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Drape behaviour of functional knitted fabrics for sport clothing

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The influence of polyester/functional fibre blends on the drape properties of knitted fabrics for sport clothing application has been studied. Several knitted fabrics have been produced using polyester fibre blended, in different percentages, with functional fibres like Outlast, Dry release, Aquator, Polybutylene terephthalate and Bioactive. The drape and flexural rigidity behaviour of the materials produced have been evaluated to optimize the composition of functional knitted fabrics based on polyester/functional fibre blends. It is observed that the knitted fabrics produced with polyester/Outlast blends show the most interesting drape behaviour. On the other hand, polyester/polybutylene terephthalate and polyester/Aquator fabrics show lower drape behaviour due to the types of fibre used. Moreover, relationships between the amount of functional fibre and the drape and flexural rigidity behaviour are also established. The study is useful to design sport clothing for professional football players.

Keywords: Drape, Flexural rigidity, Functional fibre, Polyester fibre, Sensorial comfort, Sport clothing, Thermal comfort

1 Introduction

Comfort can be defined as a pleasant physical, physiological and psychological equilibrium state between the human being and the environment.[1] However, many authors consider the following views for comfort [1-7]:

- Thermophysiological – It is related with the good thermal balance between heat generation and heat loss of the human body. Some factors related to this comfort parameter are metabolism, thermal regulation mechanism and individual health conditions. The parameters related with apparel properties include moisture absorption and release, air and vapour permeability, thermal conductivity and insulation.
- Psychological comfort – This refers to intrinsic characteristics of the clothing visual design as texture, colours, shapes and others features related to the user's feelings. Some associated factors with aesthetic specifications are the self confidence, self image , social interaction and respecting others.
- Sensorial comfort – It involves the tactile perception of sensations obtained by mechanical or thermal contact between skin and clothing. Surface characteristics of fabric and the mechanical properties, such as flexural rigidity, are some of the characteristics perceived through the human body sensory mechanisms.

Drape is defined as 'the extent to which a fabric will deform when it is allowed to hang under its own weight' (BS 5058: 1973, 1974). Some parameters, such as thickness, shear, mass per unit and surface properties, significantly affect the drape behaviour. According to Pandurangan,[8] the factors influence the drape behaviour in the following order: compression < surface < weight < shearing < tensile < bending.

The drape coefficient (F) is the most fundamental parameter for quantifying drape and the most widely used for textile materials. Drape capacity of knitted fabrics is an important factor which interferes and influences the functionality and aesthetic of clothing. For sports clothing, drape is a fundamental factor once it determines the adjustment and formability of clothing to shapes and movements of the human body.[9, 10]

Other important property in knitted fabrics is the flexibility from which the flexural rigidity coefficient (G) can be calculated using integrating length, weight and thickness.[5, 6, 8-12]

Drape and flexibility provide a sense of fullness and a gracefulness appearance, which distinguishes knitted fabrics from other materials.[10-12]

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The present paper reports the study on the influence of amount of functional fibres on the drape and flexibility behaviour of functional weft-knitted fabrics for sport clothing purposes. Different plain weft-knitted fabrics have been produced based on polyester fibre and varying amount of functional fibres, with regard to thermal regulating, moisture management and bioactive properties.

2 Materials and Methods

Several single jersey weft-knitted fabrics were produced based on different blend compositions. Blends of polyester and functional fibre, procured commercially, were used to produce knitted fabrics. The functional fibres used and the corresponding functionality are given in Table 1.

Table 2 shows the characteristics of the knitted fabrics produced. The knitting parameters have been kept constant for the whole set of knitted fabrics. The variability in thickness is the result of the functional fibre physical properties itself.

Drape coefficient was calculated by using the drape apparatus according to AFNOR G07 – 109. It is calculated based on the averaged diameter of 16 measurements from the centre point of the disc to the fabric edge. A single number is obtained for the drape coefficient, a theoretical maximum of 1 and a theoretical minimum of 0, where 0 corresponds to a very flexible and 1 a very stiff material. [6, 8]

The flexural rigidity tests were carried out according to the BS 3356:1961. This standard describes a method for determination of the flexural rigidity coefficient of textiles by means of a fixed angle flexometer. This coefficient is calculated for course-wise and wale-wise directions and depends on the knitted fabric thickness.

3 Results and Discussion

3.1 Drape

Figure 1 shows the results obtained for all knitted fabrics. For the blend PES/PBT, there is a direct relationship between the amount of PBT in the knitted fabric and its drape coefficient. This behaviour may be explained by the higher stiffness of PBT fibre yarns. In the blend PES/AQT, the drape coefficient increases with the increase in AQT amount in the knitted fabric. A clear trend may be identified between AQT amount and drape coefficient, i.e. the more the amount of the AQT the more is the fabric rigidity.

For PES/BA knitted fabrics, the results in Figure 1 show that the amount of BA in the knitted fabric does not influence significantly the fabric drape coefficient. This fact is explained by the same type of raw material (polyester) in both the fibres. For PES/OUT knitted fabrics, it is observed that the drape coefficient decreases as the amount of OUT increases. This means that the OUT fibre makes the fabrics more flexible.

For the PES/DR knitted fabrics (Fig. 1), an increase in the DR amount is leading to a more flexible fabric. This means that the cotton fibre existing in the DR has positive effect on this factor.

Table 1—Fibres used in the study and their functionality

Fibre	Commercial name	Functionality
Polyamide	Aquator (AQT)	Moisture management
Polyester (PES)	Bioactive (BA)	Antimicrobial action
Viscose	Outlast (OUT)	Thermal regulation
Polyester/cotton (85:15)	Dry release (DR)	Moisture management and quick drying

Table 2—Knitted fabrics specifications

Fibre combination	Thickness mm	Mass g/m^2	Cover factor (k)
PES/PBT			
83:17	1.65	296.49	15.99
66:34	1.58	308.40	15.93
50:50	1.57	321.03	15.93
34:66	1.60	339.23	16.26
17:83	1.61	343.84	16.08
PES/Aquator			
83:17	1.72	319.25	15.49
66:34	1.82	353.40	15.31
50:50	1.97	360.43	14.89
34:66	2.06	414.23	14.62
PES/Bioactive			
66:34	1.87	384.02	15.96
50:50	2.29	319.48	15.34
17:83	3.13	359.01	15.83
PES/Outlast			
66:34	1.98	345.88	16.37
50:50	1.78	271.25	15.59
17:83	1.54	266.52	15.53
PES/Dry release			
66:34	1.56	328.94	15.26
50:50	1.42	249.69	14.95
34:66	2.38	309.27	15.46
17:83	2.32	229.57	15.38

PES – Polyester, and PBT – Polybutylene terephtalate.

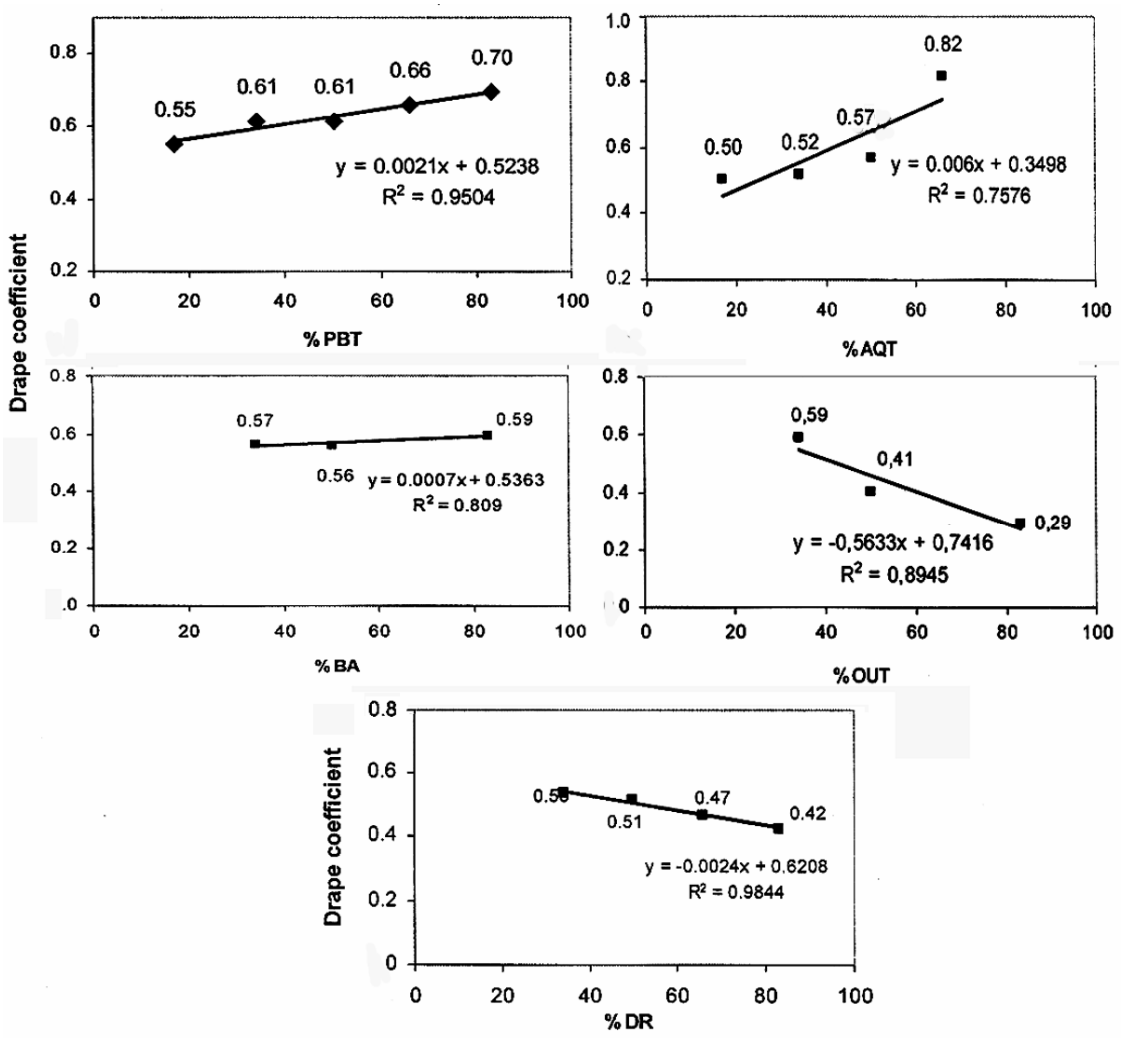

Fig. 1—Drape coefficient of various knitted fabrics

3.2 Flexural Rigidity

Figure 2 shows flexural rigidity for all the knitted fabrics in course-wise and wale-wise directions. For PES/PBT knitted fabrics (Fig. 2), the increase in PBT increases the flexural rigidity of the knitted fabrics in both directions. However, the effect is more significant in the wale-wise direction due to the knitted fabric construction once the interloping of the knitted wales leads to higher flexural rigidity. At the same time, as PBT is a stiff fibre it affects the blend more in the wale-wise direction.

PES/AQT knitted fabrics present a clear relationship between the amount of AQT and the flexural rigidity in both directions (Fig. 2). However, the trend is clearer in wale-wise direction, where a small increase in AQT amount leads to a high increase in flexural rigidity.

Figure 2 also shows the results obtained for the PES/BA knitted fabrics. As can be seen, the amount of BA affects the flexural bending, i.e. the more the amount of BA the less is the flexural stiffness of the fabric in both the directions.

For PES/OUT knitted fabrics, Fig. 2 shows that the flexural rigidity is significantly affected by the OUT added in the wale-wise direction. For course-wise direction, despite the influence of OUT, the trend is not so significant.

For PES/DR knitted fabrics, the flexural rigidity coefficient is not significantly influenced by the amount of DR added to the knitted fabrics (Fig.2). No relationship between the two factors may be established.

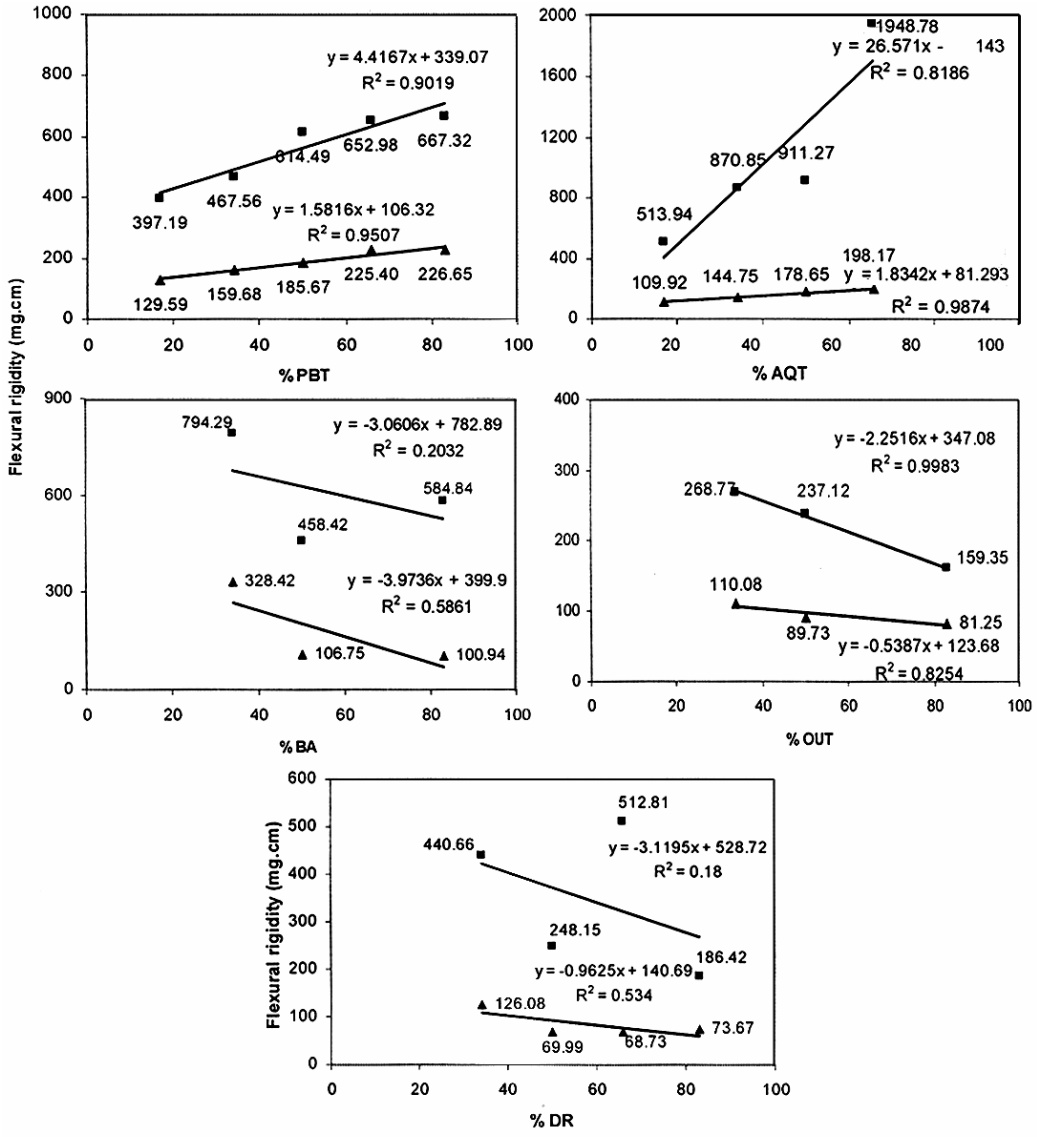

Fig. 2—Flexural rigidity for various weft-knitted fabrics [■- wale-wise and ▲- course-wise]

4 Conclusions

4.1 The amount of PBT and Aquator affects the knitted fabrics behaviour in terms of drape and flexural coefficient. The increase in these two fibres types lead to a decrease in the drape ability and an increase in the flexural rigidity.

4.2 The amount of polyester bioactive fibres in the knitted fabrics also affects their drape behaviour and a direct relationship may be established; the increase in Bioactive fibres amount leads to a decrease in flexural rigidity in both the directions.

4.3 The increase in Outlast in the knitted fabrics leads to an increase in the drape ability and flexibility.

4.4 The increase in Dry release amount enhances the drape coefficient; however it does not significantly influence the flexural rigidity.

Industrial Importance: The results obtained can be used to design sport clothing for professional football players. Drape and flexibility are important parameters to improve the comfort of the football players as they influence positively the clothing fitness to the body and the freedom to move within the match.

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