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# Investigation on Comfort Properties of Conventional Cotton and Organic Cotton of Knitted Fabric Structures

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**Abstract** The work reported in this paper is the resultant highlights of thermal properties of 100 % conventional cotton and 100% organic cotton based single jersey, 1×1 rib and interlock structures. The selected thermal properties of samples knitted fabric structured were measured. The results indicate that each knitted structure shows distinguished thermal comfort properties. Interlock and 1×1 rib fabrics have a greater thermal conductivity and thermal resistance value and thus better for winter garment products. On the other hand, single jersey fabrics of both conventional and organic cotton have greater moistures management properties with higher relative water vapour permeability values than 1×1 rib and interlock fabrics, and give a warmer feeling and hence more fruitful and could be chosen for active sports and summer apparel products.

**Keywords** Knitted Fabrics, Vapour Permeability, Thermal Comfort, Thermal Resistance, Summer Apparel

## 1. Introduction

The demand for knit garment products all over the world are rapidly growing because of more interest in knitted fabrics due to its simple production technique, low cost, high levels of clothing comfort and wide product range. Knitting technology meets the rapidly-changing demands of fashion and usage. Knitted fabrics not only posses stretch and provide freedom of movement, but they also have good handle and easily transmit vapour from the body [1]. That's why knitted fabrics are commonly preferred for sportswear, casual wear and underwear [2]. The term comfort is defined as "the absence of displeasure or discomfort" or "a neutral state compared to the more active state of pleasure" [3]. Clothing comfort includes three main considerations: psychological, sensorial and thermo-physiological comfort. The thermo-physiological comfort, the subject of this research, entails both thermoregulation and moisture management. It is known that fibre type, yarn properties, fabric structure, finishing treatments and clothing conditions are the main factors affecting thermo-physiological comfort [4]. Greyson [5] and Havenith mentioned that heat and water vapour resistance increases with the increment of material thickness and air entrapped in the fabric. Thermal properties of 1×1, 2×2 and 3×3 rib knit fabrics were compared by Ucar and Yilmaz [1]. We investigated the effect of fabric structure on thermal properties.

## 2. Experimental Materials and Methodology

### 2.1. Material

In this study the fabric structures chosen for the study named by single jersey, 1×1 rib and interlock structures and were knitted using 100% conventional and100% organic cotton (Co, $26^s$) yarn having GSM 150, 240 and 260 respectively. The knitting process of the samples single jersey fabrics was performed on 24, 20 & 18 gauges and 30" diameter having stitch length 1.25 mm, 1.45 mm & 1.7 mm on FUKAHARA (Taiwan) circular knitting machine. All machine settings on each machine were kept exactly the same during the knitting process.

### 2.2. Methods of Testing

An Alambeta instrument was used to measure thermal conductivity, thermal resistance, sample thickness and to calculate all the parameters of the measurement. The air resistances values of single jersey rib and interlock fabric structures were measured with the help of Kawabata evaluation system (KES-F8-API) under automatic air permeability tester [6]. The KES air resistance values were converted into Frazier type tester [7] values with the help of following relationship:

Air permeability ($ft^3/ft^2$.min) = 24.58/R, Where, R is the

air resistance values of KES-F8-API. And the thermal diffusion of the various knitted structures was calculated by substituting the thermal conductivity parameter in equation:

A ($m^2$s-1) = $\gamma/\rho.c$ Where, A is the thermal diffusion, $\gamma$ is thermal conductivity $\rho$ is thermal density and c is specific heat capacity [8].

Relative water vapour permeability was measured on a Permetest instrument by a similar procedure to that given by Standard ISO 11092 [10]. All the measurements were done in controlled laboratory conditions of 23°C temperature and 55 % RH. The aim of this research was the comparison of the thermal properties of single jersey, 1×1 rib and interlocks structures knitted using 100 % conventional cotton, 100% organic cotton.

## 3. Results and Discussions

The thermal properties of some selected fabric structures named single jersey, 1x1 Rib and interlock fabric from 100% conventional cotton, 100% organic cotton are shown in table 1. Because of both knitted structures and fiber type variations significant differences are observed.

### 3.1. Thermal Conductivity

Thermal conductivity is an intensive property of a material that indicates its ability to conduct heat. According to Figure 1 thermal conductivity increases depending on the single jersey, 1×1 rib and interlock structures of the cotton and polyester fabric samples. This situation can be explained by the amount of entrapped air in the fabric structure. The amount of fibre in the unit area increases and the amount of air layer decreases as the weight increases. As it is known, thermal conductivity values of fibres are higher than the thermal conductivity of entrapped air [8]. So, heavier the fabrics that contain less still air (like interlock) have higher thermal conductivity values.

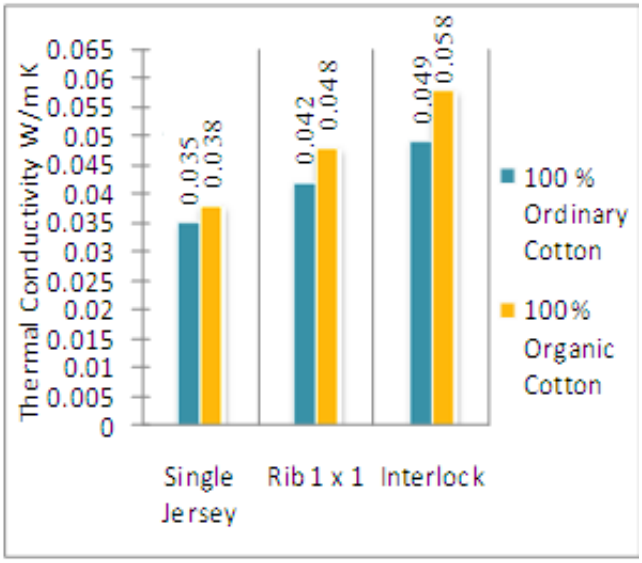


**Figure 1.** Thermal conductivity values of single jersey 1x1 rib and interlock fabric

**Table 1.** Thermal properties of S/J, 1×1 rib and interlock structures (100% conventional cotton fabric)

| Fabric Properties Name | Fabric Structures | | | | | |
|---|---|---|---|---|---|---|
| | (100% Conventional Cotton) | | | (100% Organic Cotton) | | |
| | Single Jersey | 1x1 Rib | Interlock | Single Jersey | 1x1 Rib | Interlock |
| Thickness, mm | 0.82 | 1.21 | 1.43 | 0.84 | 1.25 | 1.44 |
| Air permeability in $ft^3/ft^2$.min | 52.87 | 77.23 | 19.45 | 54.57 | 79.29 | 23.55 |
| Weight in unit area, $g/m^2$ | 148 | 236 | 254 | 152 | 238 | 258 |
| Water Vapor Permeability,% | 41.12 | 36.31 | 32.11 | 43.10 | 38.30 | 35.10 |
| Thermal conductivity, W/m K | 0.035 | 0.042 | 0.049 | 0.038 | 0.048 | 0.059 |
| Thermal resistance, $m^2$ K/W | 0.027 | 0.029 | 0.033 | 0.024 | 0.027 | 0.032 |
| Thermal absorptivity, W $s^{1/2}/ m^2K$ | 87 | 105 | 112 | 85 | 102 | 111 |
| Thermal diffusion in $m^2s^{-1}$ | 0.027 | 0.031 | 0.015 | 0.026 | 0.032 | 0.013 |

### 3.2. Air Permeability

The resistance of a fabric to the flow of air is a measure of the initial warm/cool feeling when the garment is worn. The higher the air flow value, the greater the intensity of the warm/cool feeling will be. The effect of air permeability on comfort properties is much greater when the speed of air is high, for example, in stormy weather conditions [10]. The results of air permeability, in terms of the amount of air passing through a unit fabric area per unit time, are given in figure 2. The result shows that organic fibers, being smoother, circular and coarser as compared to cotton fibers assist the easy passage of air through the yarn cross-section, which results in higher air permeability.

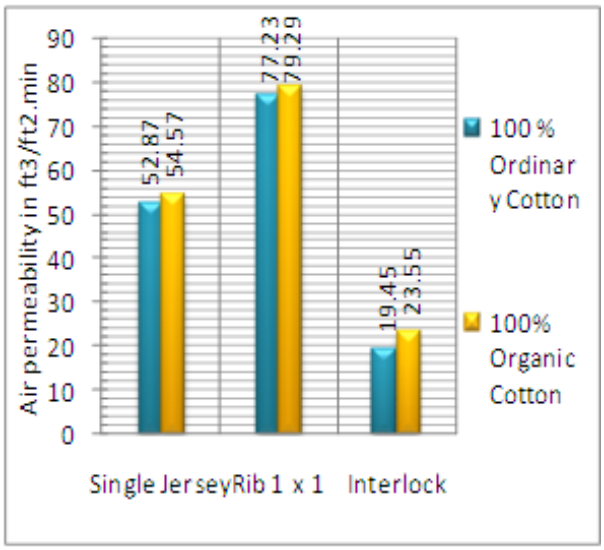


**Figure 2.** Air permeability values of single jersey 1x1 rib and interlock fabric

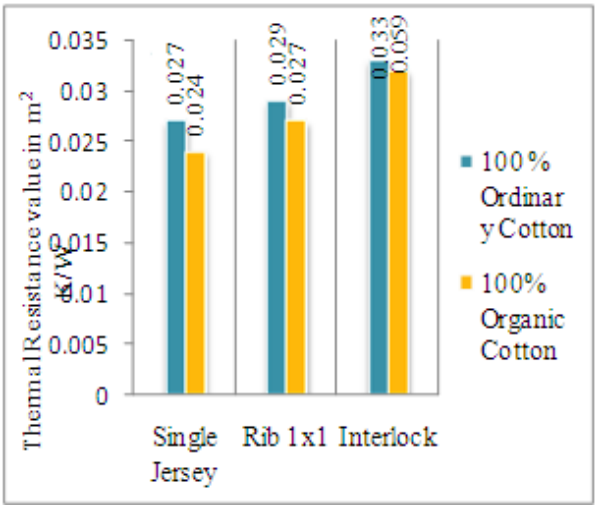


**Figure 3.** Thermal resistance values of single jersey, 1×1 rib and interlock fabrics

### 3.3. Thermal Resistance

Thermal resistance is a measure of the body's ability to prevent heat from flowing through it. Under a certain condition of climate, if the thermal resistance of clothing is small, the heat energy will gradually reduce with a sense of coolness [9]. As can be seen from the results (Figures 3 and 4), as the fabric thickness increases the thermal resistance also increases. Both the ordinary cotton and conventional cotton fabric samples gave the lowest thermal resistance values for the single jersey structure, and the greatest values were obtained for the interlock structure (Figure 3). However, the test results revealed that as thermal conductivity increases thermal resistance increases as well. This contradiction might be explained by the fabric thickness [11]. If the amount of increase in fabric thickness is more than the amount of increase in thermal conductivity, thermal resistance will also increase. And a significant increase is seen in the fabric thickness value, respectively.

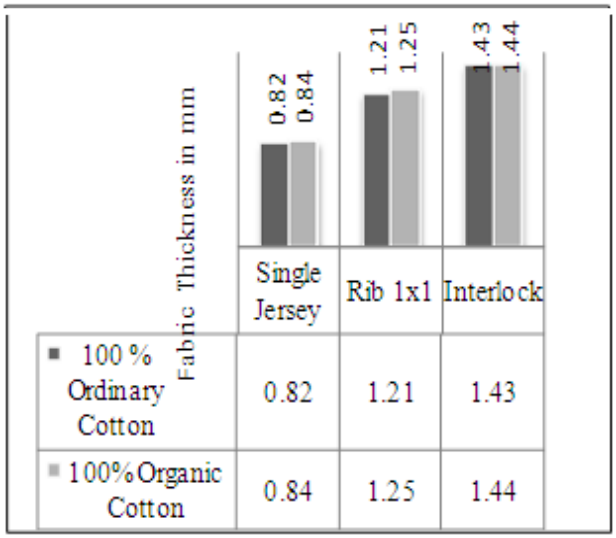


**Figure 4.** Thickness of S/J, 1×1rib and interlock fabrics

### 3.4. Thermal Absorption Properties

Thermal absorptivity is the objective measurement of the warm-cool feeling of fabrics. When a human touches a garment that has a different temperature than the skin, heat exchange occurs between the hand and the fabric. If the thermal absorptivity of clothing is high, it gives a cooler feeling at first contact [12]. In both cotton fabrics, the interlock fabrics with the highest thermal absorptivity values, gave the coolest feeling at the beginning of skin contact (Figure 5). This situation is explained by the construction of the fabric surface. The surface area between the fabric and skin is bigger for smooth fabric surfaces and these structures cause a cooler feeling.

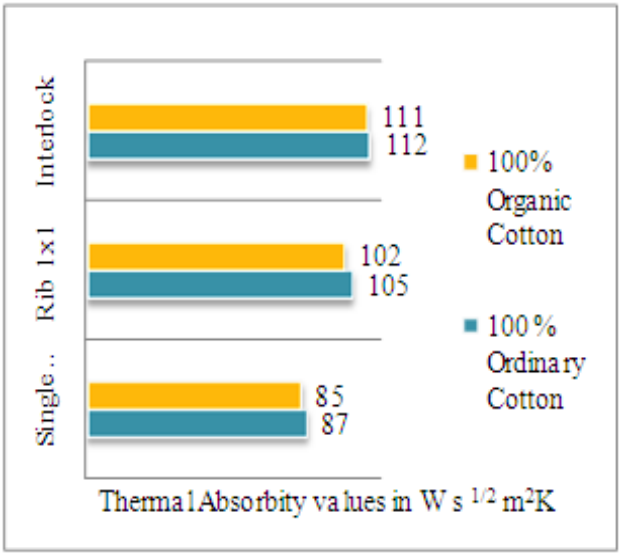


**Figure 5.** Thermal absorptivity values of single jersey, 1×1 rib and interlock fabrics

### 3.5. Relative Water Vapour Permeability

Water vapour permeability is the ability to transmit vapour from the body. If the moisture resistance is too high to transmit heat, by the transport of mass and at the same time the thermal resistance of the textile layers considered by us is high, the stored heat in the body cannot be dissipated and causes an uncomfortable sensation [13]. It can be seen from Figure 6 that relative water vapour permeability values of both cotton fabric samples increase depending on the interlock, 1×1 rib and single jersey fabrics. Because the transportation of water vapour through a thin fabric will be easier.

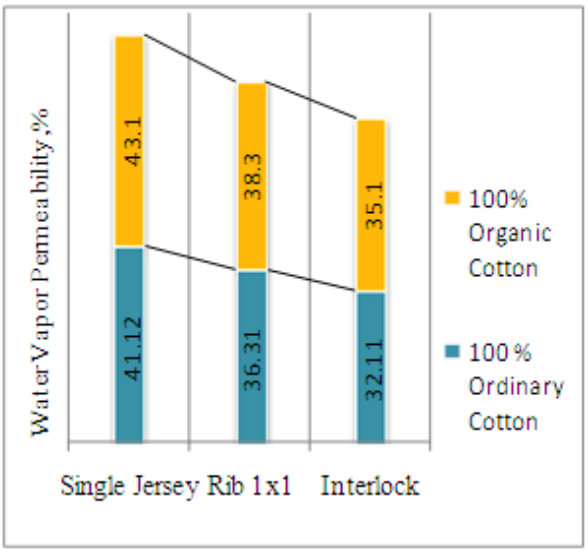


**Figure 6.** Water vapor permeability in $m^2s^{-1}$ of single jersey 1×1rib and interlock fabrics

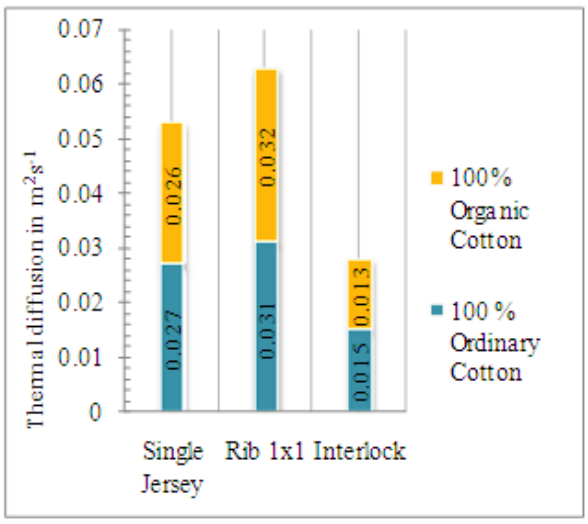


**Figure 7.** Thermal diffusion values in $m^2s^{-1}$ of single jersey 1×1rib and interlock fabrics

### 3.6. Thermal Diffusion

Thermal diffusion values of single jersey, rib and interlock fabric made out from conventional cottonand organic cotton is shown in figure 7. A significance difference is observed in case of various knitted structured. This is mainly due to the thickness and density variation of single jersey, rib and interlock structures [13]. The air permeability and fabric tightness factor play important role in the thermal diffusion variation of knitted fabric

## 4. Conclusions

As time get ahead of, knitted garments are getting more and trendier throughout the whole globe. This escalating demand of knitted garments is only due to comfort ability and comparatively lower price of knit fabrics. The earlier factor of knitted fabrics, rising demand entirely depends on the thermal properties. In this paper various comfort properties of conventional and organic cotton knitted fabrics with single jersey, 1×1 rib and interlock structures were discussed. Due to the variations in structural properties, single jersey fabrics have lower thermal conductivity and thermal resistance values as well as higher relative water vapour permeability values than 1×1rib and interlock fabrics. They also give a warmer feeling due to lower thermal absorptivity values. . Hence also because of better moisture management and thermal properties, single jersey structured fabrics are more fruitful and should be chosen for active sportswear and summer apparel products. In case of the double jersey fabrics, it can be seen that the interlock structures have higher thermal conductivity and less water vapour permeability. So it is suitable for winter wear also helpful where cold weather along with heavy wind blowing situation. So, it has been proven that different knitting structures have different comfort properties. Therefore, to achieve the ideal clothing comfort, it is necessary to consider the end use of the products while selecting the fabrics. If we compare for single jersey, 1×1 rib and interlock fabrics, organic cotton will be better to use for a warmer feeling. It is also seen from the results that organic cotton fabric provides better thermal comfort over conventional cotton in most of the areas. So the production of organic cotton & using it is encouraged for both the farmers& consumers.

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