https://doi.org/10.33472/AFJBS.6.6.2024.8513-8522

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

An Investigation into the Comfort Characteristics of Tri Layered Knitted Fabrics Produced With Multiple Yarns

Mrs. C. Manimekala[1], Dr. R. Sheela John[2]

[1]PhD Scholar**,** Department of Costume Design & Fashion, Bishop Appasamy College of Arts & Science, Coimbatore - 641 018.
Assistant Professor, Department of Costume and Apparel Design, PSGR Krishnammal College for Women, Coimbatore – 641 004
[2]Department of Costume Design & Fashion, Bishop Appasamy College of Arts & Science, Coimbatore - 641 018 Department of Costume Design & Fashion, Bishop Appasamy College of Arts & Science, Coimbatore - 641 018.

Email: mekala.har16@gmail.com[1], manimekala@psgrkcw.ac.in[2]. cdfbacas@gmail.com[3]

Article Info

Volume 6, Issue 6, August 2024

Received: 03 June 2024

Accepted: 04 July 2024

Published: 20 August 2024

doi: 10.33472/AFJBS.6.6.2024.8513-8522

ABSTRACT:

This study investigates the comfort characteristics of tri-layered knitted fabrics engineered with multiple yarns. As the demand for advanced textiles grows, understanding the impact of fabric construction on comfort is crucial. Tri-layered fabrics, composed of an outer layer, a middle layer, and a backing layer, offer unique properties influenced by the yarns used in each layer. This research aims to evaluate how variations in yarn types and their arrangement affect key comfort parameters, including breathability, moisture management, thermal insulation, and tactile sensation. In this research bamboo / micro-denier polyester / polypropylene yarns are chosen to produce tri-layer knitted fabrics. The yarn chosen for knitting is 44^{s} count of 100% bamboo, 120 denier of polyester and 120 denier of polypropylene. Interlock machine is used to produce the fabric. Then it's tested for comfort properties such as wicking, wetting, air-permeability, water permeability, moisture vapour transfer and thermal conductivity. The bamboo fiber is a type of fiber made from the fiber of bamboo, which is a type of woody grass. Polyester is a term often define as "long chain polymer chemically composed of at least 85% by weight of an ester and a dihydric alcohol and a teripthalic acid. Polypropylene is a man-made fiber, it is a thermoplastic polymer used in a wide variety of application including packaging and reusable containers. The Tri-layer knitted fabric will be useful for the development of sportswear.

Keywords: Interlock gaiting, Tri layer knitted fabric, Moisture vapour transfer, Sportswear

1. Introduction

Knitting is a process of converting yarn to fabric by forming a series of loops dependent on each other. Knitting technology can be used to create products with outstanding characteristics, such as knitting to shape, great flexibility in production (geometry, shape, and yarns), controlled mechanical properties, excellent formability, stretchability. The first clothes were made from natural elements animal skins, furs, grasses and leaves, bones and shells. Clothing which was earlier designed only for protection and now fashion is incorporating many performance oriented functions to enhance human living in a different way. The amount and type of clothing worn depends on functional consideration such as need for warmth or

protection from the elements and social consideration.
Functionality is the primary purpose of clothing. Clothing may also function as a form of adornment and an expression of personal taste and style. Clothing is not only a cover for the skin but also interacts with and modifies the heat regulating function of the skin and these are influenced by the environment. Sportswear' is the 20th century world. It is popular because of the variety of look that can make by combining separates. The common sportswear garments include short pants, T-shirts, Tennis shirt, Track suit and trainers. Sportswear fabric need to provide a comfortable environment for the wearer and consequently able to handle moisture vapour and sweat produced by the body during strenuous activity in sports to feel good. Modern sports wear's are mostly made from wicking fibers like polyester and polypropylene. They provide only good strength and wicking of sweat but are not good at absorption and comfort point of view whereas the hydrophilic fibers like Bamboo, micro denier polyester and polypropylene are recognized as having excellent absorbency and breathability**.**
Active sportswear fabrics are the fabrics which are used in that sports where lot of sweat generation occurs and clothing is an important issue for athletes and for those who practice sports just for fitness in their leisure time.

Functional Requirements of High Active Sportswear
In high active sports like tennis and soccer, heat stress is of great concern due to high level of metabolic heat generation which is in the range of 130ow. This amount of heat can increase the 800 body core temperature by 152°C. To control the temperature of body, sweat generation takes place and heat of vaporization of water is used to give the cooling effect. Sweat generation can go as high as 2.5L/h and hence the main functional requirement of high active sportswear is sweat absorbing, fast drying and cooling High active sportswear should also have high stretch and elastic recovery to provide sufficient fit and freedom of movement to the wearer. In number of active sports like jumping, running and power lifting, compression is created by stretchable fabric to enhance the performance of an athlete. Compression athletic wear (CAW) provides the necessary compression and anatomic fit to an athlete. They are also known as "skin suits as they conform to the curves of the body acting as second skin requirements laid down for active sportswear are smoothness, softness, UV light weight, and easy care.
During the strenuous activity in sports, human body perspires in two forms insensible and sensible perspiration and to be in comfortable state, the sportswear which will be worn should be allow both the type of perspiration to transmit perspiration from the skin to the outer environment. Moisture produces during the sports present on surface of fabric and which cling to human skin can often produce uncomfortable sensation and it may produce skin problem like itching and finally it affects the performance of the wearer. Hence moisture transport in textiles fabrics is one of the critical factors affecting physiological comfort. Thus this sportswear must have ability to transport moisture away from the skin to the fabric surface for evaporation.

2. Methodology

This chapter deals with the raw materials used; various test methodologies and their respective procedures that have been utilized for the development of an active sportswear.

4.1 PROCESS SEQUENCE

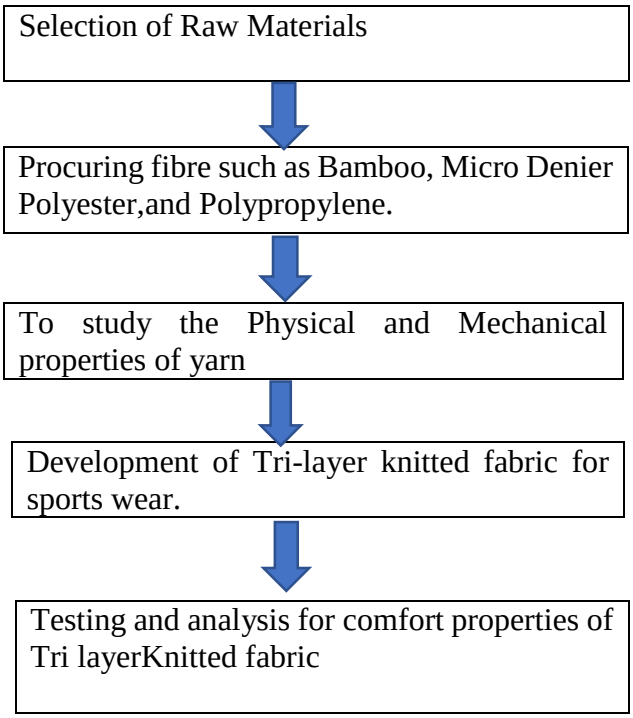

Fig.4.1 Process Sequence

Materials and Methods

5.1 MATERIALS USED

Yarn - Bamboo, Micro Denier Polyester, Polypropylene

i) 100% Bamboo
ii) 100% Micro Denier Polyester
iii) 100% Polypropylene

5.2 YARN SOURCING

All the three yarns were sourced from the yarn details are given below.

1. 40s Bamboo
2. 120d Micro denier polyester
3. 120d Polypropylene

5.3 FABRIC DEVELOPMENT

By using this yarns, five different combinations of tri-layer fabrics were developed using knitting machine in RBR Garments.

5.3.1 Fabric Construction

1. **1st combination:** Outer layer is made up of bamboo yarn whereas the middle layer is made up of polypropylene and inner layer is made up of micro denier polyester yarn.
2. **2nd combination:** Outer layer is made up of micro denier polyester yarn whereas the middle layer is made up of polypropylene and inner layer is made up of bamboo yarn.
3. **3rd combination:** Outer layer is made up of bamboo whereas the middle layer is made up of micro denier polyester yarn and inner layer is made up of polypropylene.
4. **4th Combination:** Outer layer is made up of polypropylene whereas the middle layer is made up of micro denier polyester and inner layer is made up of bamboo yarn.
5. **5th Combination:** Outer layer is made up of polypropylene whereas the middle layer is made up of bamboo yarn and inner layer is made up of micro denier polyester.

5.4 Test Method

5.4.1 Course per Inch (CPI)

The CPI was measured by using a counting glass at ten different places on each fabric sample and average values were found. 4.6.3 - 4.6.4 Stitch density The Stitch density was calculated by courses per inch and wales per inch. Stitch Density CPI WPI.

5.4.2 Wales per Inch (WPI)

The WPI was measured by using a counting glass at ten different places on each fabric sample and average values were found.

5.4.3 Loop Length

Loop length the yarns unravelled from the knitted fabrics were measured for their course length (ie. the length of yarn consumed by the feeder in one revolution of the machine). Five readings were taken for each sample. From the average course length, the loop length (course length No. of needles) was calculated.

5.4.4 Wetting Test

As per Saville (2000), this property was evaluated by measuring the time required for a piece of fabric to sink completely from the surface layer of water in a beaker. The fabric was measured by cutting a sample of 3 x 3 cm and placing it on the surface layer of water. The time taken for the sample to sink completely in water was measured. The samples were dropped on the surface of distilled water from a standard height and the time taken to sink the specimen in water was noted. This reading varies according to the way and pressure of putting the fabric. So utmost care has been taken for putting the fabric into water in a horizontal form.

5.4.5 Vertical Wicking Test

As per BS 3424 this property was evaluated. To assess the wicking characteristics of the fabric, a strip of 20 cm x 2 cm test fabric was suspended vertically with its lower end (2 cm) immersed in a reservoir of distilled water. In this method the vertical movement of water by capillary action was observed at different time interval wicking rate which is used to evaluate the sweating transfer rate from the body to fabric) and after 30 min (for wicking height which is to assess the saturated level of sweat transfer). The wicking tests were conducted with 10 samples each.

5.4.6 Moisture Vapour Transfer Test

This property was evaluated using ASTM E 96 –cup method. Moisture vapour transmission rate is the speed or rate at which moisture vapour moves through a fabric. Moisture vapour transfer test (open cup test) is used for measuring the moisture vapour transmission rate. The rate of water vapour that passes through the fabric was determined by two different methods. The same are explained in detail below.

5.4.6.1 Reduction in the height of water in the cup

Water was poured into cups up to 6cms from base level. The cups were marked for every half centimetre. The fabric samples are placed tightly on top of the cups where the water, the air above the water and the room environment are at the same temperature and pressure. After 48 hrs the level of water decreased in the cups and the reduction in height of water was noted down. The moisture vapour transfer rate is the difference between the initial height of water and the actual height of water in the cups.

5.4.6.2 Reduction in the weight of water in the cup

After measuring the height of water in the cups after 48 hours, the fabrics were taken out from the top of the cups and the cups with water were weighed in an electronic balance and the reduced weight was noted down. The moisture vapour transfer rate is the difference between the initial weight of water and the actual weight of water in the cups after 48 hours.

5.4.7 Air Permeability Test

This test was evaluated as per IS 11056: 1984. The test gave the rate of air flow through a material under a differential pressure between the two faces of a fabric. It is expressed as the quantity of air, in cubic centimetre passing per second through a square centimetre of fabric.

4. Result and Discussion

This deals with the results obtained from testing of Tri-Layer knitted fabric samples which includes geometrical and comfort properties. Subjective study of samples has also been discussed.

6.1 Yarn Testing Parameters

The following table 6.1 shows the yarn testing parameters

Table 6.1 Yarn Testing Parameters

Tests	Bamboo	Micro Denier Polyester	Polypropylene
Count	44^s	120 D	120 D
Strength	0.52	0.36	0.56
Elongation	3.5	4.5	6.5

6.2 Fabric Sample Details

The following table 6.1 shows the sample details of tri-layer fabric with different combinations.

Table 6.2 Fabric Sample Details

Sample	Details
Tri-layer fabric 1	Bamboo, Micro Denier Polyester, Polypropylene
Tri-layer fabric 2	Polypropylene, Micro Denier Polyester, Bamboo
Tri-layer fabric 3	Micro Denier Polyester, Polypropylene, Bamboo
Tri-layer fabric 4	Bamboo, Polypropylene, Micro Denier Polyester
Tri-layer fabric 5	Micro Denier Polyester, Bamboo, Polypropylene

6.3 Fabric Dimensional Parameters

The following table 6.2 shows the course per inch, wales per inch, loop length, and Thickness of tri-layer fabrics with different combination

Table 6.3 Fabric Dimensional Parameters

Sample	CPI	WPI	Loop length	Thickness (mm)
Tri-Layer Fabric 1	24	33	0.45	0.73
Tri-Layer Fabric 2	24	32	0.48	0.75
Tri-layer fabric 3	24	35		0.70
Tri-layer fabric 4	24	34		0.74
Tri-layer fabric 5	24	34		0.79

6.4 Comfort Properties of the Fabrics

6.4.1 Wetting

The evaluation of contact angle between a liquid and solid surface indicates wettability, changes in the level of surface energy and changes in the chemical and super molecular structure of the surface

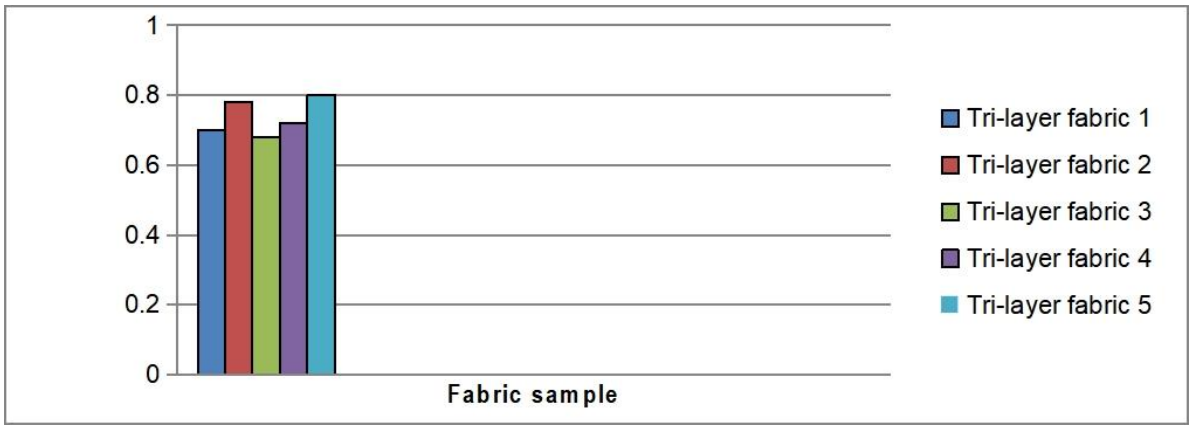

Fig 6.1 Wetting

The wetting test were carried out with five trail for each combination and fig 6.1 shows the average of test results of wetting performed on selected combinations of tri-layer fabrics. All samples are no change in wetting time.

6.4.2 Wicking

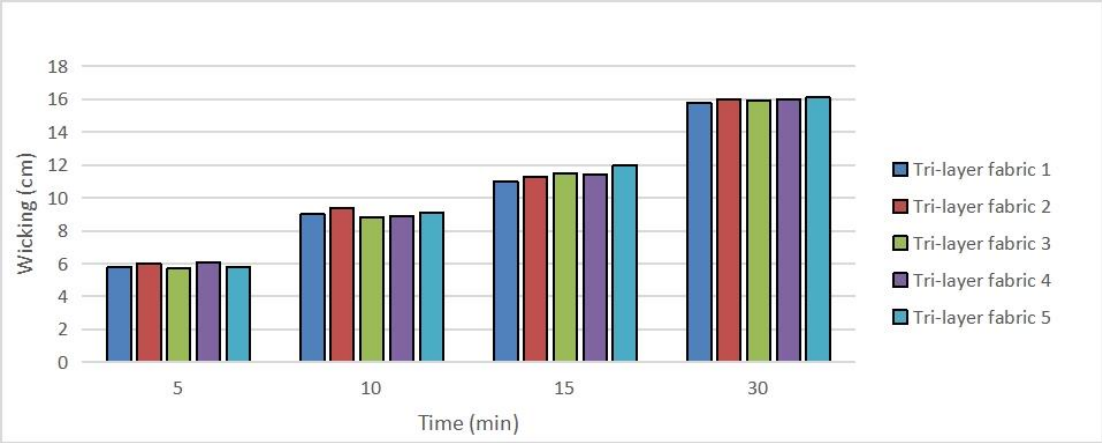

Fig 6.2 Wicking

The wicking test were carried out with five trail for each combination and fig 6.2 shows the average of test results of wicking performed on selected combinations of tri-layer fabrics. All samples are no change in wicking height.

6.4.3 Water Vapour Transfer

Relative water vapour permeability of a fabric is the ability to transmit water vapour from the body. A combination of high thermal resistance and low relative water vapour permeability can cause uncomfortable situation to the wearer as the heat stored in the body cannot be dissipated. Relative water permeability of a material is highly dependent on the macro-porous structure of the constituent fibers of the yarn.

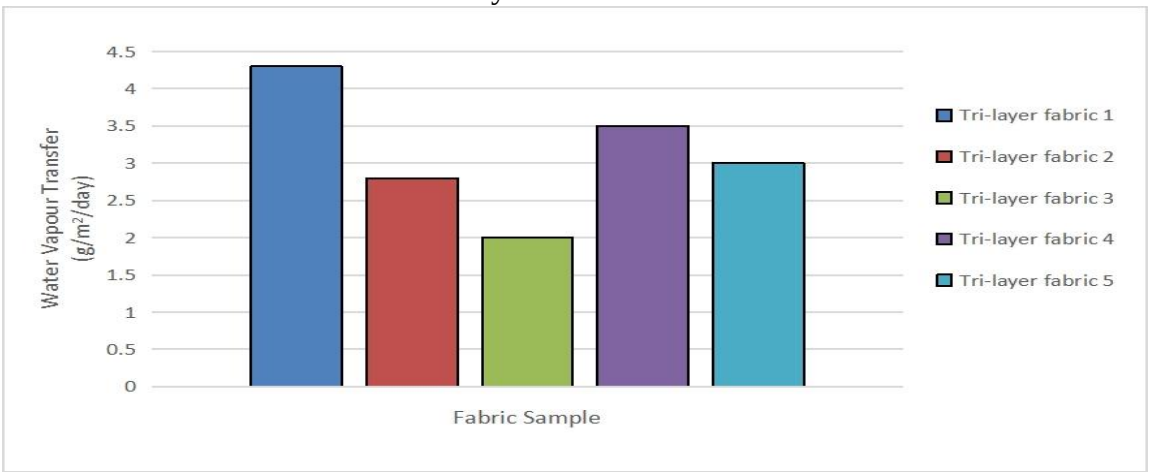

Fig 6.3 Water vapour transfer

The water vapour transfer test were carried out each combination and fig 6.3 shows the average of test results of wicking performed on selected combinations of tri-layer fabrics. No change in water vapour transfer value.

6.4.4 Air Permeability

The air permeability increases with the decreases in fabric thickness and increase in volume porosity.

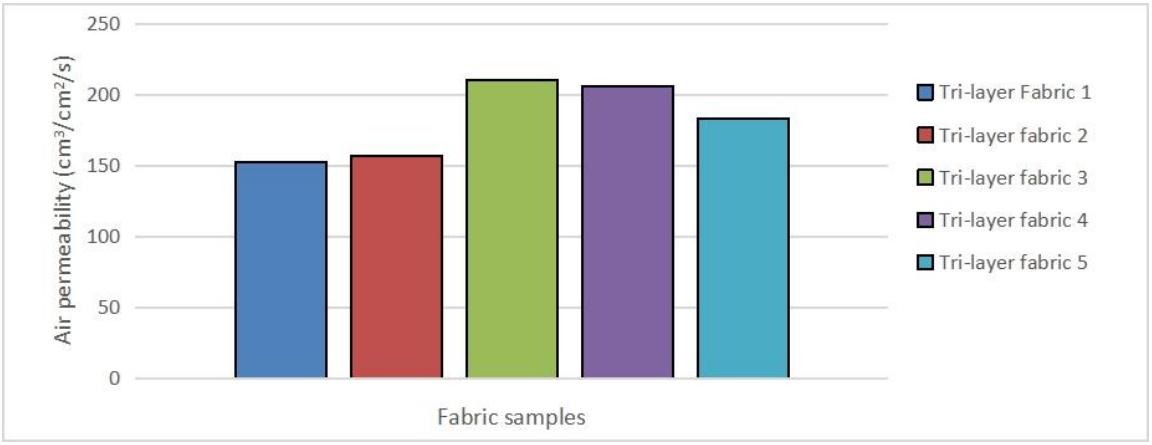

Fig 6.4 Air permeability

Fig.6.4 shows the average test results of air permeability performed on samples. As the test result the tri-layer fabric sample 3 is more than all.

6.4.5 Moisture Content

Moisture content is defined as the weight of water in a material express as a percentage of the total weight of the material.

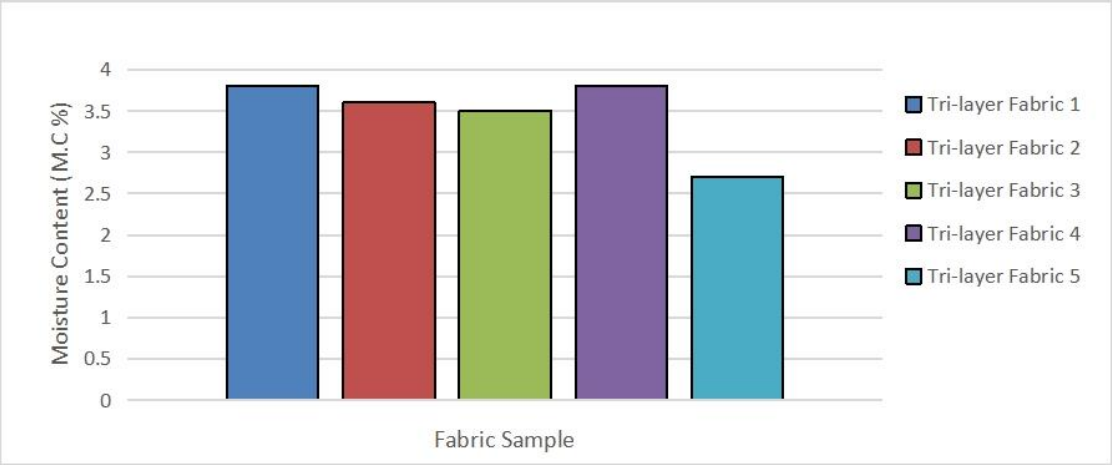

Fig 6.5 Moisture Content

Fig.6.5 shows the average test results of moisture content performed on samples. As the test result the tri-layer fabric sample 4 is more than all.

5. Conclusion

Here this research work is in the process, we purchased the raw material and visited for Rib plated knitting machine to our fabric. In this Research, Bamboo, Micro denier polyester, polypropylene yarns are chosen to produce tri-layer fabrics. The yarn chosen for knitting is 44^s Count of 100% of bamboo, 100% of Micro denier polyester of 120 denier and 120 denier of 100% of Polypropylene. After the Preparation of Tri-layer fabric the fabric is subjected to comfort tests like Wetting, Wicking, Air permeability, water vapour transfer and moisture content in the fabric. Those we trust our results in this research is help to developed the tri-layer fabric for sportswear.

In summary, the study highlights the effectiveness of tri-layered knitted fabrics with multiple yarns in enhancing comfort. These fabrics offer a range of benefits, including improved moisture management, thermal regulation, and tactile comfort. Future research could focus on exploring additional yarn types and their interactions within the tri-layered structure to further refine and expand the capabilities of these advanced textiles.

6. Reference

1. M Manshahia & A Das, High Active Sportswear – A critical review, Indian Journal of Fibre & Textile Research, December 2014, Vol.39.
2. Sri Gupta, R., and Maliwan, N., a Design and Development of Multilayered Hospital Textiles. Journal: International Textile Journal 1987.
3. Ke Baozhu,Zhang Weiyuan., The Optimal Design of Three-layer Plated Fabrics, Fibres & Textiles in Eastern Europe January / March 2007, Vol.15.
4. Sandra Varnaitë-Þuravliova , Laimutë Stygienë, Romutë cepliauskienë, Sigitas Krauledas, The Influence of Three-Layer Knitted Fabrics' Structure on Electrostatic and Comfort Properties, Materials Science (Medþiagotyra). Vol. 19, No. 4. 2013.
5. Dr.Devanand Uttam,Active Sports Wear Fabrics, International Journal of IT,Enginnering
6. and Applied Science Research, January 2013, Vol.2.

7. Pratima Chowdhury,Kartick.K,Samanta,Recent Development In Textile for Sportswear Application, International Journal Of Enginnering Research & Technology, May 2014, Vol.3.