently in direct contact with the skin. Figure 4 illustrates the wetting time results for both surfaces during yoga exercises. All samples in Figure 4 demonstrate a medium wetting time grade of 3 for both surfaces, with a duration of approximately 5-19 seconds, presumably due to the fabric's polyester and spandex composition. Fabrics with high polyester content on the outer surface facilitate exterior wetting but may impede moisture distribution to the interior, potentially reducing comfort by trapping moisture. Conversely, spandex-dominated inner layers enhance moisture evaporation but may decelerate absorption, resulting in a damp sensation on the skin. The polyester-rich outer layer contributes to preventing external moisture penetration and maintaining humidity resistance. In polyester-dominant fabrics, exterior wetting occurs more rapidly, but the interior Absorption Rate (AR) is lower. The Drying Rate (DR) is higher due to polyester's quick-drying properties, although trapped internal moisture may decelerate inner evaporation. In spandex-dominant fabrics, interior spandex can initially impede moisture absorption but enhances evaporation once absorbed, improving the interior Wicking Rate (WR) and Drying Rate (DR) while potentially decelerating initial absorption.
2. Absorption rate (AR): The speed at which the fabric spreads wetness demonstrates its capacity to transfer a solution from the inner surface to the outer surface. Figure 5 illustrates the wetting speed distribution for the yoga apparel samples. Experiments indicated that a material composed of 86.06% polyester and 13.94% spandex exhibited minimal absorption on the top surface and high absorption at the bottom. The hydrophobic nature of polyesters restricts their ability to absorb and distribute liquid. In comparison, the structure of the spandex, but not a significant absorber, enabled the solution to gradually migrate to the outer surface. Lee (2023) determined that a blend of 80% polyester and 20% spandex offered an optimal balance of comfort, flexibility, and moisture management during physical activity.

3. Spreading speed (SS): The test results of Spreading speed on yoga sportswear can be seen in Figure5. Figure 6 depicts the rate at which the liquid spread to reach the maximum wetting radius on the fabric surface. Tests on the speed distribution for the maximum wetting radius revealed that the fabric containing 86.06% polyester and 13.94% spandex demonstrated poor solution distribution on the top surface. The maximum wetting radius is influenced by the physical and chemical properties of the fibers. The hydrophobic characteristics of polyester inhibit water absorption, causing the liquid to spread across the surface instead of penetrating it. Although synthetic, spandex is more hydrophilic and elastic, allowing improved fluid absorption. The combination of polyester and spandex blends results in hydrophobic and hydrophilic properties, affecting the speed of liquid distribution and wetting radius. A higher proportion of spandex leads to a more rapid fluid distribution and larger wetting radius owing to its ability to facilitate fluid spread.
4. Maximum wetted radius (MWR): The fluid propagated radially from its origin, reaching its maximal extent on the fabric's surface. Figure 7 depicts the maximum liquid dispersion on the yoga apparel material. The distribution of fluid on the fabric mimics a diffusion process governed by adhesive and cohesive forces. The adhesion between liquid and fibers influences the rate of spreading across the fabric surface. Enhanced attraction between fluid and fiber accelerates the spreading process (Yao et al., 2006). As evidenced in Figure 7, the fabric comprising 86.06% polyester and 13.94% spandex demonstrated the highest grade. Notwithstanding the spandex component, the predominance of polyester hinders fluid distribution relative to fabrics with greater spandex content. Polyester impedes the liquid's movement on the surface. While the spread radius slightly surpasses that of pure polyester, it remains limited by polyester's hydrophobic properties, focusing on the radial fluid dispersion around the source.
5. Accumulative one-way transport index (AOTI) and Overall moisture management capacity (OMMC): Figure 8 elucidates the fabric's ability to transport solutions unidirectionally from the inner surface (skin-adjacent) to the outer surface (environment) and the corresponding OMMC values. One-way transport capability (OTC) refers to the fabric's capacity to transfer fluids, particularly humidity (e.g., perspiration), from the inner surface (proximal to the skin) to the outer surface (environment). This property is essential in athletic apparel or undergarments, where effective moisture transfer enhances comfort and maintains skin dryness (Pradana et al., 2023). The results demonstrate that the fabric containing 86.06% polyester and 13.94% spandex attains Grade 5 for both AOTI and OMMC values, indicating superior moisture management. Higher spandex content improves the material's efficiency in transporting fluid from the interior to the exterior. Conversely, fabrics with greater polyester proportions exhibit reduced absorption and transport capabilities, resulting in diminished OMMC values.

The moisture property management analysis indicated that an increased spandex content in fabric reduces its capacity for effective moisture removal. This phenomenon is attributed to the elastic nature of spandex, which exhibits a tendency to retain liquids. Conversely, polyester materials demonstrate superior properties for moisture movement and circulation within the fabric structure.

d. The effect of polyester spandex on thermal resistance (Rct) and vapor resistance (Ret) properties of yoga sportswear

Thermal and moisture transfer properties are important factors in determining the thermal comfort of sportswear, particularly during physical activities in which metabolic heat and perspiration are generated. Thermal resistance (Rct) represents the resistance of a textile material to dry heat transfer, whereas water-vapor resistance (Ret) describes the resistance of the material to the transfer of water vapor through the fabric. In general, lower Rct values indicate greater heat transfer through the textile material, while lower Ret values indicate a greater ability of water vapor to pass through the fabric. These two parameters therefore provide complementary information regarding the thermal and evaporative characteristics of clothing materials (Watson et al., 2022).

As shown in Figure 9, differences in Rct and Ret were observed among the four polyester–spandex yoga sportswear samples. Among the investigated materials, the fabric containing 91.13% polyester and 8.87% spandex (Top 1) exhibited comparatively low Rct and Ret values. These characteristics indicate relatively low resistance to heat and water-vapor transfer, which may facilitate the dissipation of heat and moisture vapor from the microclimate between the skin and clothing to the surrounding environment. Such characteristics are desirable in sportswear intended for activities where thermal and moisture regulation contribute to wearer comfort.

However, the differences in Rct and Ret among the samples should not be attributed solely to the polyester–spandex ratio. The investigated fabrics also differed in structural characteristics, including yarn count, filament number, course and wale density, and stretch properties. These parameters can influence fabric thickness, compactness, pore structure, and the amount of entrapped air within the textile structure, all of which contribute to heat and water-vapor transfer. Therefore, the observed thermal behavior is more appropriately interpreted as the combined effect of fiber composition and fabric construction rather than the isolated effect of spandex content.

The relatively low Rct observed in the Top 1 sample suggests that its fabric structure provides comparatively low resistance to heat transfer. In textile materials, thermal resistance is influenced not only by the intrinsic properties of the fibers but also by fabric thickness, density, porosity, yarn arrangement, and the volume of stationary air retained within the structure. Consequently, variations in these structural characteristics among the investigated fabrics may explain the differences in Rct values observed in Figure 9.

A similar consideration applies to water-vapor resistance. Lower Ret values indicate lower resistance to the movement of water vapor through the fabric and are generally desirable for clothing used during physical activity because they facilitate evaporative moisture transfer. The Ret differences observed among the polyester–spandex samples may therefore reflect variations in fabric porosity, density, yarn characteristics, and fiber composition. The interaction of these characteristics determines the pathways available for water vapor diffusion through the textile structure.

Taken together, the Rct and Ret results demonstrate that the thermal comfort characteristics of polyester–spandex yoga sportswear cannot be explained by fiber composition alone. Instead, fiber composition and fabric construction should be considered simultaneously when selecting materials for yoga apparel. Within the samples evaluated in this study, fabrics exhibiting relatively low resistance to both heat and water-vapor transfer may provide more favorable conditions for maintaining thermal and evaporative comfort during yoga activities. Nevertheless, these findings represent fabric-level thermal comfort characteristics and should not be interpreted as direct evidence of changes in body temperature, physiological responses, or athletic performance, as these parameters were not evaluated in the present study.

4. Conclusion

This study evaluated the thermal and moisture management characteristics of four commercially available polyester-spandex fabrics used in yoga sportswear. The results demonstrate that the investigated fabrics exhibited different air permeability, moisture-management, thermal resistance, and water-vapor resistance characteristics. Among the tested samples, the fabric containing 86.06% polyester and 13.94% spandex demonstrated favorable liquid moisture-management properties, achieving Grade 5 for both AOTI and OMMC. In contrast, the fabric containing 91.13% polyester and 8.87% spandex exhibited the highest air permeability and comparatively low thermal and water-vapor resistance.

The results further indicate that thermal comfort cannot be attributed solely to the polyester-spandex ratio because differences in fabric construction, yarn characteristics, density, and stretch may simultaneously influence heat and moisture transfer. Therefore, the findings should be interpreted as a comparative evaluation of the tested commercial fabrics rather than as evidence of a universally optimal polyester-spandex composition.

This study provides material-level information that may support the selection and development of yoga sportswear with favorable thermal and moisture-management characteristics. Because physiological responses and athletic performance were not evaluated in human participants, conclusions regarding improvements in yoga performance or athletic performance cannot be drawn from the present study. Future studies should integrate fabric characterization with wear trials and physiological or subjective comfort assessments.

5. Acknoledgement

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