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Eco-friendly Treatment on Rib Knitting Fabrics Part 2. Effect of the Treatments with Natural Compounds on Comfort Properties

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COMFORT and handle properties are considered one of the important parts in clothing evaluation and it is also considered pivotal when choosing apparel. Comforts involve thermal and non-thermal components and it depends on the wear situations. Thermal comfort is defined as mind satisfaction with thermal environment. Fabric hand is related to the concept (meaning, sense) of smoothness, softness, style and appearance Knits are comfortable to wear and easy to care for, they are elastic and have stretchy behavior, also they shed wrinkles well, have good handle and easily transmit vapour from the body. Rib cotton pleated fabrics that contain 3% and 7 % lycra) are treated with various natural compounds namely; nanoclay (NC), β-cyclodextrin (CD), chitosan (CH) and citric acid (CA). Treated fabrics were evaluated by determining their comfort, handle and physical mechanical properties such as thermal transmittance, vapor permeability (%), air permeability, thickness, bursting strength, weight, abrasion resistance and density. The applied natural compounds have generally significant effect on the tested properties. They also can enable the usage of the same fabric in both winter and summer.

Keywords: Knitted fabrics, treatment with eco material, thermal transmittance and fabric comfort.

Introduction

Knitted fabrics have good handle and easily transmit vapor from the body and provide freedom of movement [1]. Knit fabrics provide superior comfort properties due to their flexibility, softness and have long been preferred in many types of clothing [2]. That's why knitted fabrics are commonly preferred for underwear, casual wear and sportswear [3].

Concerning fiber type, Micro-denier fibres give lower thermal conductivity and higher thermal resistance [2]. Comparing thermal properties Rib knitted fabric different structures, it was found that heat decreased with the lowering in rib number [2].

In the mean time Interlock and rib fabrics have a lower thermal conductivity and higher thermal resistance value and therefore the best for winter clothing products [1]. Single jersey fabrics of both conventional and organic cotton have greater moistures management properties with higher relative water vapor permeability values than rib and interlock fabrics, and give a warmer feeling at first touch due to lower thermal absorptivity values. And hence more profitable and could be chosen for active sports and summer apparel products for better moisture management properties [3]. The knitting parameters and the type of structure not only affect the comfort but also the performance properties of the knitted fabrics [4]. Knitting machine gauge and the knitting stitch length are

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the two fundamental knitting parameters that directly affect all structure related properties of the knitted fabric [4]. Increase in knitting stitch length and decrease in knitting machine gauge result in decrease in the fabric gram per square meter and the fabric density accompanied with increase in fabric thickness and porosity [4]. These improve the fabric moisture management properties due to the increase in fabric tightness Fabric thickness; enclosed still air and external air movement are the major factors that affect the heat transfer through fabric [3, 4].

Strength determines the performance and durability of fabrics. Bursting strength is an alternative method of measuring strength in which the material is stressed in all direction, is the strength against multi directional forces; this test is applied to determine the strength of knitted fabrics [5]. Loop length had a significant effect on the bursting strength, stitch density and fabric weight. Lock nit structure records the best bursting strength result [5]. Spandex yarns were used for improving knitted fabric performance. Results show that the largest tension values under a constant draw ratio give the highest values for weight per unit area, number of courses/cm, number of stitches/cm^2 and the thickness but a lowest value in air permeability values [6]. Investigated the dimensional and physical properties of cotton/spandex single jersey fabrics, which were produced on large diameter circular knitting machines, it has been concluded that the increase of the amount of spandex doesn't have a significant effect on loop length. It leads to a decrease in course and Wales spacing values, air permeability, pilling grade and spirality and lead to increase in fabric weight and thickness [7]. In addition, the outstanding features of spandex are low moisture absorption and resistance to normal apparel exposure to sunlight and to most common chemicals [8]. Various knitted structures have different comfort properties. Then, in order to obtain the ideal clothing comfort, it is requested to consider the end use of the garment while choose the fabrics [3]. Specially to increase successfully the performance of the wearer in applications such as sports, as clothes with moisture and air resistance properties not only decrease the comfort level but also affect the body performance [4].

Some functional finishing on textile carried out for biomedical applications [9-11].

The chitosan hydrogel-coated samples showed a clear improvement of the antibacterial activity on cotton fabrics [12]. All chitosan treated fabric on cotton fabric has grade 4 in soil release property as well as improved the crease recovery [13]. The treatments with natural compounds such as nano clay, chitosan, β- Cyclodextrin (CD) and Citric acid to impart antimicrobial properties as well as performance properties on cotton fabrics (Rib knitted containing 3% or 7 % Lycra) [14].

The nano composites from mixtures of resin/nano clay were used on coated material [15]. Also, viscose fabric treated with organic nanokaolin, nanochitosan and nanocellulose to impart antimicrobial [16,17]. Nano/bio-finishing agent used to impact antibacterial activity, advanced softness and handle human dermal fibroblasts [18].

The treatment with nano clay and nano silica enhanced some functional properties and the colour strength polyester fabrics [19].

Mohmed studied the effect of AgNPs on antibacterial properties by biological methods and utilized that nanoparticles in finishing of cotton fabrics [20].

This is the part (2) of the study entitled "Eco-friendly Treatment on Rib Knitting Fabrics". The effect of the treatments on the comfort and performance such as air permeability, Vapor Permeability, Thickness, Thermal Transmittance, Bursting Strength Abrasion Resistance, weight and Wales and Courses of treated Rib Knitting fabric are the aim of this study. The treatments with natural compounds such as Nano clay, chitosan, β-Cyclodextrin (CD) and Citric acid to impart antimicrobial properties as well as on dye ability and fastness properties on cotton fabrics (Rib knitted containing 3% or 7 % Lycra) as shown in part (1).

Material and Methods

Materials

Rib knitted cotton fabrics containing 3% and 7% Lycra with mass 294 and 338 grams respectively, were treated with four natural materials, with the aim to increase the comfort of the fabrics, these materials and there concentrations are shown in Table 1.

TABLE 1. The code of treatments materials.

Natural Material	Nano clay (NC)	β-Cyclodextrin (CD)	Chitosan (Ch)	Citric Acid (CA)
Code	I	II	III	IV
Concentration	5 g/l	4 g/l	2 g/l	10 g/l

The rib fabrics were immersed in treatment solution at room temperature for one hour, then padded using SVETEMA laboratory padder; to pick up 100 %, dried at 60°C for 10 min., and then fixed at 150°C for 5 min using ROACHES laboratory thermofixation. Finally, the fabric was washed thoroughly with tap water and air dried.

Measurements

Different measured properties were determined under standard working conditions for fabrics under study before and after treatments by the following standards .

1-Thermal Transmittance (Tog) measured according to (ASTM-D 1518).
2-Vapor permeability (%) measured on Permetest at National Institute for Standard according to (ISO 11092).
3-Air permeability ($cm^2/cm^3/s$) measured according to (ASTM - D 737).
4-Thickness (mm) measured according (ASTM-D1777).
5- Bursting strength dimension (kpa) measured according (ASTM-D3786).
6-Weight (gm/m^2) measured according (ASTM-D3776).
7-Abrasion Resistance (cycles) measured according to (ASTM-D4966).
8-Fabric Density number of courses and wales per inch measured according (ASTM - D3887).

Results and Discussion

Treatment Effect on Fabrics

Figures 1-8 show the results of air permeability, Vapor Permeability, Thickness, Thermal Transmittance, Bursting Strength, Abrasion Resistance, weight and Wales/cm and Courses/cm of treated and untreated Rib knitted cotton fabrics containing 3% and 7 % Lycra.

Figure (1) illustrated the air permeability of treated and untreated Rib knitted cotton fabrics. It was found that the air permeability decreased from 2.3% to 43.6 % for 3% spandex fabric, with a mean value of 22.9%. In case of 7% Lycra these values are 15.4%, 29.1% and 22.2% respectively because increasing the percentage of Lycra leads to an increase in closing the pores of the fabrics. This indicates that the effect of the applied chemicals depends on the percentage Lycra. All the treated samples in case of the 7% Lycra have significance difference than the untreated fabric. In case of the 3% only the first and forth treatments demonstrate a significant difference, this may be attributed to the affect of citric acid on Lycra. Also it is shown in Figure (2) that the vapor permeability increased significantly in case of 3% spandex fabrics, when treated by the first, third and fourth chemicals with a mean value of 5.7%. In case of 7% lycra a significant decreased from 6.7% to 16.4% was obtained at all samples.

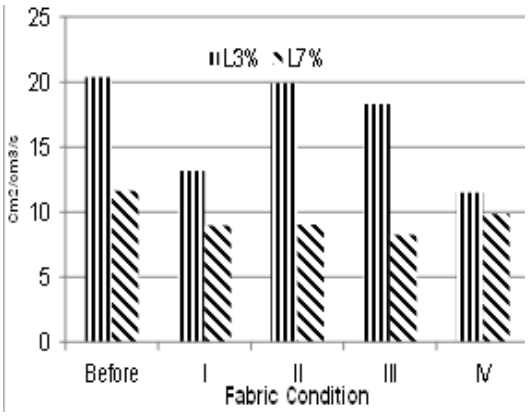

Fig. 1. Air Permeability.

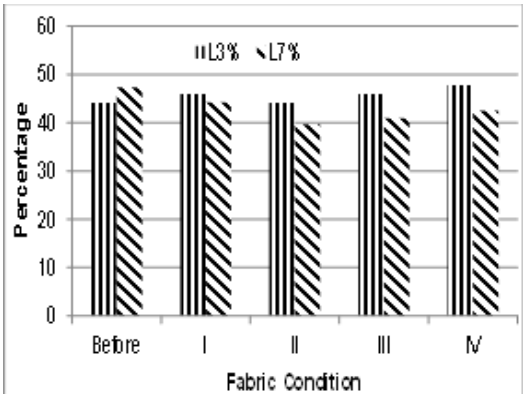

Fig. 2. Vapor Permeability.

= 3 % Lycra ‖ 7 % Lycra

I- Treated with nano clay, II- Treated with* β- Cyclodextrin, *III- Treated with chitosan, IV- Treated with citric acid

The results of Thermal Transmittance are represented in Figure (3). It can be deduced that the results due to treatments increases and decreases for the two fabrics. The rate of increase is from -46.7% to 29.2 for 3% lycra and from -31.4 to 10 for 7% Lycra. Thickness increase significantly in both fabrics as shown in Figure (3-4), the mean values are 11.7% and 18.2% respectively for 3% and 7% fabrics. The variation in the above properties can be explained by the difference in moisture regain before and after treatment. These properties are the main of the fabric comfort, so the increase and decrease due to treatment can affect significantly the comfort condition.

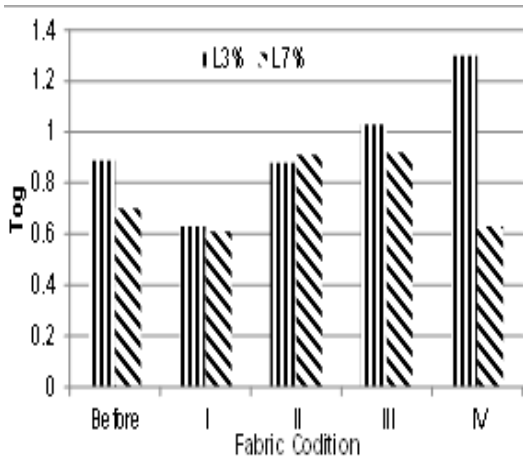

Fig. 3. Thermal Transmittance .

Figures (5) and (6) demonstrate a highly significant decrease in both abrasion resistance and bursting strength for treated Rib knitted cotton fabrics as compared with and untreated one. The percentage decrease is higher in abrasion around 49% in bursting strength it attain a value 25%. Since these properties depend on the lateral properties of fabric, lowering in tightness or binding of the yarns can be the cause. This may need successive investigations. No significant variation is detected in fabric mass as seen in Figure (7). Figure (8) shows a significant decrease in wales/inch and a significant increase in course /inch, they together tend to no variation in fabric mass. Different results can be obtained under manufacturing tension. These results led to increase the thickness of treated fabrics than untreated fabrics.

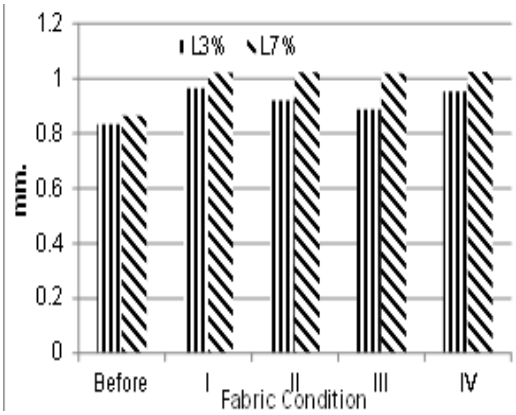

Fig. 4. Thickness

═ 3 % Lycra ‖ 7 % Lycra

I- Treated with nano clay, II- Treated with* β- Cyclodextrin, *III- Treated with chitosan, IV- Treated with citric acid

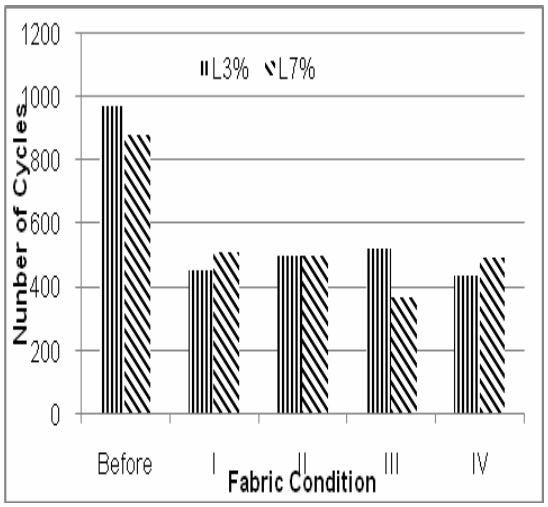

Fig. 5. Abrasion Resistance .

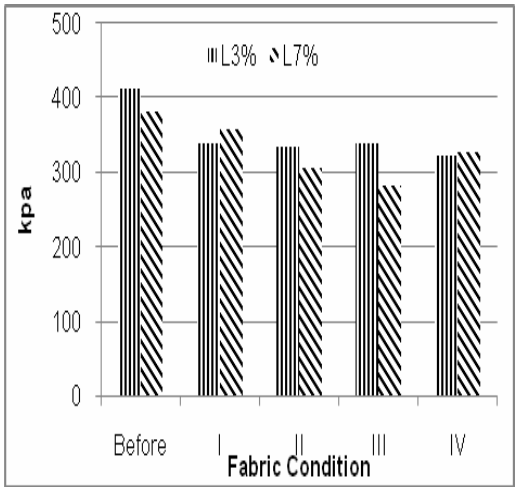

Fig. 6. Bursting Strengt.

═ 3 % Lycra ‖ 7 % Lycra

I- Treated with nano clay, II- Treated with* β- Cyclodextrin, *III- Treated with chitosan, IV- Treated with citric acid

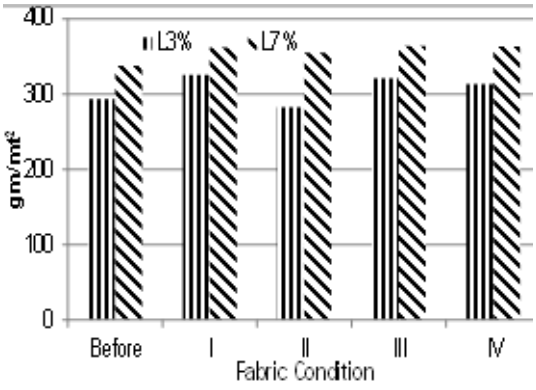

Fig. 7. Weight

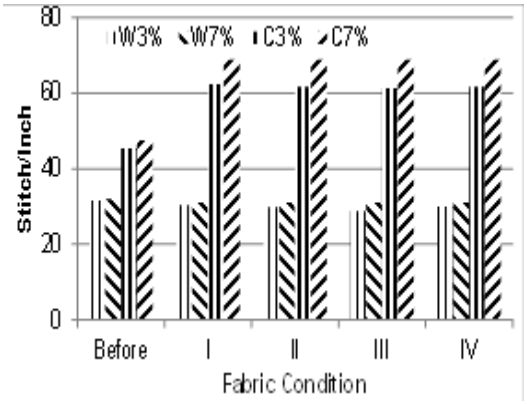

Fig. 8. Wales/cm and Courses/cm.

═ 3 % Lycra ‖ 7 % Lycra

I- Treated with nano clay, II- Treated with* β- Cyclodextrin, *III- Treated with chitosan , IV- Treated with citric acid

Comparison between the Two Fabrics

The percentage variations in all properties due to different treatments were obtained. The comparison of these variations between 3% and 7% fabrics demonstrate that no significant difference is detected in case of air permeability. For vapor permeability, thermal transmittance tog and thickness high significant difference is obtained between the two fabrics. The deviation in 7% spandex fabrics is higher than the 3% spandex. In case of mechanical and physical properties only courses per centimeter and fabric density shows significant difference.

Fabric Comfort

The demand for comforts differs from summer to winter fabrics. A summer fabric has to attain a higher air permeability, vapor permeability thermal transmittance and lower fabric thickness. Winter fabric need to perform lower air permeability, vapor permeability, thermal transmittance and fabric thickness. Based on the geometrical mean of the mentioned properties both 3% and 7% fabric treated by the first chemical can be applied for winter cloth. For summer cloth untreated fabrics is preferred.

Conclusion

From the previous results the following can be stated :

1. The applied natural materials increase the comfort of treated rib knitted fabrics than untreated one.
2. The applied natural materials have generally significant effect on the tested properties. This is due to the variation in fabric moisture content and fabric structure. Also the nano clay and citric acid demonstrate almost the better results.
3. Different tendencies due to the application of the natural compounds on physical mechanical properties on the 3% and 7% lycra was observed.
4. The variation in the comfort properties due to the applied treatments enables the application of the same fabric in winter and summer cloth untreated fabrics is preferred.
5. The deterioration in both abrasion resistance and bursting strength decrease the fabric performance. Excessive research has to be taken to attain the causes and ameliorate the results.

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Eco-friendly Treatment on Rib Knitting Fabrics Part 2. Effect of the treatments on Comfort Properties

هبة محمد درويش ، زينب عبدالمجيد و لمياء الجابرى وعادل الجيهينى

تم معالجة أقمشة تريكو (الريب) قطنية مصنعة بطريق مختلفة بإستخدام مواد صديقة للبيئة مثل نانو كلى (كاولين) و بيتا سيكلو دكسترين و كيتوزان و حمض الستريك تحت ظروف معالجة مختلفة.

تم قياس الخواص الميكانيكية و الفيزيائية لاقمشة المعالجة وغير المعالجة مثل قوة الشد والاستطالة والصلابة والسمك و واستعادة الرطوبة و مقاومة الاحتكاك و الكهربة الاستاتيكية للالياف ونفاذية الهواء.

و قد وجد ان مادتى نانو كاولين و الكيتوزان اعطت افضل النتائج.

تطبيق المركبات الطبيعية أعطت إختلافات في الخصائص الفيزيائية والميكانيكية لأقمشة الريب التي تحتوي على نسبة ليكرا (٣٪ - ٧٪) .

الإختلافات التي ظهرت في خواص الراحة للأقمشة نتيجة إستخدام المعالجات تمكن من إستخدام هذه الأقمشة صيفا وشتاءا.

التدهور في كلا خواص الإحتكاك والإنفجار يقلل من أداء الأقمشة. ويوصي بالبحث لملاحظة الأسباب ودراسة النتائج.