The Effect of Altering some Structural Elements on Properties of Summer Shirts Fabrics -With a Constant Weight

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Abstract

Light clothes represent a very important sector in textile industry, and in our practical life all across the year , that is they are worn in summer on their own , and in winter and other seasons as undergarments to keep us warmed . This study takes a special interest in the elements of weave construction of light clothes, and the effect of these elements on both natural and mechanical characteristics required for this type of cloth sustaining the same weight of the square meter .

Fixed weight is achieved utilizing two variables; different counts of wefts, and different densities . That is accomplished by using the mathematical methodology of sustaining the weight of these counts using different densities . Another variable is added to the study which is the material of the weft used . Also, use the same type, material and density of the warp. So, the same specifications are used for all the samples . These specifications is 60/2 cotton, 32 thread/ cm.

key words : " light clothes, weave construction, cotton, viscose, fibro, polyester "

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تأثير إختلاف بعض عناصر التركيب البنائي النسجي على خواص أقمشة القمصان الصيفية مع ثبات الوزن

ملخص البحث:

تمثل أقمشة الملابس الخفيفة قطاعا هاما في صناعة النسيج و في حياتنا العملية على مدار السنة, حيث يتم ارتداؤها منفردة في فصل الصيف, و يتم ارتداء بعض منها تحت الملابس الثقيلة أو المتوسطة باقي فصول السنة, ومع ارتفاع اسعار الخامات بشكل عام والطبيعية منها بشكل خاص, تتطلب الأمر دراسة كيفية تخفيض تكلفة المنتج ليتلاءم مع القدرة الأقتصادية للعميل وذلك مع الحصول على الجودة المطلوبة بأكبر قدر ممكن.

لذلك اهتم البحث بدراسة أهمية بعض عناصر التركيب البنائي النسجي ومدى تأثيرها على الخواص الطبيعية و الميكانيكية المتطلبة لهذه النوعية من الأقمشة مع ثبات وزن المتر المربع, و تتحقق عملية ثبات الوزن باستخدام متغيرين؛ ألا وهما نمر اللحمات وكثافة اللحمات. وباستخدام الحسابات الرياضية للحصول على وزن ثابت للمتر المربع بستخدام هذين المتغيرين بالإضافة إلى إضافة متغير اخر للبحث و هو خامة اللحامات المستخدمة.

وقد تم تثبيت خامة و كثافة السداء المستخدم لكل العينات باستخدام سداء من نمرة 2/60 بكثافة 32 فتلة /سم, وتم انتاج تسع عينات مختلفة. تم عمل الإختبارات المعملية لدراسة مدى تأثير القماش بالتغير في تلك العناصر (الكثافة/ النمر/ الخامة) لتترك بعد ذلك النتائج التي تم الحصول عليها بين القائم على الإنتاج (المصانع) والعميل لتحديد الخواص الأكثر أهمية للإستخدام النهائي والتي لا يتنازل عنها العميل والخواص التي يمكن أن يتنازل عنها بقدر معين مقابل تخفيض تكلفة المنتج.

1. Introduction

As the increase of the prices of all types of materials generally, and the natural types specifically, it became obligatory to study a route to lower the cost of the product to suite accommodate to the client income while maintain the required quality as much as can be possible .

This paper presents a study of the effect of some structural elements on fabric properties to produces varieties for the manufactures to decide among the tradeoff between the quality and the price .

2. Materials used for the study :

2.1 Cotton :

Cotton is considered as one of the most important weaving fibers in the world, it is planted in so many places worldwide, and it is used in textile industry on a very wide range, whether in its raw form, or mixed with other types of raw materials . It is also used in upholstery fabrics due to its special characteristics and its adequacy to a wide range of industrial purposes, some of it require solidity and elongation ability that are available in cotton, as well as its high endurance quality, and its high comfort ability [1,2] .

Cotton can adhere easily to bleach, dye, and preparing, the fact that justify the wide application range of the fabrics made of it .

2.2 Viscose :

Viscose is a manufacturing cellulose fibers that renders a lot of processing in its production , going through stages such as soaking , chopping , fermentation , and then it is treated with liquid carbon disulfide . After mixing and melting, it is stored under specified conditions for several days , then filtered and goes through the normal stages of spinning .

The word fibro is used for the short bristles of viscose , it has a low cost production that makes it a competitive woven material to its counterparts such as wool , linen and cotton [3] .

2.3 Polyester :

Polyester fibers are marked with stiffness and high resiliency . When mixed with other fibers its characteristics are highly reflected on the final produced fabric . For example, when mixed with wool, it increases the tensile strength of the outcome cloth and increase the resistance for the crease . It also contribute to retaining the original dimensions of the fabric . When mixed with cotton, the outcome cloth is better in quality than the one made of a 100% cotton, better in appearance, solidity , wrinkling resistance , and warmth . Polyester also used in other fields beside clothes manufacturing, such as carpets, blankets, upholstery, and other medical purposes [1,2] .

3 Required properties for summer clothes fabrics :

The study of the natural and mechanical properties of weave fabrics, helps to determine how justifiable these fabrics for their purpose. Summer clothes fabrics have to have special properties related to the user comfort ability . This type of fabrics must has the ability to absorb perspiration and protect the body from humidity, as well as being resilient and solid, with high endurance of friction while maintaining the aesthetic appearance [4] .

Studies have proved that there are well-known required properties to produce comfortable fabric , those would be, air permeability, decreasing of humidity absorption, comfortable texture, and decrease the weight of the cloth [5] .

In the following , the first two properties will be explained in details .

3.1 Air permeability in summer clothes fabrics:

Air permeability is a very important factor in specifying the fabric relevance to its purpose . Air permeability is defined as the volume of air in cubic centimeter that passes in one second through one cm2 of fabric at a pressure difference of 1cm head of water .

Porosity is defined as the percentage of a void part of the textile's full volume .The estimation of porosity depends on filaments volume and the cover factor . Increasing the cover factor of the warp ,r the weft or both of them , results in lower air permeability. Air permeability is an important characteristic that effects immediately body comfort ability . Though, if the fabric is made of materials or filaments that cannot absorb the humidity, or if utilizing a narrow weave design , humidity will not be seep through the porous of the fabric to the outside atmosphere which will result in huge uncomfortable sensation for the body while donning these clothes, which by turn affect the psychological and health affair of the individual wearing the clothes [5],[6].

3.2 Importance of humidity and water vapor absorbance :

The ability to transfer body humidity to the outside atmosphere is a major one in outfits fabric , that is because human body transude a regular amount of perspiration that needs to evaporate off of the skin surface to maintain body temperature ,thus maintaining the comfort ability in hot and cold weather . Even at the stability state the body continues to exude sweat in small amounts (30 gm /h) , by nature it evaporates and the body remains dry . As a result of this process the body temperature become stable . By this way the body losses part of its heat , the rest of body heat is lost through radiation and transfer . Heat lost through sweat evaporation represent 20% of total body heat dissipation . In case of temperature elevation the body increase secretion of sweat to maintain stable body temperature , and in order for clothes to provide comfort ability , they have to be able to shed humidity through fabric . As long as the fabrics have high ability for shedding body sweat , they would be suitable for sustaining body comfort ability whether in hot or cold weather . Despite the fact that in cold weather, the body is protected with more layers of clothes to decrease the rate of heat dissipation, it must has the ability to release humidity specially if the body is in motion and exuding a lot of heat, the fabric must has the ability to absorb humidity and then transfer it to the outside weather . Wool has the type of filaments that is capable of absorbing humidity without the wet feel, that is mainly because fabrics made of wool are hardly contiguous to the skin [6],[7],[8] .

4 Experimental Work

Three counts have been selected for this study on the wefts (50/1 , 40/1 , 30/1) for its adequacy as a fabric for light weight clothes . Medium counts are preferred for its high absorbance ability and in the same time they allow a sufficient amount of voids in between threads that in turn secure a passage for air to pass through to the body , and for humidity to pass out . And warp number 60/2 cotton has been used . This is a warp number that is most common in production of summer shirts . The difference between wefts counts is set to 10 English counts , that difference is considered sufficient to obtain physiological differences when comparing the natural and mechanical characteristics of the threads .

This research intend to use a cotton warp to retain the cotton percentage higher than the ratio of any other material that is used in the wefts .

The weft materials are (cotton - viscose - polyester) ;to study the effect of weft diversity as an element of woven structure on the produced fabric characteristics , and the three materials are appropriate for summer .

Using the weave construction 1/1 , a group of samples has been produced with a warp number of 60/2 cotton, 32 threads/cm. , and wefts of different counts, densities and materials , as shown in the following table below :

Table (1) : Samples Parameters

samples	Material of weft	Count of the weft/ eng	Density of weft/cm
1	cotton	30/1	22
2		40/1	29
3		50/1	36
4	viscose	30/1	22
5		40/1	29
6		50/1	36
7	polyester	30/1	22
8		40/1	29
9		50/1	36

The plain weave construction is selected to be 1/1 for samples , because it is considered as the standard in production of woven light fabrics .

4.1 Tensile strength and elongation test :

Estimate of the tensile strength of a fabric is considered a test of major importance , because tensile strength is a characteristic that is an indication of fabric solidity and endurance for exertion and traction , and it is also an intimation of the fabric ability to stretching at exposure to mechanical forces .

4.2 Air permeability test :

One of the major tested properties in light (or summer) clothes , due to its direct influence on the comfort ability factor as well as shielding the body from humidity.

4.3 Stiffness test :

Elasticity is an essential factor to comfort and durability of the cloth, It is the ability of the cloth to retain its natural properties , and return back to its original shape after the demise of the influential. So, measuring the stiffness of the fabrics indicate its elasticity .

5 Results And Discussion:

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

Table (2) : Results of testes

	Warp tensile strength	Weft tensile strength	Warp elongation	Weft elongation	Stiffness in warp direction	Stiffness in weft direction	Air permeability
1	32.66	20.66	22.3	14	32	31.1	1073
2	35	24.3	24	17	34.58	32.86	553
3	36.33	33	28	19.6	36.12	33.6	494
4	31.3	45.33	26.3	17.33	31	33	1165
5	34	47.66	29.66	18.66	32.4	43	812
6	36.2	48.2	32.17	20.2	34.1	48	543
7	32.66	46	27	19	32.4	40.5	1125
8	35.66	58	30.66	28.3	35.4	46.3	753
9	38.1	64	33.15	35.2	37.2	51.1	520

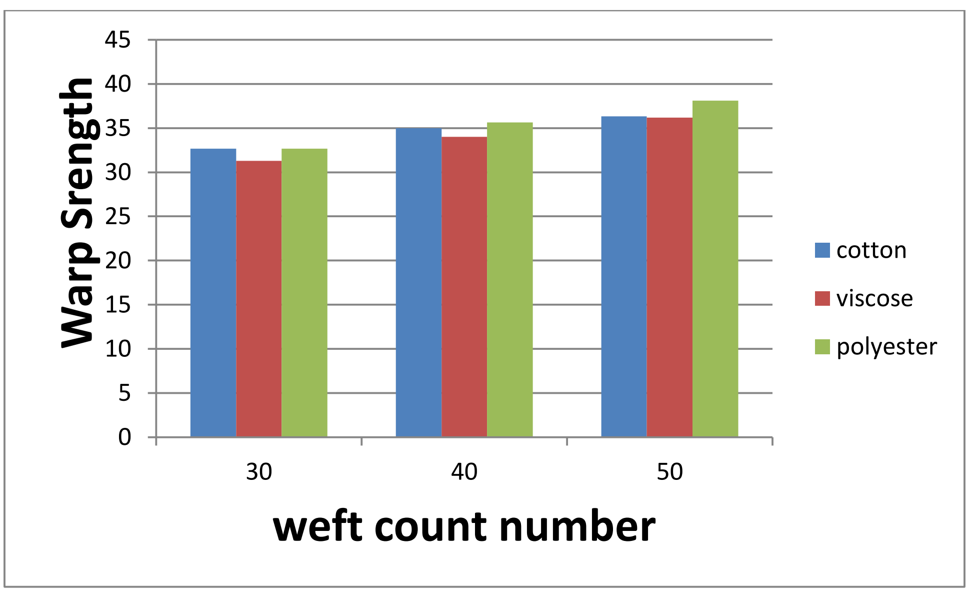

Fig. (1) Relation between cotton and weft counts and warp tensile strength for three materials under study

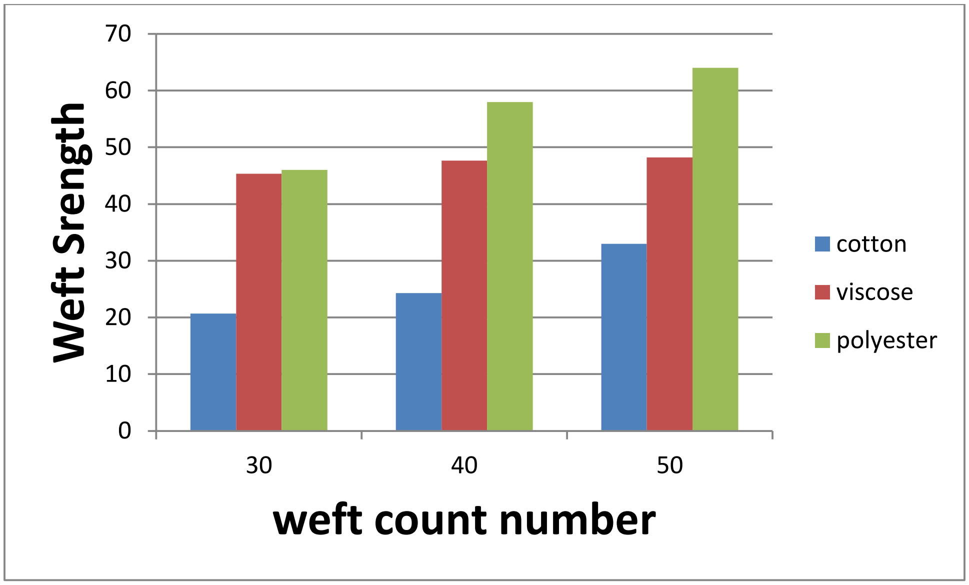

Fig. (2) Relation between cotton and weft counts and weft tensile strength for three materials under study

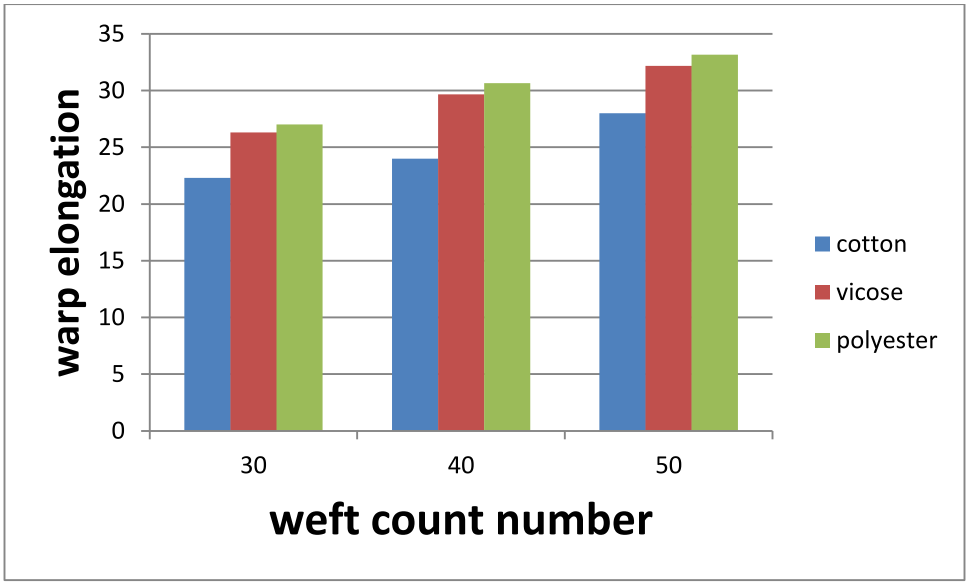

Fig. (3) Relation between cotton and weft counts and warp elongation strength for three materials under study.

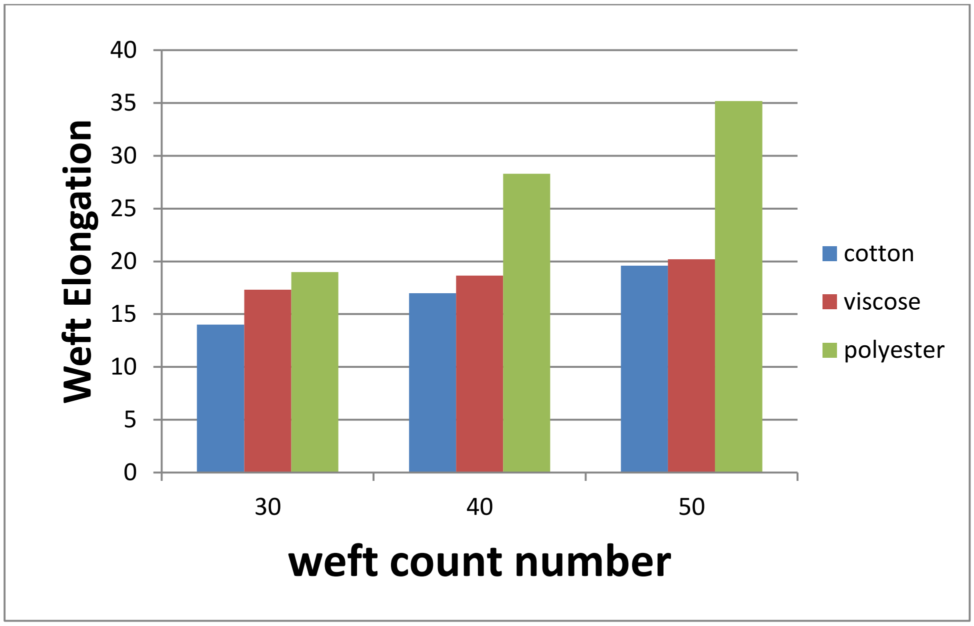

Fig. (4) Relation between cotton and weft counts and weft elongation strength for three materials under study.

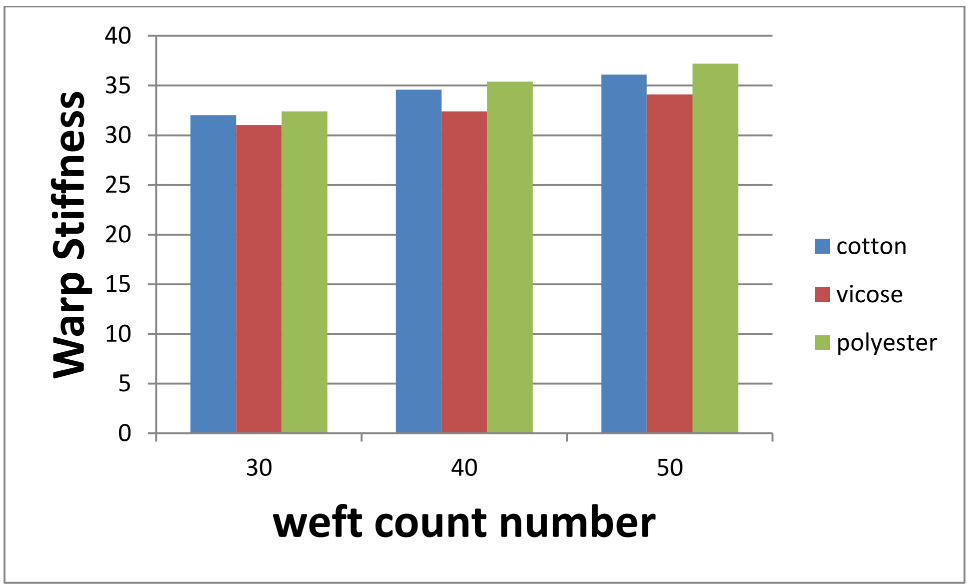

Fig. (5) Relation between cotton and weft counts and warp stiffness strength for three materials under study.

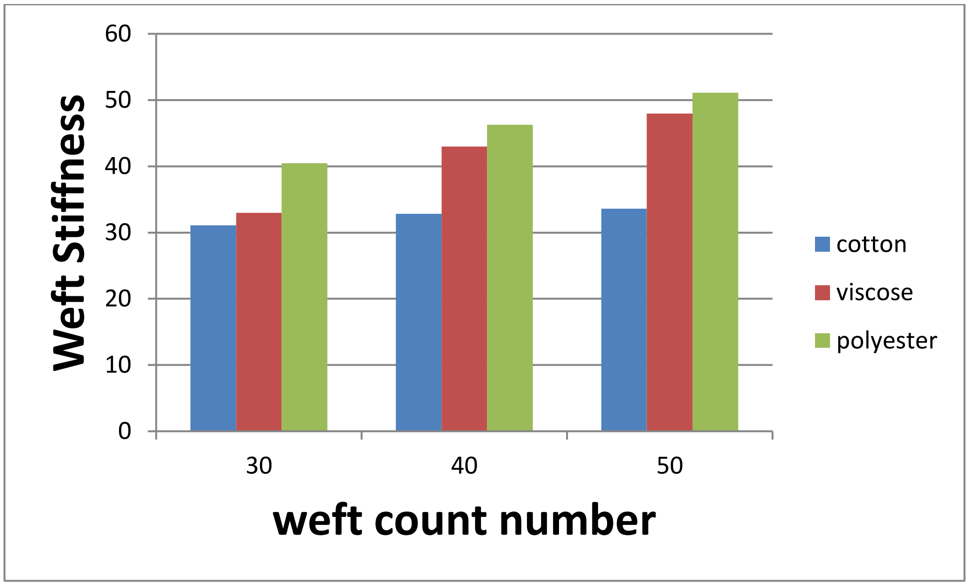

Fig. (6) Relation between cotton and weft counts and weft stiffness strength for three materials under study.

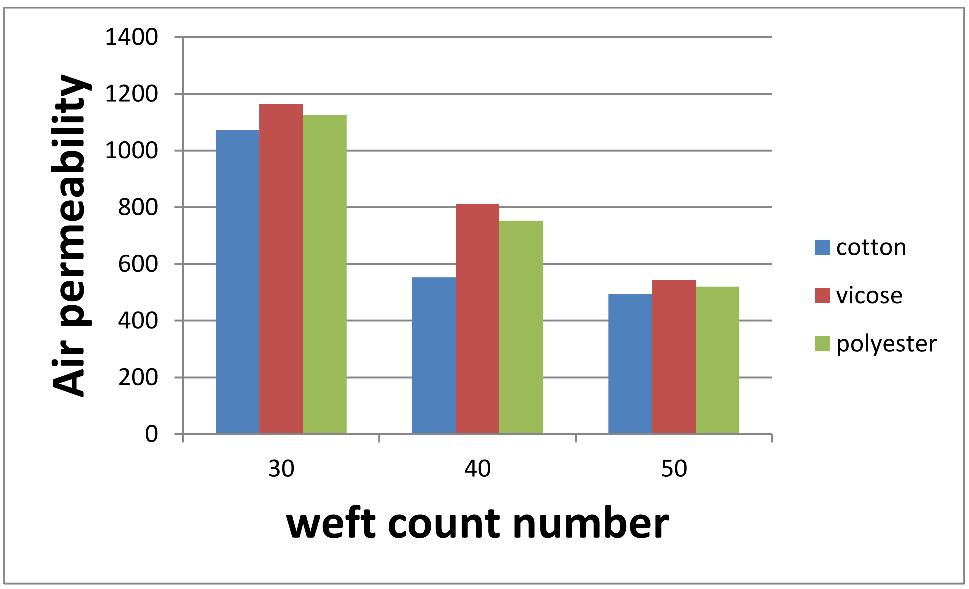

Fig. (7) Relation between cotton and weft counts and air permeability for three materials under study.

After the statistical analysis for the tests results, the factors of influence based on the research variables have been deduced, and they are as follow :

5.1 Tensile strength of the warp

Table number (2), and figure (1) demonstrates the warp tensile strength test results of the samples produced according to the research variables . These variables are ; weft material , weft counts , and weft density. The test results point that the warp tensile strength of the samples is little affected by the change in the counts and the density of weft threads , It is also clear from the test results that the effect of changing the weft material on tensile strength is very weak in conclusion, the tensile strength increases with the increase in the weft density and with the usage of finer counts , and decreases with decreasing weft density and using thicker counts .

So , Studying the variables effect clarifies what follows :

5.1.1 Variation in weft material effect :

Studying the effect of using different weft material in the production of the research samples , as the only variable with the other variables being fixed , illustrates that changing the weft material does not have much influence on the warp tensile strength , where the readings of tensile strength for the three cases of different used materials are of a very close proximity , as is illustrated in table (2) , subsequently, weft material does not have a sensible effect on warp tensile strength when all other variables are being fixed.

5.1.2 Weft count and density effect :

From the presented study that is based on fixing the weight of the square meter , By changing the two variables density and counts of wefts , it was found that each variable cannot be measured individually , where the results show the overlapping of the two variables effects on the measured feature . Table (2) clarifies that the usage of thin or fine weft counts alongside a higher density of weft increases the warp tensile strength more than the case utilizing thicker weft count and less density. That can be explained by that the increase in weft density per centimeter results in more intersection points , and employing a thin weft that twists around warp threads easily ,So it decrease the stress upon that warp, also, increasing intersection points allows longer length for the warp to be more able to endure the tensile strength .

5.2 Measuring tensile strength of weft :

Table num.(2) illustrates the test results of weft tensile strength of samples produced for this research , using the same variables referred to before. The results indicate the great effect for changing the three variables on weft tensile strength. In more details weft material factor has a greater effect more than the other two factor . Also tensile strength increases with the increase of weft density. Studying the variables effect results illustrates the following :

5.2.1 Weft material effect on weft tensile strength :

By studying the effect of different weft material types on tensile strength towards wefts , it is demonstrated that Polyester achieves the highest tensile strength record , as shown in table (2) , then viscose. where the cotton made wefts come last . this results is based on the properties of the weft material itself ,For the same counts and weaving process, polyester is known to have higher tensile strength than viscose and cotton , and Viscose threads has higher tensile strength than cotton made threads .

5.2.2 Weft count and density effect :

Table (2) ,and figure (2) , illustrate how weft tensile strength is greatly affected by changes weft density and count . The results demonstrate that weft tensile strength increases by the increase of weft density per centimeter , and the increase of weft count via usage of indirect numbering. In spite the known fact that weft tensile strength is inversely proportional with weft count in English numbering system ,But in the case presented, the increase in thin count density , and the decrease in thick count density result in the opposite effect. And it has the proven effect on making weft tensile strength proportional with higher density of thin count .

5.3 Measuring of fabric elongation in warp direction :

Table(2), and figure (3) illustrates test results of warp elongation for research samples . The results clarify that warp elongation is affected by overlapping of research variables , where is fabric elongation in warp direction achieves highest rates when Polyester wefts are employed , then it slightly less with the use of Viscose , and lessens more with cotton made wefts .It is also clear that Warp elongation is proportional with increased weft density . Studying the variables effects illustrates the following :

5.3.1 Weft material effect :

By studying the effect of different weft material , we find that warp elongation is in its highest rate for polyester made wefts , then with Viscose , and in its least rate with cotton made wefts. That is because of the Polyester thread weave regularity and the proximity of its fibers , which result in a small thread diameter , that subsequently lessens the warp crimp ratio , and subject it to less stress , which allows higher ability of elongation when subjected to tensile strength.

5.3.2 Weft density and count effect :

At studying weft count and density effect on warp elongation , we find that with the increase in weft count , the diameter of weft thread decreases which help it to coil easily around the warp threads and thus lessens the warp crimp , and in turn lessens the stress put upon it even with higher weft density . as decreasing the warp elongation ratio during the weaving process , as increasing warp ability for elongation after weaved when it is under stress . Also increasing the weft density results in increasing the tensile strength which in turn increase the fabric elongation before cutting .

5.4 Measuring fabric elongation in weft direction

Table (2) illustrates weft elongation testing results for it is clear that the research samples . Fabric elongation in weft direction is greatly influenced by research variables . Polyester wefts results in the highest fabric ability to elongate , Viscose made wefts came second , cotton made one give the least ability to elongate . The results also points at the direct correlation between the number of wefts per centimeter and the weft elongation rate. Studying the results concluded in the following

5.4.1 Weft material effect :

By examining the results , and as illustrated in figure (4) , using cotton wefts or Viscose made one , gave proximate results , where the elongation ability of Viscose wefts is slightly higher than those made of cotton . But when Polyester made wefts were employed the ability of elongation is much higher , This is due to the tenacity of polyester fibers and its ability to resist the tensile and elongation before cutting and this is considered as the important merit of the polyester materials .

5.4.2 Weft count and density effect :

Table (2) , and figure (4) , illustrate that weft threads ability to elongate increases with higher thread density per unit , though higher thread density means thinner fibers . It is well known that thread count in English system is inversely proportional with its ability to elongate . But in the presented research the factor of increasing - specialy when the difference in weft count is seven wefts which is a vital difference represents 25% of the whole thread count in one measuring unit - has the stronger effect on the ability of the fabric to belong ate in the weft direction before cutting

5.5 Fabric stiffness measure in the direction of warp :

stiffness measure test results for research samples , illustrated in table (2), and figure (5) point that samples stiffness in the direction of warp is affected to a minor degree by the change in density , count , or material (research variables) , where samples stiffness increased by only 7 to 8% when subjected to the changes in research variables . It was also noticed that Viscose made wefts yielded to the least stiffness in the direction of warp , followed by cotton one , and then Polyester which yielded the highest rate of stiffness in produced samples .The results also clarify that fabric stiffness in the warp direction , increases by the increase of weft density , by the increase of density the void spaces between threads decrease thus allowing less mobility which subsequently induce the stiffness of the produced samples.

5.6 Fabric stiffness measure in the direction of weft :

Weft stiffness measure test results for the produced samples , that are illustrated in table (2), and figure (6) point to the different reaction cotton made wefts had to the overlapping of the other two variables , where weft stiffness is in its highest rate when Polyester is employed, Viscose comes next , then cotton comes last in the list to achieve the least stiffness ratio . Also the overlapping effect of the two variables (density , count) does not cause a noticeable cotton wefts reaction, where the readings are found proximate. On the other hand when polyester or viscose is employed , a great reaction is noticed, and the readings are found divergent on a great scale . That is due to the fact that polyester and viscose fibers are more solid than cotton fibers , that effect transfers on to fabrics made of these fibers.

5.7 Air permeability measure for fabrics:

Table (2) and the figure (7) illustrate air permeability test results for the produced samples . Air permeability of fabrics is affected by the overlapping action of both density and weft count , in addition to the change in sample material . Air permeability is at its highest form when less density and thicker counts are applied in the case of the three materials . And it is in its lowest form when higher density and thinner counts are employed. Lower density means more void spaces as a result to warp intersecting with wefts which allows more air permeability in fabric . On the other hand using high density of thinner threads results in close range wefts with less inter spaces from warp and wefts intersections, subsequently less air permeability to the fabric produced.

The results also show that the three materials (polyester , cotton , viscose) yield proximate results when counts 30/1 is applied . If count 50/1 is applied , the first being the thicker number could be used , and the second being the thinner. But when counts 40/1 is applied the results vary that is because of the difference in yarn quality and the regularity of the threads that in turn result in slight change in the counts.

By studying the results , we find that cotton made wefts allow slightly lower air permeability than polyester made weft or viscose , and the reason for that is the smooth surface of polyester and viscose threads in comparison to cotton, that allow more void and inter spaces between threads thus allowing more air permeability .

6 Conclusions :

From the previous results and discussion concerning with summer shirts fabrics properties such as tensile strength, stiffness and air permeability, some conclusions were achieved for the production of these fabrics. So, better efficiency of the functional performance of those fabrics is obtained. Conclusions of this research can be summed as follows:

1- Warp tensile strength is not affected by weft material when constant count is maintained constant , On the other hand, it slightly varies (not more than 10%) with respect to both the count and density of the weft .

2 - It is obvious from the experimental results that when the number of picks increase per centimeter the tensile increases in turn regardless of the type of material used . This effect is even more noticeable when thinner counts are applied . So when pick number is increased and thinner counts are applied the tensile strength increases in the same direction .

3- The research validates that as weft number increases per single unit, fabric tensile strength in weft direction increases . This effect is due to the increase in thread merging rate that in turn increase overlapping among warp threads , thus boasting fabric breaking tenacity .

4- Test results for elongation in the direction of weft are close in value in cases of cotton and viscose samples , with a slight preponderance in favor of viscose . On the other hand , polyester achieves the highest elongation proportion amongst the three .

5- Fabric stiffness in the direction of warp remains unaffected even when altering material types , as long as the weft count remains constant . And it is slightly affected with the alteration in weft density and count , where the raise in weft density per centimeter results in increasing the number of overlapping which is reflected on warp threads movement ability , which in turn increase the stiffness of the fabric , but in rather slight ratio .

6- Fabric stiffness in the direction of weft increases with the increase in weft number , that leads to higher merging level among warp and weft threads , decreasing fabric's elasticity as the density increases , even with usage of thinner wefts.

7- Fabric stiffness in weft direction differs regarding to weft material . Where the highest stiffness ratio is accomplished with polyester , then decreases with viscose , and in it is minimal with cotton .

8- Results show that fabric air permeability decrease noticeably with higher weft density level , even with thinner wefts. Where the increase in weft number leads to overlapping increase which results in smaller internal spaces among weft and warp threads of the fabric .

9- Results verify that the highest material to achieve the highest level of air permeability is viscose , that is due to the nature and specifications of viscose threads , its irregularity and the smoothness of its surface , which allow air to penetrate easily through the fabric.

10- Results conclude that viscose made wefts achieve the best results in stiffness , elongation , and air permeability , with a medium elasticity , and a lesser cost compared to cotton made wefts . In this case, cotton can be used only for warp in order to maintain an acceptable level of the desired qualities .

11- Experiments show that polyester scores the highest results in stiffness and elongation tests , and achieve an average score in air permeability test among the tested samples but it scores lower elasticity and cost that cotton or viscose .

REFERENCES

[1] M. Sabri, "Textile raw materials", Faculty of Applied Arts, H. University, Egypt, 2013.

[2] M. A. Sultan "Textile raw materials", Faculty of engineering, Alex. University, Egypt, 2004.

[3] محمد فؤاد عاشور -التحليل والفحص للالياف والخيوط والاقمشة - مكتبة الانجلوالمصرية - 1975

[4] تامر فاروق, أسامة عز الدين و أسامة محروس - "تأثير إختلاف بعض عناصر التركيب البنائي النسجي على خواص أقمشة القمصان الصيفية مع ثبات معامل تغطية اللحمات" مجلة علوم و فنون, المجلد 19, العدد الأول, يناير 2007.

[5] K. S. Aung "A study of the nature of fabric comfort design- oriented fabric comfort modle"503(5), 2004, 128 :135.

[6] Faten M. Abd-eltwab , Thesis, ' Specification for Achievement of Comfort Property in Ready Made Garments' Depart of Textile, Faculty of Applied Arts, Helwan University, Egypt, 2008.

[7] A. Z. Ismail " Determine the most appropriate textile structure combinations to achieve the physiological properties of comfort to wear sports training in the Egyptian climatic conditions "Master's degree , Faculty of Applied Arts, Helwan University, Egypt ,2008.

[8] F. F. Saied "The prediction of garment comfort from measured fabric properties" Sixth Ar. Conf., Faculty of Economics, M. Univ., Egypt, 2001.

[9] ASTM., American Society for Testing and Material (D 737)., Standard Test Method for Air Permeability of Textile Fabrics, Vol. 07.01 (1993) pp 225-227.

[10] Nassif., G., A., A., Effect of Weave Structure and Weft Density on the Physical and Mechanical Properties of Micro polyester Woven Fabrics, Journal of American Science 2012, 8(8).