# DEVELOPMENT OT TRI-LAYERED KNITTED FABRIC FOR SPORTS WEAR APPLICATION

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## ABSTRACT

*In recent years, there has been an increase in revolution of sportswear to provide high comfort ness and to achieve the perfect fit. The elements that are considered while developing fabric for sportswear are fabric, type of yarn, fibre technology and techniques to acquire high performance and comfort of fabric. There has been a use of textile technology and science for the manufacturing of leisure and sportswear to fulfil the needs for the sports activities for their greater performance. Sports fabrics are materials which are used technically that help the wearer to be more comfortable while practicing sports, the fabric will be based on moisture and high heat management properties, particularly good elasticity, quick drying and extremely breathable, to obtain thermal and moisture management properties, creation of fabrics with multi layers is incredibly significant to get preferable comfort for clothing. The present research work emphasizes on development of fabric for sportswear with tri layers using yarn such as viscose, micro denier polyester, polypropylene of interlock structure using circular knitting machine as these yarns are more favorable for making of sportswear and to discuss the test results of fabrics for their comfort properties.*

**Keyword:** *Tri layer fabric, viscose, Micro Denier polyester, polypropylene, interlock, moisture management properties, comfort properties*

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## 1 INTRODUCTION

Sportswear is a type of functional garment that is used by people while they go for run, exercise, etc. Type of wear when indulge in physical activity. In consider to make workout session more comfortable people prefer clothing that enables to move quickly and reduces perspiration. Therefore, sportswear was created with significant types of material. In recent years, there has been an increase in revolution of sportswear to provide high comfort ness and to achieve the perfect fit. The elements that are considered while developing fabric for sportswear are fabric, type of yarn, fibre technology and techniques to acquire high performance and comfort of fabric. There has been a use of textile technology and science for the manufacturing of leisure and sportswear to fulfil the needs for the sports activities for their greater performance. Sports fabrics are materials which are used technically that help the wearer to be more comfortable while practicing sports, the fabric will be based on moisture and high heat management properties, exceptionally good elasticity, quick drying and extremely breathable, to obtain thermal and moisture management properties, creation of fabrics with multi layers is incredibly significant to get preferable comfort for clothing. The better Thermal – physiological regulation is achieved by use of microfiber yarn. The wettability features of polyester, cotton, and multi-layered polyester/cotton fabrics to regulate human perspiration were investigated by Sharabaty et al, and it was discovered that multi-layered textiles have a higher wicking coefficient. Compared to cotton fabrics.

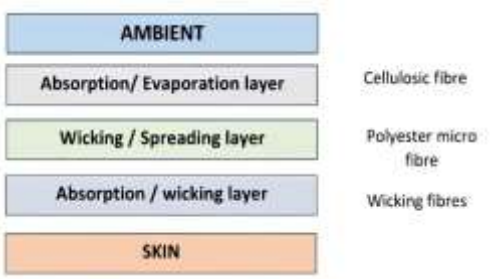
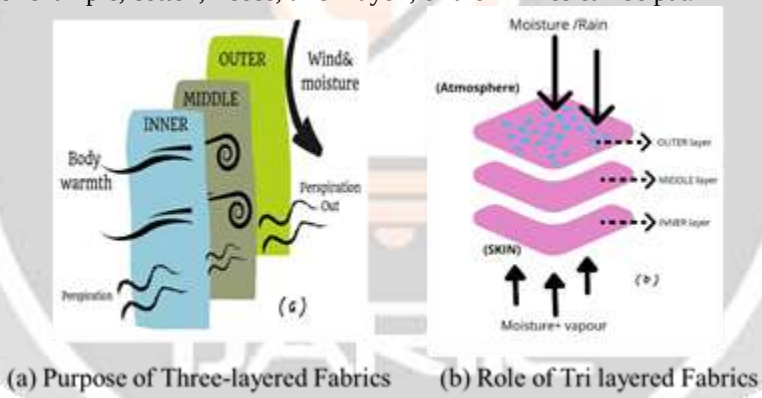



**Fig -1**: Tri-layered Fabric Structure for Sports Wear

The impact of clothes on individual comfort and performance at work or in sports is particularly important since physiological pressures can reduce a person's physical and mental capabilities [3]. Physiological, psychological, ergonomic, and skin sensory factors are the four main aspects of wear comfort [4]. Thermo-physiological comfort is a broad term that refers to a variety of factors including fabric thermal qualities, water vapour transport, sweat absorption, and drying capabilities [5]. To eliminate wetness on the skin, the clothing should be able to release moisture vapour trapped in the climate to the atmosphere [6]. To feel comfortable while strenuous activity when liquid sweat generation is strong, garments should have adequate liquid transfer properties [13]. Wicking is a key quality for maintaining a comfortable feeling while sweating. The capillary hypothesis is used to quickly extract perspiration and moisture from the skin's surface, transfer it to the surface of the fabric, and then dissipate it [14]. Many examinations have been focussed on double face structures to accomplish significant degree of solace [15-18]. The presentation of layered texture in thermo-physiological guideline is better than single layer material construction [19, 20]. In the inward side of a different layer material, a manufactured material with great dampness properties, like polyester, nylon, acrylic, or polypropylene is utilized though outwardly, a material which is a decent spongy of dampness, for example, cotton, fleece, thick rayon, or their mixes can be put.




(a) Purpose of Three-layered Fabrics (b) Role of Tri layered Fabrics

**Fig -2**: Functions of Tri-layered Fabric Structure

Layering materials that are likely to be worn as clothing has a significant impact on qualities such as air and water vapour permeability, thermal resistance, and thermal conductivity. The moisture content of a single layer fabric is determined not only by the material qualities of that layer, but also by the material properties of adjacent layers or even the entire combination [2]. Layered fabric has become usual for active sportswear. The Thermal physiological regulation performance of the layered fabric is far better than single layer. Each layer as definite function thus the layer following the skin must be away perspiration quickly to outer layer, which take up and dissipates it speedily to aura by evaporation. . By performing this, it helps to remove some of hotness from body and keep it cool. For inside layer, a synthetic material with nice moisture property is used; on the other hand, outer material is good moisture absorber example -viscose.

Multi-layered textiles heat resistance rises as the unit mass area rises [29]. The moisture content of single layer is affected not only by its own material properties, but also by those of neighbouring layers [31]. To improve the moisture management qualities of multi-layered fabrics, diverse types of yarns are utilised in the inner and outer layers [32]. The ability of clothes to transmit heat and vapour, absorb perspiration, and dry depends on their thermal comfort [14]. The thickness of air gaps in textiles, air humidity, and fabric water absorption all influence water vapour transit and condensation.[25] knitted fabrics have several advantages that other technologies have not been

able to match. These fabrics continue to be used in modern and innovative products. So, to have solace textiles material with good thermal and comfort properties tri layered knitted fabric of interlock structure were manufactured in this research work. The main purpose of this research work is to develop a tri layered knitted fabric and to determine the thermal and comfort properties.

## 2. MATERIALS AND METHODS:

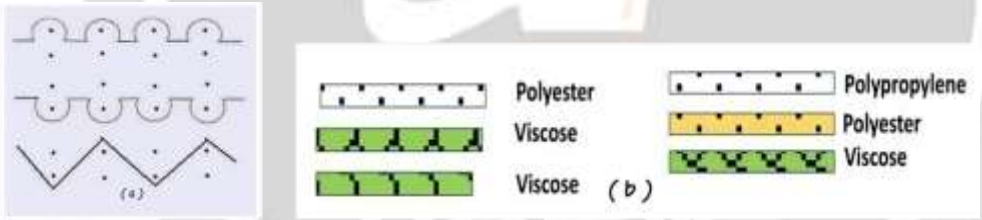
To reinforce the thermal and comfort properties of sportswear, 2 types of Three-layered fabric were produced from yarn such as viscose (40 S), micro denier polyester (40 S), polypropylene (30 S) in two different combinations. They were produced in 2 types PP/MDP/V and MDP/V/V.

In PP/MDP/V combination fabric, the top layer of fabric contains polypropylene and the middle layer contain MDP, the bottom layer i.e.) layer that is in contact with the skin contains viscose. THE BOTTOM Layer is formed with viscose as they can absorb the water and sweat nicely, making it greater for t-shirt and sports material. Viscose is extremely airy forming it a light weight and breathable fabric. viscose makes the body cool, comfortable and dry. The middle Layer IE) The connecting layer contains micro denier polyester that assist the moisture transfer from inner layer to outer layer. MICRO denier polyester which has high ability of wicking acts as an effective medium to transfer moisture from inner layer to outer layer. It is also more stain resistant than other fabrics and they are repeatedly used in athletics types of wear as they move the perspiration away the body and cools the body of wearer by subsequent evaporation. They are very elastic and they also withstand and hold it in shape. It is an excellent choice when there is a need for extra warmth. The top layer which contains PP is light fast, soft, and easy to clean. They have no active dye sites; no allergic reactions are caused by PP as they have a hygienic structure. polypropylene can provide high strength at necessary ratios and they also have anti-bacterial properties. The composition of distinct types of Three-layered fabrics produced are listed below.

Sample 1: (PP/MDP/V) made of polypropylene (top layer), micro denier polyester (middle layer), viscose (bottom layer).

Sample 2:(MDP/V/V) made of micro denier polyester (top layer), viscose (middle layer) and viscose (bottom layer).

An interlock circular knitting machines are used to produce three layered fabrics. the structure of three-layer fabric for knitting is given below in fig




.(a) Knit Structure of 3 Layer Fabric (b) Types of Fabrics Used

**Fig -3**: Arrangements of 3 layer knit structure.

## 3. TESTING PROCEDURE

The fabric strength and fabric geometry has been tested from the three-layered fabric that were created. Fabric geometry such as loop length, Wales per inch, course per inch, stitch density and GSM test were conducted. Fabric properties such as water vapour permeability (BS 7209), Rate of water spreading using standard testing methods. FABRIC WEIGHT PER UNIT AREA, tensile properties thickness and other physical properties of fabric were calculated for all three-layered fabric. Thermal conductivity (ASTM D 5930) was measured and the fabric ability to absorb water as per AATCC 79 were measured in terms of spreading action and absorption rate. Longitudinal wicking has also been conducted. Air permeability of treated fabric was measured in terms of cm3/cm2/s, using ASTM D 737-2004 test standards. The rate of water diffusion through the layered fabric was evaluated.

**Table -1:** Machine Specifications

| DESCRIPTION | SPECIFICATIONS |
|---|---|
| Machine type | Circular knitting machine |
| Machine model | Orizio |
| Machine diameter | 26 |
| Gauge | 24 |

| | |
|---|---|
| No. of. Feeders | 48 |
| No.of. Needles | 1956 |
| Revolution per minute (rpm) | 20 |

## 4.1. RESULT AND DISCUSSION

The three-layered fabrics of two types were tested for parameters of fabric and conclusions are listed down.

(i) SAMPLE 1: POLYPROPYLENE / MICRO DENIER POLYESTER/VISCOSE - 37 Wales per inch ,31 course per inch,0.3 loop length ,0.8 stitch per inch and GSM of the fabric is 279.46 g/m2 ,the thickness of fabric is 0.94 mm.

(ii) SAMPLE 2: MICRO DENIER POLYESTER/VISCOSE/VISCOSE - 43 Wales per inch ,36 course per inch,0.32 loop length, stitch per density is 0.82 and GSM of the fabric is 265.58 g/m2 , thickness of the fabric is 0.83 mm.

**Table -2:** Testing results

| **Parameters** | | **Sample 1** | **Sample 2** |
|---|---|---|---|
| **Longitudinal wicking** | **30 sec** | 6.5 | 7.4 |
| | **1 min** | 7.4 | 8.6 |
| | **5 min** | 11.6 | 12.4 |
| | **15 min** | 13.8 | 14.5 |
| **Water absorption %** | | 109.4% | 129.9% |
| **Thermal Conductivity (Clo)** | | 0.045 | 0.027 |
| **Wettability (sec)** | | 1.5 | 1.4 |

### 4.2 Longitudinal Wicking:

To track the passage of water, a 5 × 1 inch strip of test fabric was stretched vertically with its lower end 2.5 cm soaked in a reservoir of distilled water. After 1,5 and 15 minutes of water moving upward on a strip of fabric, the wick up movement of water spreading by capillary action was seen. A dye can be introduced to the water to detect the position of the water line. The height of rise measured in a particular time is used as a direct indicator of the test fabric's Wick ability.

The longitudinal wicking tester works on the capillary action principle. A vertically clipped 5x1 inch strip of test fabric is clipped on the tester's stand. The lower end of the 2.5cm length is immersed in water. After aa period, the rise of water capillary forces on a strip of fabric has been observed. The measured height of rise over a period is used to determine the wick of the test fabric's capabilities. Fiber composition, yarn count and tightness, have significant effects on longitudinal wicking. The tight fabric will give a significant higher longitudinal wicking. [ 27] The coarser yarns wick faster than the finer yarn [28,29].

### 4.3 Water absorption:

The rate of water absorption is graphed below, the micro denier polyester/viscose/viscose fabric shows higher rate of water absorption due to the combination of fabrics that have magnificent moisture absorption and transporting effects. The process involves a wettability of fabric, a small square specimen of 2.5*2.5 cm is slit and it is dropped on the water surface. The time taken is measured until the specimen sink below the water surface.

### 4.4 Thermal Conductivity:

The thermal conductivity rate of the three-layered fabrics is listed below; PP/MDP/V - 0.817w/mk-1 and for MDP/V/V - 0.254 w/mk-1. The key factor that effects heat transfer through the cloth are fabric thickness, still air and the exterior air movements are the factors that influence the heat transfer was proved by Milenkovic et al. Morris [30] provided a study on thermal characteristics of textile, concluding that with increase in density the thermal conductivity increases, related to his findings when two fabrics of similar thickness, there will be a greater thermal insulation in the fabric with low density.

### 4.5 Wettability:

The time taken by the two types of three-layered fabric to wet has been observed. The time take by the PP/MDP/V -1.5 seconds and by MDP/V/V - 1.4 seconds. The water absorbency is affected by the texture and porosity of the fabric. [33]. It decreases with increases in density.

## 5. CONCLUSION

The thermal conductivity and wick ability of the tri-layer weft knitted fabrics contribute to the garment comfort attributes required by the user. This fabric has several unique practical qualities, such as moisture absorption, in

which moisture from the body is received by the bottom layer, transferred through the connecting layer, and dissipated by the top layer. The interlock knitted structure have good dimensional stability that is very essential for performance in sports apparels. Based on the analysis of three-layered fabric made of polypropylene/micro denier polyester/ viscose combination and micro denier polyester / viscose/viscose combination the subsequent results were drawn. The three-layered fabric containing micro denier polyester, viscose, viscose has high water vapour permeability, air permeability, water absorption and good thermal conductivity due to the use of viscose fabric this sample experience particularly good comfort properties than the other three-layer fabric consisting polypropylene, micro denier polyester and viscose. The use of micro denier fabric provides greater dimensional stability than the other fabrics which is distinguished by stitch density and tightness factor.

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