PRODUCE SURGICAL DRAPES BY USING POLYESTER MICROFIBER TO SAVE HYGIENIC ENVIRONMENT

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ABSTRACT

The purpose of research is to produce surgical drapes made out of polyester micro fiber to save physical, mechanical and hygiene properties to drapes which used in surgical rooms.

Microfiber with (150, 300 denier/ 144 fibers) were used to produce samples with two fabric structures which are: Honeycomb and satin. Cotton fiber has used to compare between samples in physical, mechanical and hygiene properties.

Microfiber samples show higher results in water permeability, air permeability, tensile strength and resistance to bacteria and fungus growth.

Key words: Drapes, polyester microfiber, Microbial activity tests, rapidity of water

I. INTRODUCTION

For many years the textile world was very simple when it came to the function of textile. With increasing use of the term “functional textile“, the situation has become more complex. The synthetic fiber industry has been developing new products and marketing approaches claiming enhanced “physiological function in textiles” for sportswear and other fields[1].

The objective was to produce the evidence needed to make medical sector aware of the excellent “inherent functionality” microfiber sheets and that in many cases there is no need to use highly sophisticated functional synthetic fibers and finishes to achieve a “functional textile”[1]

There are two ways of developing the physiological functions of a textile product.

Properties can be modified or enhanced by work on the fabric development level and/or fibers can be used which offer physiological functions on the fiber level. The best products will result from a combination of the two approaches. The “inherent physiological functions” of textile fibers can be postulated that:

When hygroscopic or hydrophilic fibers come into contact with water, they absorb it into the fiber structure.

Cellulosic fiber plus water gives inherent physiological functions. It is only thecombination of cellulose with water that gives interesting physiological properties.

3. Hydrophobic synthetic fibers do not absorb water into the fiber structure; they can only adsorb water onto the fiber surface.

4. Therefore the combination of synthetic fibers with water normally will not result in added physiological properties (or only to a very low extent).

5- Microfiber has different absorption behavior when it exposed to water. It gives enhanced physiological properties.[1]

1- Methodology of research:

The properties needed to drapes used in surgical rooms:

1-1sterile drapes should be used within the sterile field:

Drapes create a barrier between the surgical field and possible sources of microbes. Microbial migration and contamination from non-sterile to sterile areas is minimized by isolating the incision site and creating a sterile field with the use of sterile drapes. Drapes protect the patient from their own skin flora (endogenous source of contamination) and surgical team members and environment (exogenous sources of contamination). Methods of sterilization for drapes include, but are not limited to, radiation, steam, and ethylene oxide.

Current studies from the USA and some European countries show that Staphylococcus aureus is still the most common cause of sternal wound infections. For example, Jonkers et al. from the Netherlands found that *S.* aureus was the most common bacterium isolated from sternal wound infections; it was found in 26% of the cultures. In that study, various Gram-negative bacteria were found with a relatively high frequency, while Staphylococcusepidermidis and other coagulase-negative staphylococci (CoNS) were found in only 10% of the cultures [2]. From the USA, Sharma et al. reported *S.* aureus as the dominating pathogen in deep sternal surgical site infection after coronary artery bypass graft, followed by CoNS, and only exceptionally Gram-negative rods [3]. When a foreign material such as a biomaterial, e. g. stainless steel wires, isintroduced into the body, the surface will immediately be coated with extracellular matrix proteins such as albumin, fibronectin, vitronectin, and others. These proteins will facilitate the growth of connective tissue cells, predominantly fibroblasts, on the surface and thereby promote the integration of the biomaterial into the body. If staphylococci are present there will be a competitive situation between the bacteria and the fibroblasts and other cells, illustrated by the expression coined "the race for the surface". Hospitals sterilize all tools involved in the surgery in autoclaph by heating. When polyester microfibers are sensitive for heat so fabric has sterilize by Gamma rays. [4]

Gamma radiation (sometimes called gamma ray), denoted by the lower-case Greek letter gamma (γ), is extremely high-frequency electromagnetic radiation and therefore consists of high-energy photons. Paul Villard, a French chemist and physicist, discovered gamma radiation in 1900 while studying radiation emitted by radium. In 1903, ErnestRutherford named these radiation gamma rays. Rutherford had previously discovered two other types of radioactive decay, which he named alpha and beta rays.

Gamma rays are ionizing radiation, and are thus biologically hazardous. Decay of an atomic nucleus from a high energy state to a lower energy state, a process called gamma decay, produces gamma radiation. This is what Villard had observed.[5]

1-2-Drapes should be resistant to fluid penetration.

Intraoperative patient body fluids and irrigating solutions come into contact with the drapes. Draping material should be impervious and fluid-resistant to prevent strike-through contamination from microorganisms. Prevention of strikethrough contamination reduces the risk of SSI. When cotton used in drapes or any hydrophilic fibers, they absorbed fluids into fabric structure but microfibers have the ability to absorb water with capillarity property.

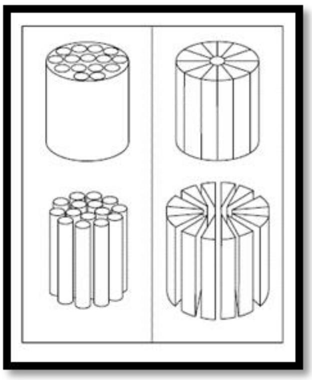


Fig (1) the cross section of microfiber

Microfiber refers to synthetic fibers finer than one or 1.3 denier or decitex/thread. By comparison, microfiber is 1/100th the diameter of a human hair and 1/20th the diameter of a strand of silk. [6]

The most common types of microfibers are made from polyesters, polyamides or a conjugation of polyester, polyamide, and polypropylene (Prolen). The special characteristics of Microfiber which stand out for their softness, fall, strength,durability, cleaning and ability without scratching or leaving fluff, great absorption capacity (capillarity), washing resistance (up to 95ºC), lightness and comfort in use .[7] The microfibers create a mechanical action that removes soils from surfaces. Microfiber is extremely small, but the size of the fiber is not the only reason for its superiority. Traditional cleaning cloth fibers are cylindrical and have a tendency to push dirt and moisture around leaving the surface unclean and wet. Blended microfiber is shaped like an asterisk (*)As in Fig (1).[8]

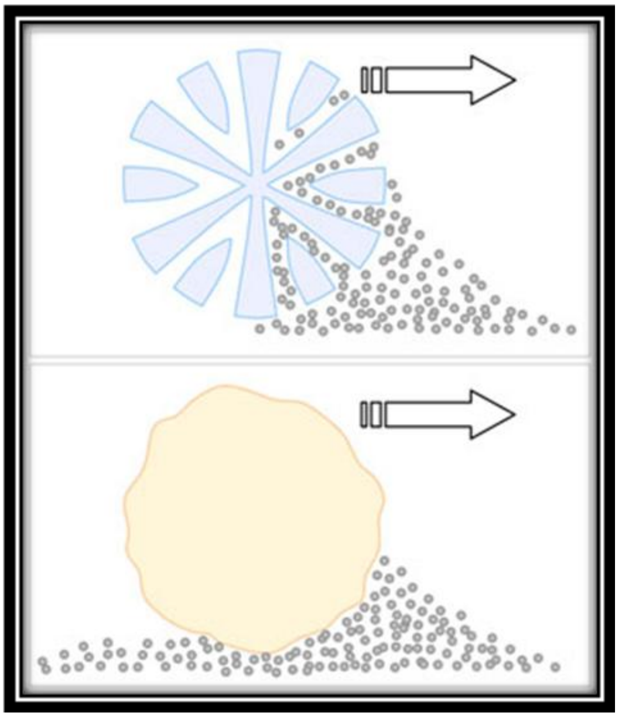


Fig (2) the difference in theory of absorption dust in microfiber and cotton

It has the ability to pick up and lock dirt, dust and moisture into the fibers actually cleaning and drying the surface. If the microfiber is not blended and split, it has a cylindrical shape and has the same problems associated with traditional cleaning towel fibers. As in Fig (2)

Microfiber is positively charged, which adds to its ability to attract dirt like a magnet (dirt is negatively charged). It is also lint free, leaving nothing behind when cleaning or drying. The fibers are so small they are able to penetrate cracks and crevices than cotton fibers are unable to clean, along with cleaning the microscopic surface pores of most materials. Due to the increased surface area of the fibers and their asterisk shape they are able to hold 7-8 times their weight in liquid, making them excellent drying cloth. [9]

A study done at UC Davis comparing traditional mop heads to microfiber mops heads has really brought microfibers cleaning superiority to light. After cleaning a surface with conventional tools, a bacteria culture showed a 30-percent reduction, while with microfiber materials the bacteria was reduced by 99 percent. Microfiber is so small it can pick up bacteria, whereas rayon or cotton is a large, round fiber and it can't [4].

In addition, they also last much longer than conventional towels. A microfiber towel can be washed over 500 times, compared to just 55 for a conventional towel, providing a lower lifetime cost. As well as saving costs with towel purchases, less cleaning chemicals are used to clean surfaces, which also save costs. Fabrics from microfibers have excellent breathability and have been used for wound care. Their softness, high permeability and breathability guarantee a high level of comfort in wearing when used as surgical gowns and for application as surgical face masks[5].

One caution related to synthetic microfibers is heat sensitivity. Because the fiber strands are so fine, heat penetrates more quickly than with thicker conventional fibers. As a result, microfibers are more heat sensitive and will scorch or glaze if too much heat is applied or if it is applied for too long a period. Generally, microfibers are wrinkle resistant, but if pressing is needed at home or by dry-cleaners, care should be taken to use lower temperatures[6].

1-3- Drapes should be lint free

Lint is recognized as a vector for causing SSI. Additionally, airborne lint serves as a medium for transport of microbes. A. Lint free drapes minimize airborne contamination and spreading of particles into the surgical wound.[2]

II. EXPERIMENTAL WORK

This study aimed to produce fabrics used for drapes used in surgery rooms which using polyester warp yarns of 150 denier and polyester microfiber weft yarns of 150,300denier.Two different woven structures were also used for producing samples under study, 8-satin fabricweave and Honeycomb fabric.

2.1 Finishing Technology

DE weight ofpolyester fiber offers many favorite physical properties for fabric like water absorption and fabric softness. Drapes fabric need these properties to physiological characteristics.so all polyester samples in this study were treated with a chemical treatment to be suitable for drapes. After that, all samples exposure to Gamma rays for sterilization before makes any tests.The specifications of loom as in Table (1).

Table (1) Specifications of the machine used for producing samples under study

No.	Property	Specification
1	Machine type	Simt Textile GS 900 (Rapier)
2	The manufacturer country	France
3	Shedding system	jackred
4	Jackred type	Staubli
5	Machine width	172 cm
6	Number of healds	3072 helds
7	Machine speed	picks/ min
8	Reed used(dents / cm)	9 dents /cm
9	Denting	8 ends per dent

S. No.	Yarns type		Fabric structure	Yarns count		Yarns set	
	Warp	Weft		Warp	Weft	Warp set End/cm	Weft set pick/cm
1	polyester	Polyester-microfiber	8-satin	150 den.	150 den.	72	40
2	polyester	Polyester-microfiber	8-satin	150 den.	150 den.	72	42
3	polyester	Polyester-microfiber	8-satin	150 den.	150 den.	72	44
4	polyester	cotton	8-satin	150 den.	40/1	72	44
5	polyester	Polyester-microfiber	honeycomb	150 den	150 den	72	32

Table (2-1)The specification of all samples under study

S. No.	Yarns type		Fabric structure	Yarns count		Yarns set	
	Warp	Weft		Warp	Weft	Warp set End/cm	Weft set pick/cm
7	polyester	Polyester-microfiber	honeycomb	150 den.	150 den.	72	36
8	polyester	cotton	honeycomb	150 den.	40/1.	72	36
9	polyester	Polyester-microfiber	8-satin	150	300	72	28

10	polyester	Polyester-microfiber	8-satin	150 den.	300	72	30
11	polyester	Polyester-microfiber	8-satin	150 den.	300	72	32
12	polyester	cotton	8-satin	150 den.	20/1	72	32
13	polyester	Polyester-microfiber	honeycomb	150 den.	300	72	28
14	polyester	Polyester-microfiber	honeycomb	150 den.	300	72	30
15	polyester	Polyester-microfiber	honeycomb	150 den.	300	72	32
16	polyester	cotton	honeycomb	150 den.	20/1	72	28

Table (2-2) The specification of all samples under study

Table (3) Results of all tests applied to samples under study

S. No.	Weight Gm/m^2	Thickness cm	Air permeability (cm^3/cm^2/sec)	Rapidity of absorption (sec.)	Wrap		Weft	
					Tensile strength (kg/5 cm)	Elongation (%)	Tensile strength (kg/5 cm)	Elongation (%)
1	192.93	0.24	8.84	7.2	195	41	110	34
2	196.4	0.25	6.7	7.9	195	41	112	32
3	199.86	0.26	4.486	8.6	195	41	117	31
4	192.14	0.25	11.14	5.4	195	41	90	29
5	220.75	0.67	11.4	10.7	195	41	115	35
6	225.5	0.76	11.14	11.7	195	41	115	35
7	236	0.78	8.71	12.6	195	41	120	32
8	224.75	0.75	17.6	9.5	195	41	70	30
9	220,67	0.35	27.2	9.2	195	41	160	44
10	227.6	0.36	24.8	9.8	195	41	165	42
11	234.53	0.38	20.7	10.7	195	41	190	40
12	223.29	0.31	8.71	6.5	195	41	90	18
13	267.75	0.90	27.546	12.3	195	41	170	40
14	280.25	0.97	23.068	12.8	195	41	175	40
15	296.25	1.04	21.98	13.6	195	41	195	50
16	221.5	0.82	18.7	7.9	195	41	55	10

III. RESULTS AND DISCUSSIONS

From the research it was reached to the following result :

3.1 Fabric weigh test

It is obvious from the results in Table (3) that when increase the number of weft per c.m. the increase of weight. It is obvious too when used thick count the weight increase.

3-2 Fabric thickness test

It is obvious from the results in table (3) that, there is a direct relationship between fabric weight and its thickness. We can state that the increase in fabric weight means an increase in number of intersections per unit area which caused an increase in the number of projections on the surface of the fabric caused an increase its thickness.

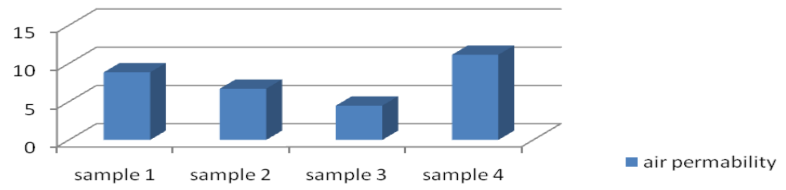
Also the increase in number of intersections per unit area allow fabric to store more length of yarns caused an increase its thickness.

It is obvious from the results in table (3) that the fabric structure was an effective factor on the thickness. It is obvious that the samples made of honeycomb construction have recorded the highest rates of thickness compared to the samples made of satin. We can report that the construction technique of honeycomb weave allow fabrics to have many more number of intersections which allow the fabric to store more length of yarns and so this fabric scored the highest rates of thickness compared to satin construction .

It is also clear from the results in table (3) that, the samples made of cotton / polyesterhave recorded the lowest rates of thickness compared tothe samples made ofpolyester/microfiber. We can report that microfiber material is more bulky than cotton material which caused that the yarns made of microfiber had more space which caused an increase in thickness of samples made of Polyester / microfiber than the samples made of polyester / cotton.

3.3 Air permeability test

It is clear from the results in Table (3) and Fig.(3) that, there is inverse relationship between number of weft per/ cm and its air permeability in samples (1, 2, 3) which structured by satin weaves. We can state that the increase in number of weft means decrease in the pore space of free area between yarns leading to a decrease in air passage. But cotton sample (4) has scored an increase in air permeability more than in microfiber because of fine count of cotton which leads to increase in pore spaces between wefts and that leads to increase in air passage.



fig(3) the effect of increasing weft on air permeability for satin structure of count 150 denier

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It is obvious from the results in Table (3) and Fig. (4)that, samples (5, 6, 7) made of honeycomb weave have scored more rates of air permeability compared to the samples made of satinweave. We can report that the construction technique of honeycombweave allow fabrics to have more voids which allow the free passage of air compared to samples of satin weave. But, there is an inverse relationship between weft number per cm. and air permeability. Cotton sample (8) has scored also more air permeability than microfiber in the same weave construction.

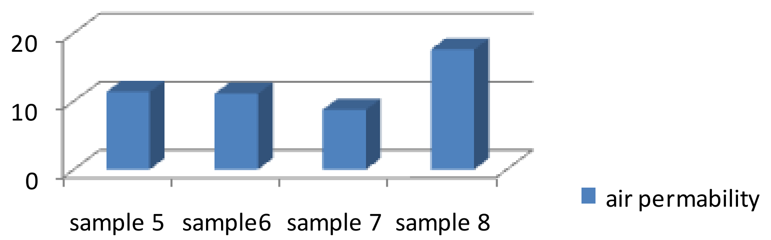


fig (4) the effect of increasing wefts on air permability in honycomb structure for count 150 denier

it is clear from Table (3) and Fig (5) that samples (9,10 and11) which used count number in weft (300) denier and satin weave have scored increase in air permeability than cotton which have made from count (20/1)cotton. We can report that the construction of yarn which consist of (144 fiber) in cross section that occupy the double space of count (150) denier in previous samples and that lead to more spaces and that make more passing of air. While cotton weft (20/1) includes more fiber than count (40/1) so the number of pore spaces decrease and that lead to decrease of air permeability.

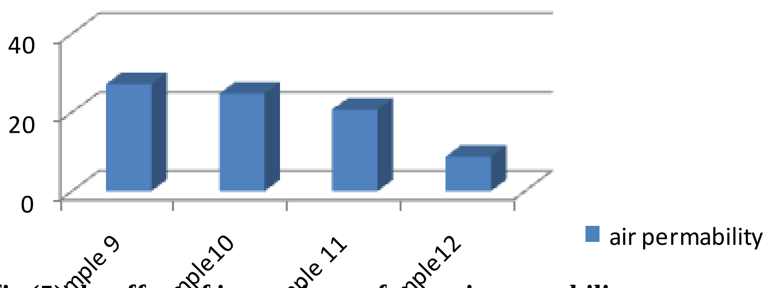
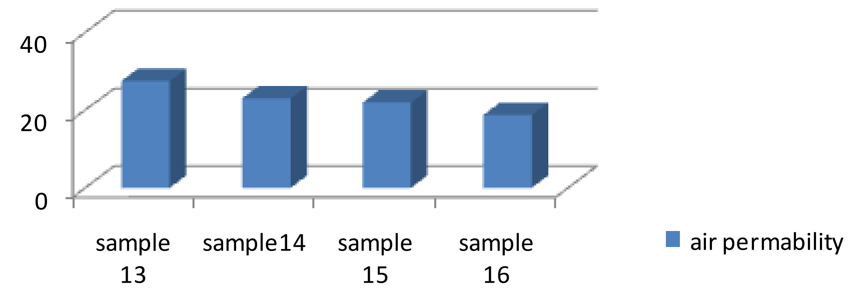


fig (5) the effect of increasing wefts on air permability in satin structure for count 300 denier

It is also clear from the results in Table (3) and Fig. (6)That samples (13, 14, and 15) which used honeycomb weave have listed higher results than satin weave. This happening is due to the difference of construction between honeycomb and satin which honeycomb has pore space more than satin. When compared the two structures it can be reported that the two structures have the same number of warps and wefts in one repeat but the number of intersections of honeycomb are higher than satin so this intersections make passages to air so the air permeability of honeycomb is more than satin.



Fig(6) the effect of increasing wefts on air permeability of honycomb structure of count 300 denier

3.4 Rapidity of Absorption Watertest

It is obvious from table (3) and fig.(7) there is a direct relationship between number of wefts per cm. and its water permeability. We can state that the increase in weftsnumber leads to a relatively larger dispersion area owing to the smaller inter- fiber and inter- yarn capillary radii, which increase the transporting capacity of water through the fabric. It can report the microfiber scored increasing velocity water absorption which due to asterisk construction of fiber. Cotton listed lower results than microfiber because cotton depends on non-crystalline region to absorbed water.

It is also clear from table (3) and fig.(8) that, samples of honeycomb have recorded the highest rates of

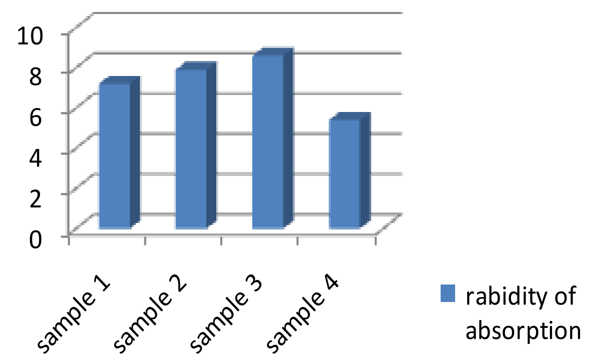
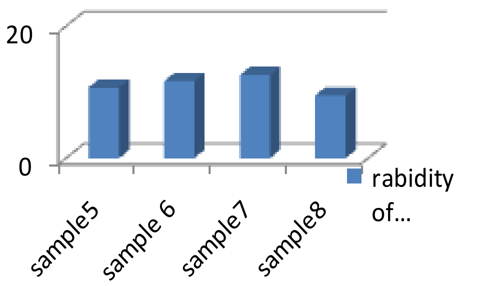


Fig (7) the effect of incresing wefts on rabidity of absorption in satin structure and count 150 denier



Fig(8) the effect of increasing wefts on rabidity ofabsorption in honycomb structure and count 150 denier

permeability compared to samples of satin weave. We can report that the increases of number of intersections lead to increase of water absorption so the intersections of honeycomb are more than satin weave so the absorption rapidity of honeycomb is higher than satin.

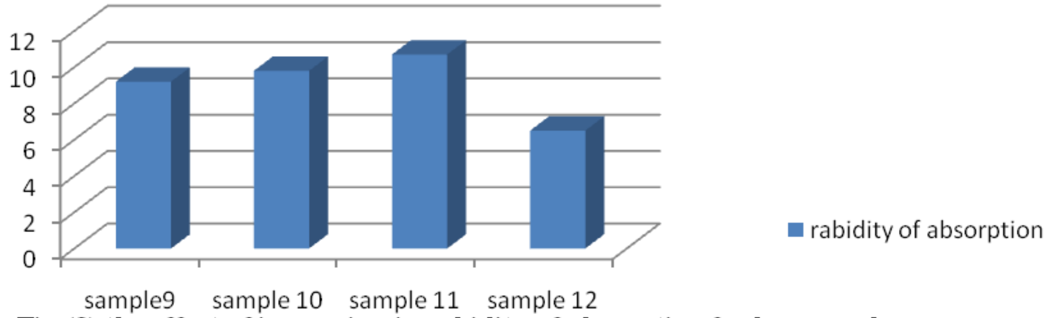


Fig (8) the effect of increasing in rabidity of absorption for honycomb structure and count 150 denier

- It can be noticed from Table (3) andFig. (9), samples of weft count (300) denier have scored the highest rates of water permeability compared to weft count (150) denier. We can report that count (300) have more number of pore blanks between fibers than count (150) and that lead to increase of capillary of fabric. Cotton with weft count (20/1) cotton has scored absorption rapidity higher than weft count (40/1) cotton because the thicker count has more fibers so it increase of number of non-crystalline region and increase of number of ions which make ionic bonds.

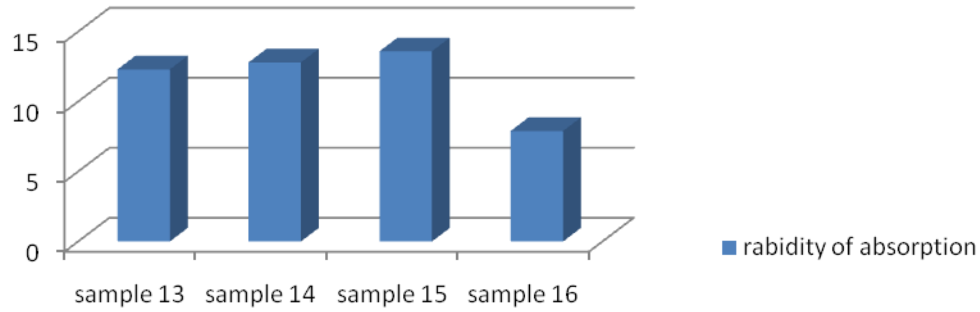


Fig (9) the effect of increasing wefts on rabidity of absorption for honycomb structure and count 300 denier

3.5 Tensile strength and elongation test:-

It is obvious from the results in Table (3), there is a direct relationship between fabric weight and its strength and an inverse relationship between fabric weight and its elongation. We can state that the increase in fabric weight means an increase in number of yarns per unit area, so that contact areas between yarns will also be increased leading to the increase in fabric tensile strengths and the decrease in its elongation.

It can be seen from Table (3) that, samples of polyester microfiber have recorded the highest rates of tensile strength and the highest rates of elongation compared to samples of cotton/ polyester. We can report that strength of polyester is higher than cotton while the construction of yarn of microfiber makes the yarn more elastic than cotton yarn so cotton recorded less elongation

It is clear from table (3) that samples of satin weave have recorded the lowest rates of tensile strength of weft yarns compared to honeycomb samples. We can report that number of intersection per unit in honeycomb samples was more which make them stronger than satin weave. The inter section of honeycomb make the weave ability of fabric is less satin weave so honeycomb have free spaces more

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than satin which make weft has the ability to move so the elongation of honeycomb was more than satin

3.6 Microbial Activity Tests

The agar plate method was used to evaluate the antimicrobial activities of blended cotton and polyester microfiber textile samples. This disc diffusion test was done according to Collins and Lyne (1985). The antimicrobial activities of the textile specimens were tested against two bacterial test microorganisms (Staphylococcus aurous, G+ve bacteria and E. coli, G-ve bacteria) and yeast test microbe (Candida albicans) as well as fungal test strain Aspergillus niter.

Sample discs (10-mm diameter) were located on the surface of the agar plates (10-cm diameter containing 25 mL of solidified media). The discs were placed on inoculated agar plates and incubated for 24 h at 37°C and for 48h and at 30oC for fungal test microbe.

All samples are sterilized with gamma rays. Discs of samples put in plates with different kinds of bacteria and fungus after saturated with water.

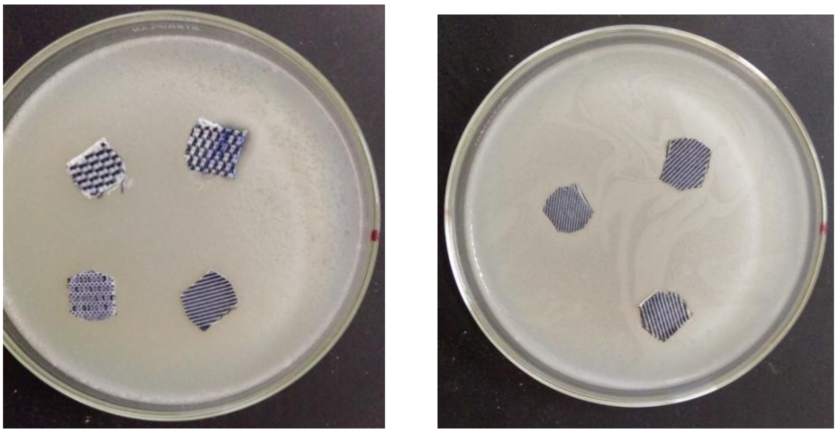

Fig.(10) these two plates illustrate the samples which do not affect by bacteria

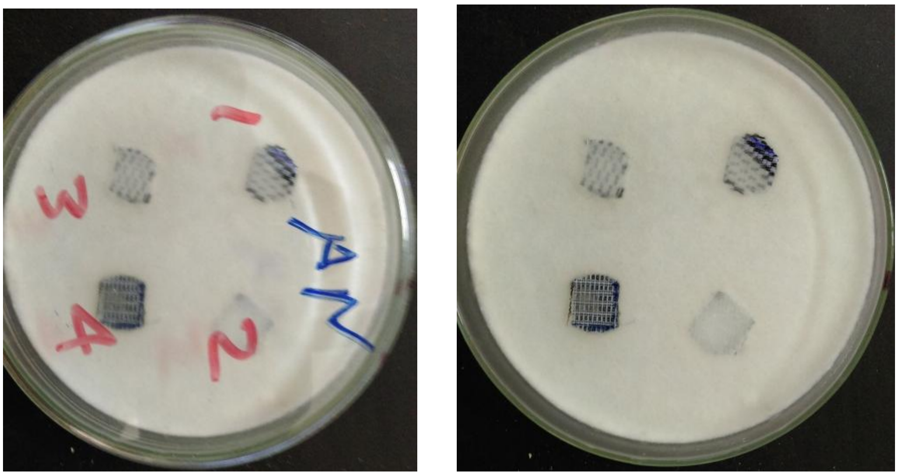

Fig.(11) these two plates illustrate the samples which affect by bacteria

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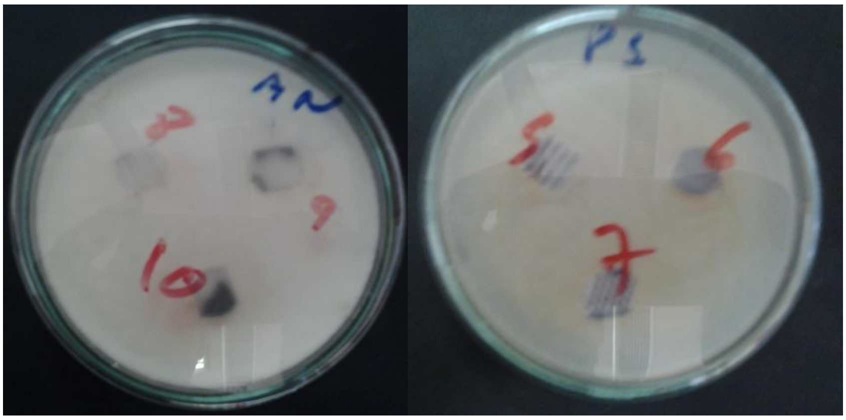

Fig.(12) these two plates illustrate the samples which affect by bacteria

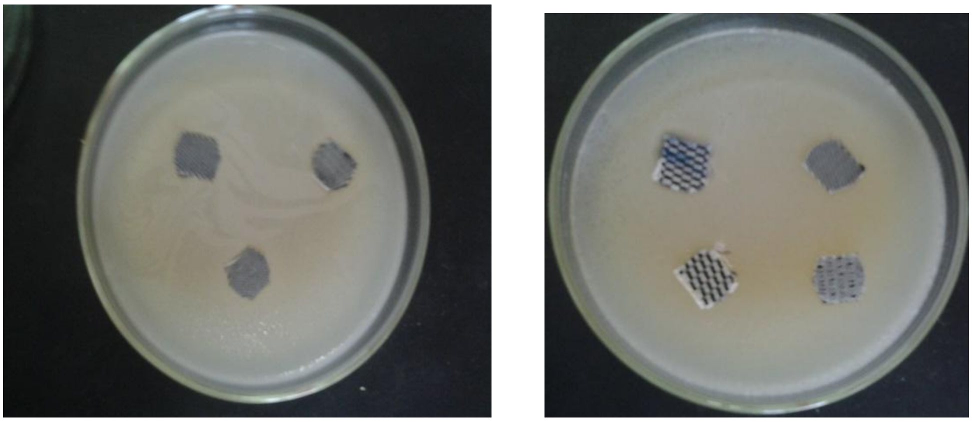

Fig.(13) these two plates illustrate the samples which did not affect by bacteria

It is clear from Fig (10, 13) that samples of polyester and microfiber did not affect with bacteria or fungus but samples made of cotton as in Fig. (11, 12) affect with bacteria and fungus. The samples of microfiber did not absorb fluids in its structure but between fibers and that made unsuitable environment for growth of bacteria and fungus. Cotton absorb fluids in its entire structure of fiber and make ionic bonds so this make a suitable environment for growth ofbacteria and fungus and the second problem cotton need time to dry but microfiber do not need time to dry.

IV. CONCLUSION

it can conclude from radar system as in fig. (15)

Samples made of microfiber scored absorption rate for fluids more than cotton samples

Microfiber samples have scored resistance against growth of bacteria and fungus more than cotton fabric

Samples with microfiber and honeycomb have reportedwater and air permeability more than satin weave.

Honeycomb samples are thicker than satin weave and scored more tensile strength but less in elongation.

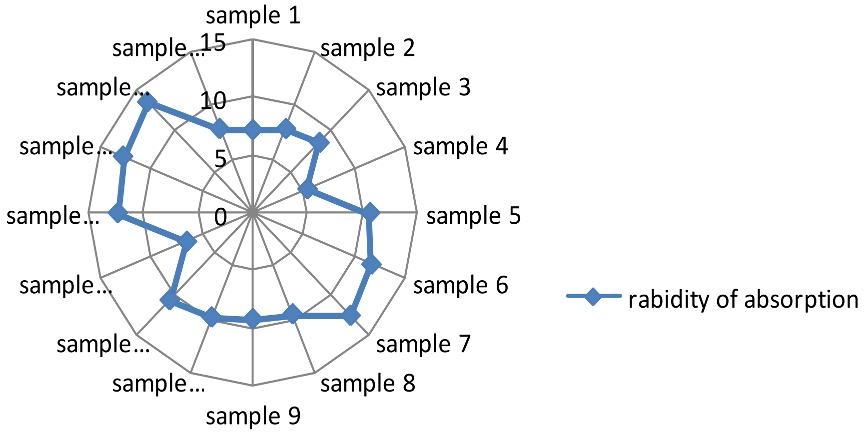

Fig (15) rabidity of absorption of all samples

V. RECOMMENDATIONS

1- It is recommended to expand in using microfiber drapes in surgical rooms to avoid contamination of bacteria and fungus.

2- Using gamma rays in sterilization medical drapes and tools because it has ability to penetrate materials and do not harm the internal structure.

3- Using microfiber weaving drapes reduce the costs because it could be washed and sterilized for many times but using non-woven products which is eliminated after one surgery and increase the costs.

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