SCIENCES &ARTS-RESEARCH STUDIES VOL.23 NO.3 JULY 2011

Effect of Some Construction Specifications on Fabric Properties Produced for incontinence pad to Suit Functional Purpose

Mohamed Hashem[1*], Ghalia E. Ibrahim[2] Marrwa A. Ali[3]

[1] Textile Research Division, National Research Centre, Cairo, Egypt.

[2] Textile Department, Faculty of Applied Arts, Helwan University, Cairo Egypt.

[3] Spinning and Weaving Division, National Research Centre, Cairo, Egypt

Abstract

This research is mainly concerned with designing woven fabrics used in diapers. The woven technique was applied to produce these fabrics, using cotton yarns. The produced fabrics were treated with Scouring, Bleaching ,antibacterial ,softening, water repellency, hydrogel or superabsorbent formation by Quat-188, Actigard and carboxy methyl cellulose. Different parameters were studied including, fabric structure (plain weave 1/1, regular hopsack 3/3 honeycomb and mock leno).Their influence on the performance of the end-use fabric and the achieved properties were studied. On the other hand physico-chemical properties including; antibacterial, water repellency, absorption, air permeability, water permeability, handle, 9-tensile strength & elongation, thickness and weight, were evaluated according to the final product needs.

1. Introduction

Hygiene products are those conventional hygiene absorbent pads, such as sanitary towels, diapers and incontinence pads and so on (1) .Incontinence is normally regarded as a problem of the very young, the very old and the disabled or bedridden. There are number of incontinence suffer of all ages, the main problem is that of urinary incontinence with stress (caused by laughing, sneezing exertion or emotional upset). Product designs need to meet the different levels of incontinence according to different levels of activity from fully active to chair bound or bedridden. Incontinence protection must not leak, or cause discomfort or skin irritation to the patient (2).the most common absorbent material used in these disposable pads is wood- pulp, melt-blown micro-fiber webs, normally made from polypropylene, polyester, polyethylene or polyamide which are used to manufacture coverstock fabrics.

Disposable diapers and incontinence pads for the personal care market are rapidly improving. Diapers come in contact with the skin, and consumers are concerned about whether they cause dermatitis or skin irritation. The water transport properties and handle (softness and smoothness) of diapers are considered to be related to both diaper dermatitis and wearing comfort. Clinical studies of the effects of diaper wearing on infant skin have been the subject of other works [2, 3, 6]. Increases in both skin wetness and pH are associated with diaper dermatitis [1], and the degree of skin wetness is proportional to diaper wetness. Water transport properties of incontinence pads, such as absorption capacity and strike-through times, have been studied in relation to wet comfort [4, 5]. In general, the best wet comfort is provided by pads with high absorption capacity, low rewet, and fast strike-through time. The relationship between rewet performances of experimental pads and their construction of absorbent cores has been systematically studied [7], but little attention has been given to the hand of disposable diapers in terms of their surface and mechanical properties. A method for objective evaluation of the hand of men's suiting has been developed based on precise measurements of certain mechanical and surface properties [8]. The instruments used for these measurements, known as the KES-F system, are widely used, and data for fabric properties measured by the KES-F system have been used to control both the processability of fabrics in clothing manufacture and the making-up performance of suiting [9]. In addition, instruments that measure the water and heat transfer properties of fabrics have been developed in order to study the control mechanisms of clothing microclimates [10, 1]. After the objective hand evaluation system for suiting became widespread, it was applied to a group of nonwovens used for materials near human skin [12). In our previous study, we extended our investigation to the objective hand evaluation of nonwovens used for disposable diapers [14]. We examined the measuring methods for compression and surface properties of disposable diapers that have been applied to the objective evaluation of diaper hand. We found that the equation developed for predicting the quality of men's suiting is also applicable when evaluating the hand quality of dry diapers, and that the hand of wet diapers can be evaluated from their rewet, compression, and surface properties [14). The equation that connects these diaper properties to the subjective hand evaluation of wet diapers and the prediction ability of the equation will be discussed in another paper. In this study, we investigate the changes in compression, surface, and heat transfer properties of disposable diapers caused by wetting in order to clarify their performance in use, and we discuss the properties of diapers estimated to have good hand in both dry and wet conditions.

Nonwoven fabrics are used to minimize the cost of coverstock materials .cover stock must allow the rapid passage of urine or blood through the materials, but they mustn't retain liquid themselves or allow liquid to leak back to the skin [3]. There also some requirements demand of coverstock, it should has adequate strength, impermeable to lint from the absorbent pad, good skin-compatibility, and it should also has good drape properties. It is also important that the coverstock be soft to the skin and not abrasive [4].

-Nappies (diapers)

Nappies (diapers) are used to absorb waste from babies for maintaining health and hygiene of baby as well as his environment .Mothers used to cover the baby with old clean and absorbent cloth (5) .Whenever the diapers get solid ,they are changed ,washed ,dried ,and reused .(6) The types of nappies or diapers vary greatly through out the world from reusable cloth to the modern disposable type. (5) Disposable diapers and similar have been manufactured using one or more layers of cellulose tissue which makes the diaper relatively stiff .(7) Reusable nappy is made from woven terry cloth which is a woven, warp-pile cotton fabric covered on both sides with uncut loops . The cloth can vary in thickness and weight according to the thickness and quality of the yarn used and the density of the structure .(8) Reusable nappies need to be changed ,washed and dried.

Reusable napes can be classed into 3 categories:

One layer diaper ,one-layer diaper has the problem that all the moisture stays evenly distributed through the diaper so that a high amount of urine remains in direct contact with the baby's skin and can cause diaper rash.

Multi layers diaper ,multi-layer diaper using 100% cotton for skin contact layer and synthetic nonabsorbent layer of polyester or equivalent to provide a wicking action to draw and hold moisture away from the skin.

A five –layers diaper ,a five layers construction present the deal balance of comfort .The first layer is an interior shell of 100% cotton , The second layer is 100% synthetic nonwoven of mono-filament which allows moisture to pass through to the lower layers , the third layer is a 100% cotton wetting pad for maximum additional absorbency with minimum bulk , next is a layer of terry cloth in a cotton/ polyester blend , for extra absorbency . The fifth layer is also a terry cloth of similar blend to give a panty-like dressed appearance (9)

2. The experimental Work

This research concerns with producing fabrics suitable for diapers. All samples in the research were produced with woven, nonwoven and knitted technique.

2.1.Finishing treatment

The produced fabrics were undergoing special treatments before being used. Scouring, Bleaching, antibacterial, softening, water repellency, hydrogel (superabsorbent formation) by Quat-188 , Actigard and carboxy methyl cellulous as following

-Scouting

Samples of 100 % cotton

The samples were padded in an aqueous solution containing 30 gm/ L sodium hydroxide and 5 gm/L nonionic wet ability substance (ejetol) ,using concentrations from 1 to 50

Samples of cotton /polyester

The prior same method was applied using 20 gm/L sodium hydroxide

-Bleaching

Samples were padded in an aqueous solution containing oxide hydrogen 6 gm/L , sodium silicate 3 gm/L , and sodium hydroxide 2 gm/L, at 95 0 for 30 min ,after finishing bleaching ,the samples were washed and dried at room temperature.

-Antibacterial treatment

In this study, antibacterial finishes was applied to the samples. Antibacterial finishes were applied to fabrics to prevent the growth of microorganisms exposed to the fabrics

Samples were padded in an aqueous solution containing 100 % Quat -188 and 35 g /L and then squeezed to a wet pick up 100 %.Samples were dried at 45 ^{0}C for 15 min ,then thermo-fixed at 120 ^{0}C for 20 sec.

Softening treatment

The fabric samples were padded in an aqueous solution containing 50 gm /L solusoft and then squeezed to a 100 % wet pick up 100 %.The fabric samples were dried at 110 ^{0}C for 5 min

-Water repellency treatment

Samples were padded in an aqueous solution containing **Novo NB** and then squeezed to a 100 % wet pick up. The fabric samples were dried at 85 ^{0}C for 5 min ,then thermo-fixed at 120 ^{0}C for 3 min.

-Hydrogel or superabsorbent formation for medium layer

There are three methods used to achieve medium layer superabsorbent Using Quat -188

-Wood pulp was treated with Quat -188

The fabric samples were padded in an aqueous solution containing 33 gm/ L sodium hydroxide and Quat -188 with concentrations from 25 to 100 gm/ L and then squeezed to a 150 % wet pick up.The fabric samples were dried at 85 ^{0}C for 5 min ,then thermo-fixed at 120 ^{0}C for 15 min ,

Using Actigard

The fabric samples were padded in an aqueous solution containing 5 to 15 %, at PH 5 and then squeezed to a 150 % wet pick up.Samples were dried at 85 ^{0}C for 5 min ,then thermo-fixed at 140 ^{0}C for 3 min , using carboxy methyl cellulous.

2.2.Tests

Several tests were carried out in order to evaluate the produced fabrics, these tests were:-

1-**Antibacterial**, this test was carried out according to the AATCC standard test method 90-1982 (10)

2- Air permeability, this test was carried out according to the (ASTM-D 4491/92) (11)

3- Water permeability, this test was carried out according to the ISO 811: 1981(12)

4-Fabric handles, this test was carried out according to the B.S.3424: (1987) (13)

5-tensile strength & elongation this, test was carried out according to the ASTM-D 4595 (14)

6-water repellency this test was carried out according to the AATCC 392-1963 (15)

7-Bursting resistance, this test was carried out according to the ASTM-D 3787-89 (16)

8-Fabric thickness, this test was carried out according to the (ASTM-D1777/1996) (17)

9-Fabric weight, this test was carried out according to the ASTM-D 3776- 79 (18)

3.Results and discussion

Results of the experimental tests carried out on samples under study were presented in tables. Results were also statistically analyzed for the data listed and relationships between variables were obtained.

3.1. Antibacterial test

Samples were treated with Quat-188 , and Actigard ,it can be seen that there is a direct relationship between Quat-188 increased concentrations and the antibacterial effect. it could be stated that the efficiency of the antibacterial finish is not affected by the repellent finish, but the effectiveness of the repellent finish varies with the add-on level of the antibacterial finish .

Woven samples

1-we can see from tables and figures that untreated fabrics did not provide any resistance against bacteria

2- Treatment of fabrics with Quat-188 led to improvement in properties of the anti-microbal resistance.

3- It can also be seen that the diameter of free activated bacterial zone has increased from 0 to 6.5 at Staph and from 0 to 6 at E.Coli

4-bacterial and softening treatment have increased the antibacterial resistance ,we can state that the softening material ,gave the fabric hydrophobicity ,which increased the antibacterial resistance.

Nonwoven samples

1-we can see from tables and figures that untreated fabrics did not provide any resistance against bacteria

2- Treatment of fabrics with Quat-188 and Actigard led to the improvement in the anti-bacterial properties .

3- It can also be seen that the diameter of free activated bacteria zone was increased from 0 to 8.5 at Staph and from 0 to 6.5 at E.Coli

4-the cellulous increase the antibacterial resistance, so samples produced with 45 g/m2 have achieved the highest rates of bacteria zone increase.

Knitted samples

1-we can see from tables and figures that untreated fabrics did not provide any resistance against bacteria

2- we can see from tables and figures that treated samples have achieved the highest diameter of free activated bacteria zone as it increased from 7.5 to 8 at Staph and from 7 to7.5 at E.Coli

3- It is also seen that samples of high weights ,pique 195 g/m2 ,single jersey 170 g/m2 and single jersey cotton /polyester 170 g/m2 have achieved the highest diameters of free activated bacteria zone ,whereas single jersey cotton /polyester of 140 g/m2 has achieved the lowest diameter of free activated bacteria zone.

We can state that cellulous samples have absorbed the treatment material more than the blended samples ,also the increases of weight g/m2 has increased the absorption of the treatment material leading to the increase in the free activated bacteria zone

3.2. Bursting resistance

It is clear from the diagrams that cotton samples produced of 195 g/m2 and single jersey structure have achieved the highest rates of bursting resistance , whereas cotton / polyester samples produced of 140 g/m2 and 170 g/m2 and single jersey structure have achieved the lowest rates . we can report that the increase in number of yarns per unit area, cause the increase in bursting resistance because of the increase in friction between yarns.

we can also notice from the diagrams that samples made of polyester /cotton have recorded the highest rates of bursting resistance, whereas samples made of 100% cotton have recorded the lowest rates. We can report that polyester yarns have high tensile strength and durability compared to cotton yarns , which increase the bursting resistance.

It is also obvious from the statistical analysis of the bursting resistance results after antimicrobial treatment that there is loss of tensile strength from 1.49 to 9.2 % but this loss was insignificant ,and this loss has increased after softneing treatment , beside that water repellency treatment also cause loss of tensile strength but in some samples the bursting resistance was increased , we can report that sample have crimped because of alkali treatment.

3.3. Absorption

From tables and figures ,it is obvious that the increase of Quat-188 concentrations 0 % (which is made of methyl cellulous in cross correlation with methyelene bisacrylamide)gives the highest content of Hydrogel absorption in SRV to 2000 % and WRV to 2500% . Also it is obvious that the carboxy methyl cellulous gives the lowest area of surface of bacterial for both bacterial and fungal activity .Where ,the diameter of free activated bacteria zone for Staph bacteria was 3 mm and E.Coli 0 mm .From tables and figures ,it is also obvious that the increase of Quat-188 concentrations from 1 to 6 % gives the highest content of water absorption Hydrogel in SRV to 5000 % and WRV to 4500% . Also it is obvious that the carboxy methyl cellulous gives the biggest area of surface of bacterial for both of bacterial and fungal activity .Where, the diameter of free activated bacteria zone for Staph bacteria was 7 mm and E.Coli 5 mm .It is obvious from results that the viscose samples have achieved the highest rates of absorption, whereas cotton samples have achieved the lowest rates, this is due to that the moisture regain of viscose is 14 % whereas the cotton 8.5 %.

3.4. Water repellency

Woven samples

From tables, and figures , that samples achieved zero of water repellency before treatment ,we can state that cotton material is a highly absorption material, beside of the used structures had pores and didn't achieve water repellency

After treatment the samples achieved high water repellency ,but the effect of fabric structure was insignificant ,so the plain weave 1/1 achieved the highest rates of water repellency (80 %) whereas the others structures have achieved 70 %

Nonwoven samples

From results obtained before treatment , samples of cotton or viscose have achieved 0 % water repellency whereas samples of synthetic fibers have achieved the highest rates ,and after treatment with Novo NB ,the water repellency has increased as samples of natural fibers have achieved 50 % water repellency whereas the samples of synthetic fibers have achieved 100 % water repellency, we can report that the natural fibers have high absorption rates compared to synthetic fibers .

Knitted samples

From results obtained before treatment, all samples have achieved 0 % water repellency, we can report that the knitted construction contain pores which increased the absorption but after treatment , single jersey structure of cotton /polyester and 170 g/m2 has achieved the highest rates of water repellency (70 %) ,whereas single pique cotton samples of 195 g/2 did not change and the other samples achieved 50 % of water repellency

It was also found that, there is a direct relationship between Novo NB concentrations and water repellency. Where it could be reported that the increase in concentrations cause a decrease in fabrics pores (blocking of the surface) and so increase fabrics compactness, and thus increasing its fabric water repellency

3.5. Tensile strength

Woven construction

It is clear from the diagrams and tables that plain weave 1/1 has obtained the highest rates of tensile strength , whereas regular hopsack 3/3 has obtained the lowest rates, and this is for sake of the increase in the number of intersections per cm for the plain weave 1/1 which cause increasing of the tensile strength in the fabric but the difference was insignificant. It is also obvious from the statistical analysis in the warp direction that tensile strength was obtained the higher tensile strength than the weft direction in all structures .It is also obvious from the statistical analysis of the tensile strength results after antimicrobial treatment that there is loss of tensile strength from 7 % to 10 % ,and this loss increases after softening treatment ,besides that the water repellency treatment had also caused loss of tensile strength from 2.5 % to 15 %

Nonwoven construction

It is also obvious from the statistical analysis that tensile strength in machine direction is higher than the tensile strength in cross machine direction. This is due to that carding machine make fibers straight in machine direction which cause an increase in the friction between fibers. Samples of polyester blended with viscose fibers of 45 g/m2 have achieved the highest rates of tensile strength, followed by 100% viscose samples of 45 g/m2 , cotton samples of 36 g/m2 , and then viscose samples of 16 g/m2 . It is also obvious from the statistical analysis of the tensile strength results after antimicrobial treatment that there is loss of tensile strength from 5 to 33 % ,and this loss increases after softening treatment , besides that water repellency also cause loss of tensile strength but in some samples the tensile strength was increased , we can report that alkali treatment caused samples to be crimped..

3.6. Elongation

Woven construction

It is obvious from the diagrams that regular hopsack 3/3 has recorded the highest rates of elongation , whereas plain weave 1/1 has recorded the lowest rates . We can report that regular hopsack 3/3 weave has less intersections than plain weave 1/1, ,and so the friction between yarns will be decreased and the ability of yarn slippage will be increased and so elongation in the fabric will be increased .

Nonwoven construction

It is also obvious from the statistical analysis that elongation in machine direction is lower than the elongation in cross machine direction. This is due to that carding machine make fibers straight in machine direction which cause an increase in friction between fibers in machine direction and decrease the ability of fibers slippage which cause decrease in the elongation. It is also obvious from tables that viscose samples of 16g/m2 have achieved the highest rates of tensile strength, followed by cotton samples of 30 g/m2 , cotton samples of 36 g/m2 , and then viscose / polyester samples of 45 g/m2 . We can state that the increase in tensile strength cause decrease in the elongation . It is also obvious from the statistical analysis that tensile strength in machine direction is higher than the tensile strength in cross machine direction. This is due to that carding machine make fibers straight in machine direction which cause an increase in the friction between fibers. It is also obvious from the statistical analysis of the elongation results after antimicrobial treatment that there is loss of elongation in machine direction and in cross machine direction ,and ratio of loss was from 1% to 36%

Bursting resistance

knitted construction

It is clear from the diagrams that cotton samples of 195 g/m2 and single jersey structure has achieved the highest rates of bursting resistance , whereas samples produced with cotton / polyester of 140 g/m2 and 170 g/m2 using single jersey structure have achieved the lowest rates . We can report that the increase in number of yarns per unit area, cause increase in bursting resistance because of the increase in friction between yarns.We can also notice from the diagrams that samples made of polyester /cotton blend have recorded the highest rates of bursting resistance, whereas samples made of 100% cotton have recorded the lowest rates. We can report that polyester yarns have high tensile strength and durability compared to cotton yarns , which increase the bursting resistance. It is also obvious from the statistical analysis of the bursting resistance results after antimicrobial treatment that there is loss of tensile strength from 1.49 to 9.2 % but this loss was insignificant ,and this loss has increased after softening treatment , beside that the water repellency also caused loss of tensile strength but in some samples the bursting resistance was increased , we can report that alkali treatment caused samples to be crimped.

3.7. Handle test

Woven samples

In fabric handle test , the less angle value ,the more smoother the fabric .According to this ,it is clear from the diagram that mock leno weave is considered the most smooth fabrics among all woven fabrics followed by regular hopsack weave 3/3 ,honeycomb weave and then plain weave 1/1.This is probably because mock leno structure have the advantage of containing long floats and less intersections besides that it has ridges and hollows and so reduce the friction between the diaper and skin, besides that the warp and weft threads float freely on both sides, so that frication points between the tested fabrics and the standard woolen fabric ,used in the test are minimized allowing easily sliding of fabric down the slope .After antimicrobial treatment the fabrics smoothness has decreased because the treatment was made using alkali and high temperature , these factors cause a decrease in fabric smooth , beside this softening material was added to antimicrobial treatment bath to increase the fabric smoothness.

Nonwoven samples

Nonwoven fabrics are considered a little bit coarser than woven fabrics ,and this is due to the parallel technique used for arranging fibers which increases the friction between the fabric and the woolen standard fabric used in this test . It is also obvious from tables that cotton samples of 36g/m2 and viscose sample of 16 g/m2 are considered the most smooth respectively, whereas samples produced from blended cotton /polyester fibers had the lowest rates of smoothness. We can report that the natural fibers have a naturally very smooth surface resulted from their negular cross section which has a serrated circular shape which resulted in flat surface in the longitudinal view of the fibers. After antimicrobial treatment the fabrics coarseness were higher because the treatment was made using alkali and high temperature , these factors cause decrease in fabric smoothness .

Knitted samples

It is clear from the tables that samples produced with cotton / polyester of 140 g/m2 and single jersey structure have achieved the highest rates of smoothness among all produced samples . we can state that this is due to polyester fibers have a very smooth surface .After antimicrobial treatment the fabrics coarseness become higher but after addition of softness material , samples of cotton / polyester, single jersey and 140 g/m2 have recorded the highest rates of smoothness followed by single pique cotton samples.

3.8. Water permeability

Woven samples

It is obvious from the table, that effect of fabric structure on water permeability was insignificant before and after treatment .

Nonwoven samples

From the results it is obvious that samples produced of viscose fiber have achieved the highest rates of water permeability among all produced samples .this is due to that viscose fibers are higher than in water absorbency (14%) compared to polyester fibers (0.4%), and so allow the free passage of water through the fabric .It is also clear from pervious diagrams that samples of low weights have recorded the highest rates of water permeability compared to samples of high weights, because low weight means decreasing in number of fibers per unit area which allow water to be passed. easily

knitted samples

We can notice that the differences between samples in water permeability were insignificant . It is clear from the diagrams that cotton samples of 140 g/m^2 and single jersey have achieved the highest rate of water permeability . This is due to that the decrease in fabric weight means decrease in number of yarns per unit area and so spaces between them will be increased causing fabric to be highly porous and so water will be passed easily.

References

1 - Ramani, T.,V., and Jacob, M., " From rag waste to disposable diapers", The Indian Textile Journal, RS. 30,vol. 100, No. 10, July, 1990, p. 144-145.

2-Brody, H., " Synthetic fiber materials ", Longman group UK,limited,London,1994,p.,329,334,

3-Shamash, K., " A healthy prognosis", Textile month, December,1980,p.15,16.

4-Bottcher ,P.," Medical Textiles :Current Status and Trends "Industrial Textile Bulletin ,4 th Quarter ,Vol.41,1995.P4-5

5-Mathews,A., and Hardingham,M., "Medical and Hygiene textile production", Intermediate technology ,Russell press Ltd, Nottingham, UK, 1994,p. 10,15

6 – **Barbara , J., Cohen, J.,B.,** " Medical terminology ", Lippincot company ,Philadelphia , 1989, p. 95,62.

7 - Qin, Y., Agboh, C., Wang ,X., and Gilding, K., " Alginate fibers and dressing ", The Textile Institute, vol.1, April 1996, p. 419.

8 – **Smith & Nephew,** " Development of materials " Medical Textile, vol. 3 ,No. 8,December, 1986 , p. 3,4,5.

9 – **Kunzendorf , F.,** " Industrial fabrics for special fields of application ", Meliand and berichte, vol. 3, No. 3, March, 1984, p.38.

10- AATCC 90-1982 " Standard test method for measuring Antibacterial

11- ASTM-D 4491/92 " Standard test method for measuring Air permeability

12- ISO 811: 1 " Standard test method for measuring Water permeability

13- B.S.3424: 1987 " Standard test method for measuring fabric handles

14- ASTM-D 4595 " Standard test method for measuring tensile strength & elongation

15- AATCC 392-1963, " Standard test method for measuring water repellency "

16- **ASTM-D 3787-89** " Standard test method for measuring bursting resistance

17- ASTM-D1777/1996 " Standard test method for measuring Fabric thickness

18- ASTM-D 3776- 79 " Standard test method for measuring Fabric weight

List of table

Table (1) specifications of woven samples, produced in this research

No	Property	Specification
1	Warp type	Cotton
2	Weft type	Cotton
3	Count of warp yarns	80/2 English
4	Count of weft yarns	80/2 English
5	Warp set (ends / cm)	18
6	Weft set (picks / cm)	12
7	Fabric structures	Plain weave 1/1,regular hopsack 3/3 , honeycomb and mock leno
8	Reed used	18 dents /cm
9	Denting	1 end /dent
10	Finishing	Treatment with Scouring , Bleaching ,antibacterial ,softening, water repellency

Table (2) specifications of nonwoven samples, produced in this research

No	Property	Specification
1	**fiber type**	Cotton ,polyester ,viscose ,polypropylene , polyester /viscose 70/30 ,polyester /viscose 10/90 and polyester /viscose 40/60
2	**Fiber length**	30 and 38 mm
3	**Fiber count**	1.5 denier
4	**We-formation**	Spun lace
5	**Web - bonding**	Thermo bonding
6	**Weight g/m^2**	16 ,30,36,40 and 45
7	**Finishing**	Treatment with Scouring , Bleaching ,antibacterial ,softening, water repellency

Table (3) specifications of knitted samples, produced in this research

No	Property	Specification
1	fiber type	Cotton /polyester and cotton
2	Fabric structure	Single Jersey and single pique
3	Yarn count	24/1 and 30 /1 English
4	Number of courses	22 and 24
5	Number of	50 and 61
6	Weight g/m2	140,170 and 195
7	Finishing	Treatment with Scouring , Bleaching ,antibacterial ,softening, water repellency

Table (4) results of tensile strength and elongation tests applied to woven produced samples for outer layer (close-to-skin) before and after treatment

Tests	Tensile strength (Kg/cm)						Elongation (%)					
	Before treatment		Antibacterial treatment		Softness and antibacterial treatment		Before treatment		Antibacterial treatment		Softness and antibacterial treatment	
Fabric structure	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
Plain weave 1/1	21.7	17.13	16.87	13.81	20	15.5	20	10	19.33	9	18	9.3
Regular hopsack 3/3	19.8	12.5	14.5	11.96	15.7	13	26	18	25	16.5	25.5	17
Honey comb	20.5	15.5	16.37	12.5	17	14.2	22	13	22	11	21.3	11.87
Mock leno	20	15	18	13	17.66	13.15	25	11	22	10	22.6	10.2

Table (5) results of antibacterial ,handle and water permeability tests applied to woven produced samples for outer layer (close-to-skin) before and after treatment.

Tests	The diameter of free activated bacteria zone (mm)						Handle (0)			Water permeability (cm3/cm2/sec)		
Fabric structure	Before treatment		Antibacterial treatment		Softness and antibacterial treatment		Before treatment	Antibacterial treatment	Softness and antibacterial treatment	Before treatment	Antibacterial treatment	Softness and antibacterial treatment
	E.Coli	Staph.	E.Coli	Staph.	E.Coli	Staph.						
Plain weave	0	0	6.	6	7	6.5	44.5	45	42	0.115	0.115	0.115
Regular	0	0	5.	5	6	6.5	38.16	44	24.5	0.116	0.116	0.116
Honey comb	0	0	5.	5	5.5	5	38.16	42	20	0.115	0.115	0.115
Mock leno	0	0	5.	5	5.5	5	34.3	42.	34	0.115	0.115	0.115

Table (6) results of tensile strength and elongation tests applied to the nonwoven produced samples for outer layer (close-to-skin) before and after treatment

Tests		Tensile strength (Kg/cm)						Elongation (%)					
Fiber type	weight	Before treatment		Antibacterial treatment		Softness and antibacterial treatment		Before treatment		Antibacterial treatment		Softness and antibacterial treatment	
		M.D	C.Md	M.D	C.Md	M.D	C.Md	M.D	C.Md	M.D	C.Md	M.D	C.Md
cotton	36	4.687	1.9	3.837	1.7	3.933	1.1	66	71	42	57	51	69
Viscose	16	4	1.5	3	1	3.3	1.2	75.3	86	53	80	58.6	72
Viscose	45	10.12	4	8.6	3.86	7.825	3.466	59.75	74	49	86	48	71
Polyester /viscose 70/30	30	5	1.75	4.2	1.53	3.933	1.466	68.3	82	53.9	80	53.6	70
Polyester /viscose 60/40	45	10.83	4.13	9.625	3.783	8.8	3.6	60.66	70	49	69.87	47.32	69
Polyester /viscose 30/70	45	7.66	3.1	6.8	2.883	5.866	2.776	58.8	73.8	49.8	70	48.5	73
Polyester /viscose 90/10	45	19.25	2.6	7.76	2.23	7.8	2.13	61	72	49	65	53.2	69

Table (7) results of antibacterial ,handle and water permeability tests applied to nonwoven produced samples for outer layer (close-to-skin) before and after treatment.

Tests		the diameter of free activated bacteria zone (mm)						Handle (^{0})			Water permeability ($cm^3/cm^2/sec$)		
Fiber type	Weight	Before treatment		Antibacterial treatment		Softness and antibacterial treatment		Before treatment	Antibacterial treatment	Softness and antibacterial treatment	Before treatment	Antibacterial treatment	Softness and antibacterial treatment
		E.Coli	Staph.	E.Coli	Staph.	E.Coli	Staph.						
cotton	36	0	0	8.5	6.5	5	4.5	17.6	25	23	0.1136	0.1136	0.1136
Viscose	16	0	0	5.5	5	6.5	6	41.3	45	43.5	0.1141	0.1138	0.1136
Viscose	45	0	0	8.3	6.7	6.5	6	45	45	43	0.1136	0.1136	0.1132
Polyester /viscose 70/30	30	0	0	8.5	6.5	5	4.5	45	42	17.5	0.114	0.114	0.1138
Polyester /viscose 60/40	45	0	0	6	5	4.5	4	45	45	43.5	0.1132	0.1132	0.1132
Polyester /viscose 30/70	45	0	0	8.3	6.7	6	5.5	45	45	44	0.1136	0.1132	0.1136
Polyester /viscose 90/10	45	0	0	5.5	5.5	5.5	5	45	45	44	0.1136	0.1141	0.1136

Table (8) results of bursting resistance and antibacterial tests applied to knitted produced samples for outer layer (close-to-skin) before and after treatment

Tests			Bursting resistance (Kg/cm^2)			The diameter of free activated bacteria zone (mm)					
Fabric structure	Fiber type	Weight (g/m2)	Before treatment	Antibacterial treatment	Softness and antibacterial treatment	Before treatment		Antibacterial treatment		Softness and antibacterial treatment	
						Staph.	E.Coli	Staph.	E.Coli	Staph.	E.Coli.
Single pique	Cotton	195	6.6	6.5	6.1	0	0	8	7.5	8	7.5
Single jersey	Cotton	140	10.25	9.25	9.3	0	0	8	7	5.5	5
Single jersey	Cotton	170	11.3	10.6	10.636	0	0	8	7.5	7	7.5
Single jersey	Cotton /polyester	140	6.875	6.3	6	0	0	7.5	7	8	7
Single jersey	Cotton /polyester	170	6.7	6.6	6.050	0	0	8	7.5	7.5	7

Table (9) results of handle and water permeability tests applied to knitted produced samples for outer layer (close-to-skin) before and after treatment.

Fabric structure	Fiber type	Tests	Handle (^{0})			Water permeability ($cm^3/cm^2/sec$)		
		Weight (g/m2)	Before treatment	Antibacterial treatment	Softness and antibacterial treatment	Before treatment	Antibacterial treatment	Softness and antibacterial treatment
Single pique	Cotton	195	45	45	42	0.1111	0.1087	0.1087
Single jersey	Cotton	140	45	45	45	0.1136	0.1123	0.1074
Single jersey	Cotton	170	45	45	45	0.1123	0.1091	0.1099
Single jersey	Cotton /polyester	140	39.5	43	39	0.115	0.1136	0.1123
Single jersey	Cotton /polyester	170	45	45	45	0.1123	0.1099	0.1099

Table (10) results of water repellency ,tensile strength and elongation tests applied to woven produced samples for outer layer (non close-to-skin) before and after treatment

Tests	Water repellency		Tensile strength (kg/force)				Elongation (%)			
Fabric structure	Before treatment	After treatment	Before treatment		After treatment		Before treatment		After treatment	
			Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
Plain weave 1/1	0	80	21.7	17.13	19.6	15.25	20	10	18.83	9.98
Regular hopsack 3/3	0	70	19.8	12.5	18.6	11.5	26	18	23	15
Honey comb	0	70	20.5	15.5	20	13.25	22	13	20.66	11.5
Mock leno	0	70	20	15	19	12.92	25	11	22	10.3

Table (11) results of water repellency ,tensile strength and elongation tests applied to nonwoven produced samples for outer layer (non close-to-skin) before and after treatment

Fiber type	Weight g/m^2	Water repellency		Tensile strength (kg/force)				Elongation (%)			
				Before treatment		After treatment		Before treatment		After treatment	
		Before treatment	After treatment	M.D	C.Md	M.D	C.Md	M.D	C.Md	M.D	C.Md
Polyester	36	70	100	8.25	2.5	5.9	2.3	73.87	135	54	117.5
Viscose	40	0	80	4	1.5	3.43	1.3	75.3	86	65.5	80
Viscose	16	0	70	10.13	4	6.661	3.4	59.75	74	46.8	57
Polypropylene	45	70	90	4.375	3.3	3.75	2.9	66.58	44.5	46.5	38
polypropylene	16	70	100	9.066	11.833	12.1	9.74	116.6	41.66	99.5	53
Polyester /viscose 70/30	30	50	90	5	1.75	3.4	1.41	68.3	82	57.5	70
Polyester /viscose 60/40	45	50	70	10.38	4.13	8.1	3.55	60.66	70	51.3	67
Polyester /viscose 30/70	45	50	80	7.66	3.1	6.65	2.8	58.8	73.8	50.5	63.5
Polyester /viscose 90/10	45	0	80	9.25	2.6	6.8	2	61	72	54	59.75

Table (12) results of water repellency and bursting resistance tests applied to knitted produced samples for outer layer (non close-to-skin) before and after treatment

Structure	Fiber type	Weight g/m^2)(	Water repellency		bursting resisting	
			Before treatment	After treatment	Before treatment	After treatment
Single pique	Cotton	195	0	0	6.6	7.2
Single jersey	Cotton	140	0	50	10.25	10.4
Single jersey	Cotton	170	0	50	11.3	10.6
Single jersey	Cotton /polyester	140	0	50	6.875	6.2
Single jersey	Cotton /polyester	170	0	70	6.7	6.2

Table (13) results antibacterial and absorption tests applied to produced samples for medium layer before and after treatment

Tests	The diameter of free activated bacteria zone (mm)								Absorption			
Fiber type	Quat-188 concentration (75 g/L)				Actigard concentration (10 g/L)				Before treatment		After treatment	
	Before treatment		After treatment		Before treatment		After treatment					
	Staph.	E.Coli	Staph.	E.Coli	Staph.	E.Coli	Staph.	E.Coli	(SRV%)	(WRV %)	(SRV%)	(WRV %)
Cotton	0	0	3	3	0	0	7.5	8.4	2000	2000	5000	4000
Wood pulp	0	0	3	3	0	0	7.5	8.4	2000	2500	5000	4500
Cotton /viscose	0	0	3	3	0	0	7.5	8.4	2400	2600	5500	5000

Table (14) results antibacterial test applied to produced samples for medium layer

Test	Antibacterial											
Treatment material	Actigard concentration							Quat-188 concentration				
Concentration	0	2.5	5	7.5	10	12.5	15	0	1	2	4	6
Bacteria type	The diameter of free activated bacteria zone (mm)											
E.Coli	0	2.5	2.9	6.4	8.4	8.4	8.5	0	3	4.5	5	5
Staph.	0	1	2.5	5.5	7.5	7.5	7.5	3	6	6	7	7

Table (15) regression equation and correlation coefficient for the relationship between of blend ratio of viscose /polyester on The diameter of free activated bacteria zone for non woven outer layer (closed-to –skin)

Structure	Regression equation	Correlation coefficient
Before treatment	Y =-0X+0	**-1**
Antibacterial treatment	Y =-0.04667+9.4	-0.937509
Antibacterial and softness treatment	Y=-0.00833X +5. 3333	-0.8273

Table (16) regression equation and correlation coefficient for effect of weight g/m^2 on bursting resistance for knitted outer layer (nonclosed-to –skin) .

Structure	Regression equation	Correlation coefficient
Before treatment	Y=-0.188 X +43.26	-1
Antibacterial treatment	Y=-0.164 X +38.48	-1
Antibacterial and softness treatment	Y=-0.18144 X +41.4808	-1

Table (17) regression equation and correlation coefficient for effect of weight on fabric on bursting resistance for knitted outer layer (nonclosed-to –skin)

Structure	Regression equation	Correlation coefficient
Before treatment	**Y=0.188 X +43.26**	**-1**
After treatment	**Y=-0.136 X +33.72**	**-1**

List of figures

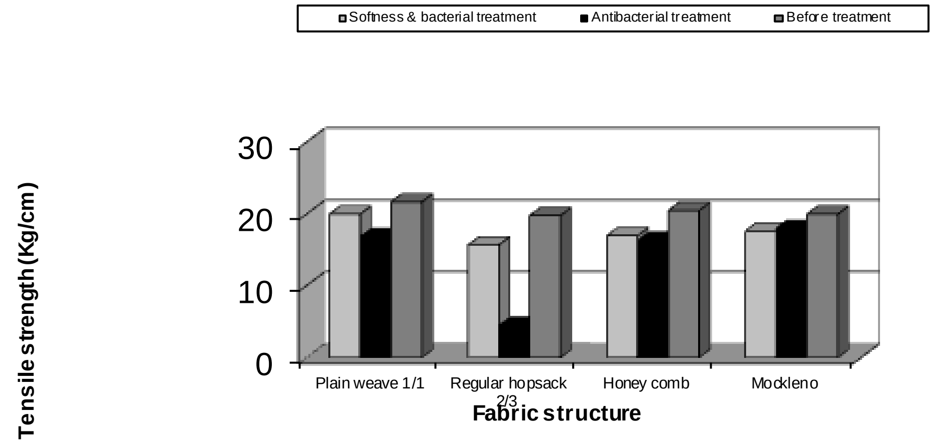

Fig. (1) effect of fabric structure on tensile strength for woven outer layer (close-to-skin) before and after treatment at warp direction

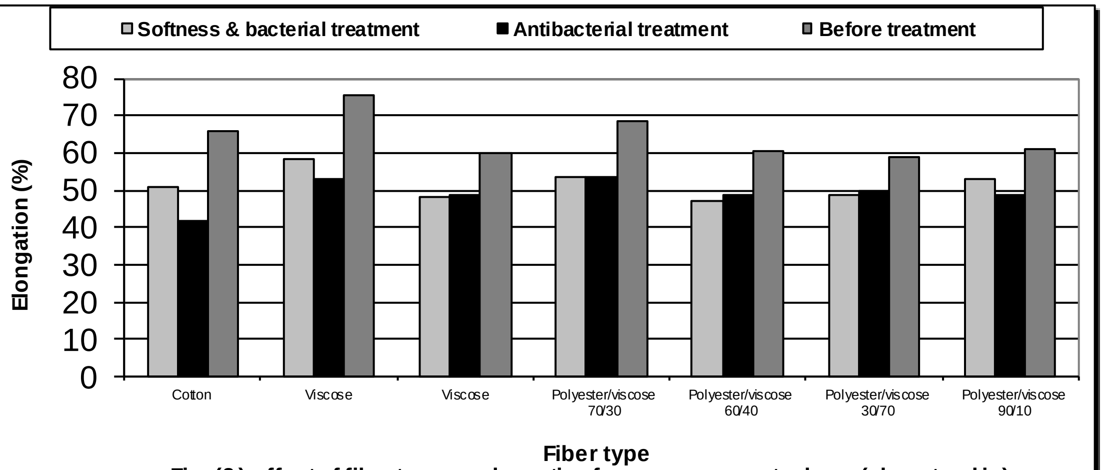

Fig. (2) effect of fiber type on elongation for nonwoven outer layer (close-to-skin) before and after treatment at warp direction at machine directiont

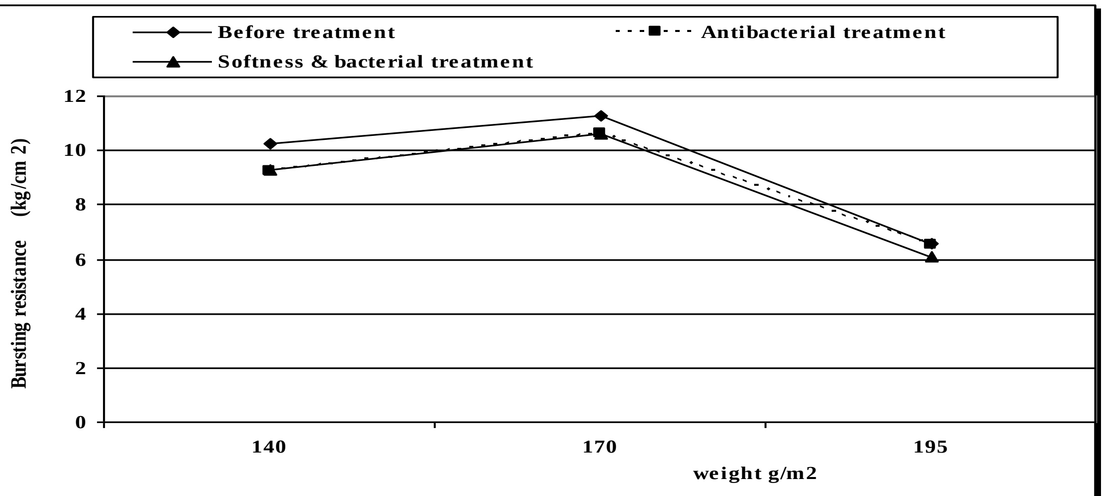

Fig. (3) effect of weight gm/m2 on bursting resistance for knitted outer layer (close-to-skin) before and after treatment at weft direction before and after treatment

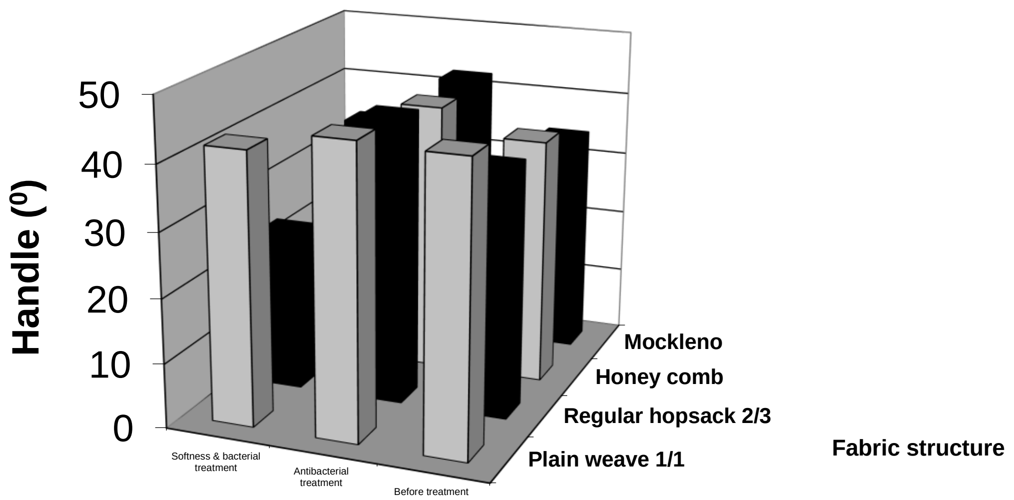

Fig . (4) effect of fabric structure on handle for woven outer layer (close-to-skin) before and after treatment

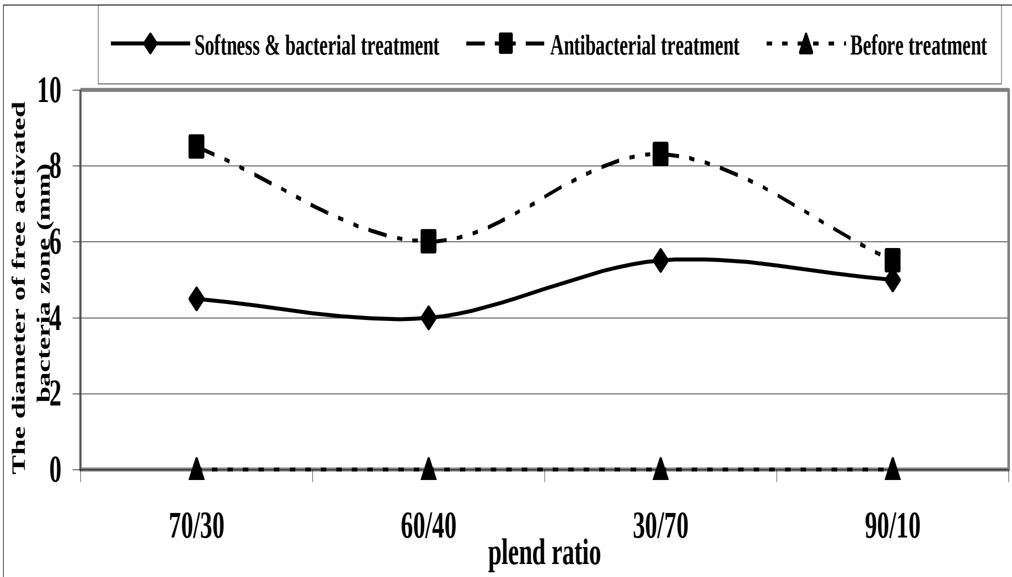

Fig . (5) effect of blend ratio of viscose /polyester on antibacterianon for nonwoven outer layer (close-to-skin)

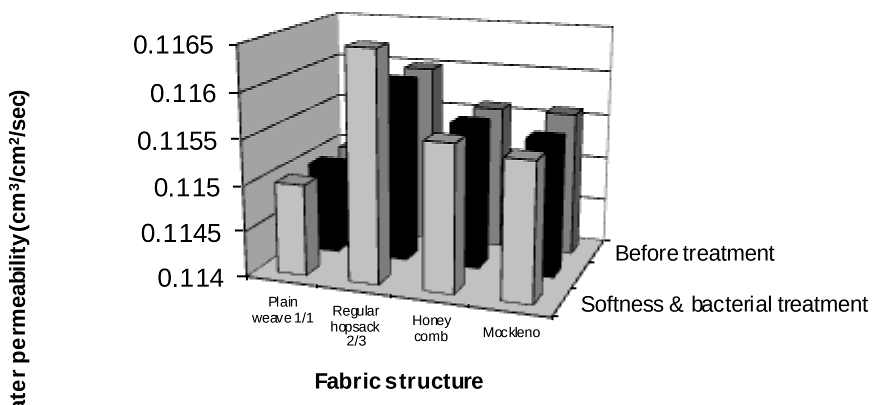

Fig. (6) effect of fabric structure on water permeability for woven outer layer (close-to-skin) before and after treatment.

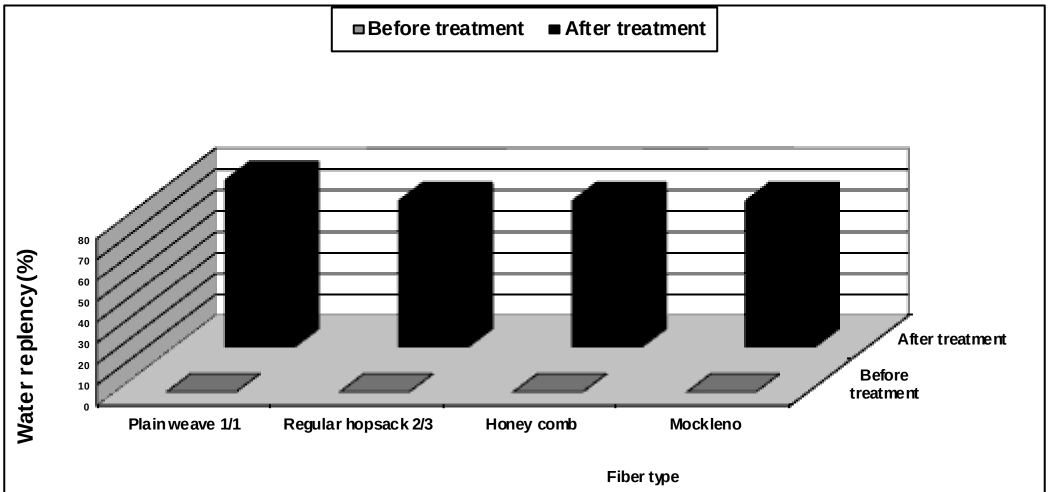

Fig . (7)effect of blend ratio of viscose /polyester on antibacteril for woven outer layer (nonclose-to-skin)

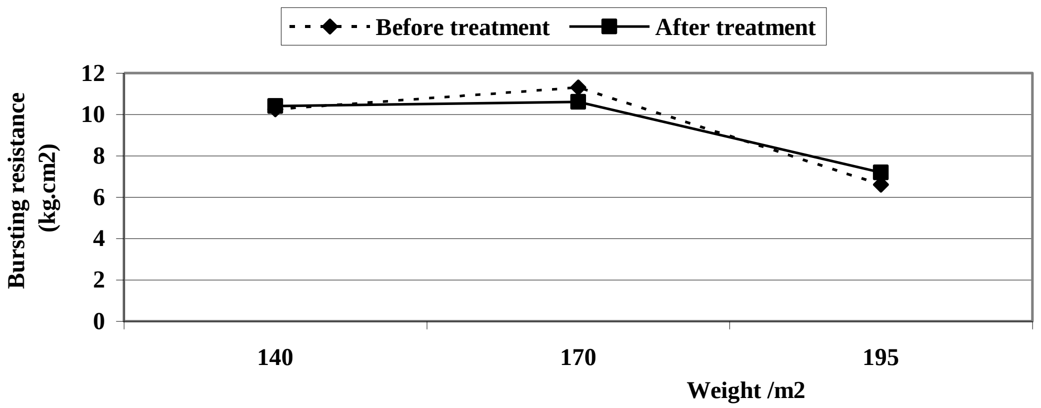

Fig . (8) effect of weight on bursting resistance for knitted outer layer (nonclose-to-skin)

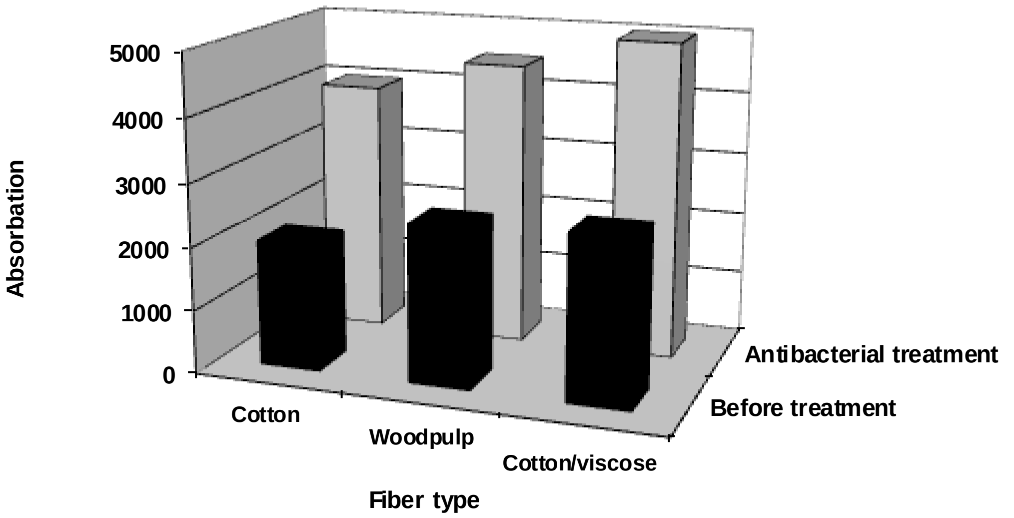

Fig. (9) effect of fiber type on antibacterial for medium layer

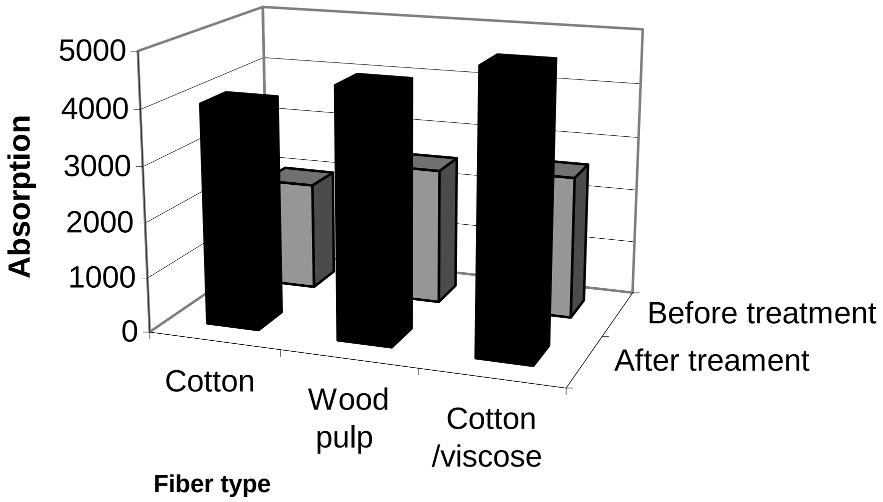

Fig. (10) effect of fiber type on absorption for medium layer