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Effect of Weft Knitted Fabric Variables on the Performance of Children Clothes

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Knitted fabrics are very special and sensitive fabrics where any change in its specifications will affect all its properties and end uses. The weft knitted fabrics are the most suitable fabrics for daily clothes specially with children garment, because of knitted fabric properties like softness, stretching so it is easy deformation and comfortable to children Moving. Fabric structure and fabric weight are the most important fabric specifications which direct effect on all fabric properties, also they are one of the most important factors which determine the fabrics end use. This paper presents a study of the effect of weft knitted fabric variables using different cotton fabric structure and weight/ unit area on children garment properties. It was studied some of properties which will be suitable to the children clothes durability like Penetration force and Bursting strength, Also the properties which related to the children clothes' comfort like Wick ability and air permeability. The data analysis concluded that both of the tested parameters are significant, but fabric structure is more effective than weight/ unit area on the most properties.

Keywords: weft knitted fabrics, Wicking test, sewability , Bursting strength, Air permeability, comfort, durability.

Introduction

Knitted fabric contains a series of interconnected loops made with one or more sets of yarns, can be raveled from top to bottom, possesses stretch and elasticity, adapts to body movement, has good recovery from wrinkles, is air permeable, has open spaces between yarns and bulky, porous and less opaque [1, 2]. As knit fabrics are produced on different machines with various conditions to produce different types of fabric, they bear different qualities. Knitted fabric structures and finishing processes influence the physical properties and connected with the wearing properties of knitted garment.

Also, fabric structure shows great impact on different properties of weft knitted fabric if processing parameters will be controlled [3]. Single jersey one of the main knitted fabrics which used in different garment, especially on summer clothes. single jersey performed many advantageous properties such as breath ability and lightness than other knitted fabric [4, 5].

People select their clothing based on their needs and desire. Although, peoples' performances change with the climate, age, type of activity. Finally, Comfort is main target for clothing selection, especially for children clothes. Children's clothes need suitable fabrics and clothing for freedom of movement, and easy handling [6-9], so the knitted clothes fabrics are more suitable because of their high elasticity.

The wetting and wicking behaviors affect the moisture and thermal comfort of clothing systems. A clothing system with high wicking ability can hold the liquid perspiration quickly from the skin area and transfer it to the top side of the fabric, providing a good level of comfort to the wearer due to evaporating cooling. There are some factors that affect the wicking property of a textile structure namely; fiber content, fiber cross-section, number of filaments, fabric structure, spinning system, and the surface structure [10, 11].

Air permeability is defined as the volume of air in milliliters which is passed in one second through 100mm2 of the fabric at a pressure difference of 10mm head of water. The air permeability of a fabric is a measure of how well it allows the passage of air through it [12, 13]. In outdoor clothing it is important to have air permeability as low as possible to achieve better wind protection [14, 15].

Generally, air permeability can influence fabric comfort behaviors, also this property may be an indication of water and vapor permeability. Air permeability has a strong relation with the fabric thermal resistance and is influenced by the fabric

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structure [16]. It studied air permeability, and thermal resistance for eleven cotton and viscose fabrics. They found that loop length and stitch density are significant factors that affect both air permeability and thermal resistance[17].

Bursting strength is one of the properties of measuring the knitted fabrics durability. Burst strength of knitted fabrics can be affected by structure and yarn type. Jersey, rib and interlock knits made from compact yarns had higher bursting strength, elongation and pilling resistance than those made from ring spun yarns but lower pilling [18, 19]. Furthermore, lycra or elastin content influences bursting strength with fabric weight and fabric thickness; and elongations [18-21]. The amount of recovery depends on the structure of the material and the time of applied force. Practically, elasticity determines the permanent elongation or deformation after applied force. If there is no permanent elongation, deformation does not form and the material turns back to its original shape [18, 22]. The sewing process is one of the critical processes in the determination of productivity and the quality of the finished garment in apparel production. To satisfy the customer sewing quality is essential if the apparel manufacturer [23, 24].

Penetration force is an indication of Sewability process. Sewing needle is considered one of the most important machine parts, which has great effect on sewing performance. The Sewing needles are the main source of fabric distortion due to the needle temperature. The main causes of needle temperature because of (i) the friction between fabric and needle (ii) the friction between sewing thread and needle. The higher temperature will cause fabric distortion, needle breaks, and sewing thread cutting. Another study was about the effect of stitch length, yarn count, and needle size on the penetration force which indicates the fabric sewability. The properties of these fabrics were also tested. The results of this study conclude that the Sewability (which is indicated by penetration force) of 100% cotton single jersey fabric is inversely proportional to its stitch length. At the same time, the fabric with a coarser yarn count gives a higher penetration force [25].

The knitting fabrics are the most widely used in clothing manufacturing which are mainly divided into two major sections warp and weft knitting, each of them have own characteristics [26]. Warp knit fabric is similar to that of a woven fabric where the supplied yarns are feeding from warp beams. The fabric is produced, however, by interlacing loops in the knitting elements rather than intermeshing warps and wefts as in a weaving machine. It is commonly has good characteristics like better drapability, less extensibility, more strength than weft knitted fabrics [27]. The common its use in upholstery field.

Materials and Method

Materials

In this study, 100% Egyptian cotton weft knitted samples, two different structures – single jersey and rib were applied with using light and heavy weight for each structure. Samples were fully relaxed, then tested for different properties in a standard atmosphere of 20 ±2 C^o and 65 ±2 % relative humidity. Table (1) shows the specification of all samples. Table (2) shows the experimental design for the Parameters (factorial design).

Table 1. fabric specifications

Fabric code	Structure	Weight (g/ m^2)	Thickness (mm)	Wales/cm	Courses/cm
1	single jersey	120	0.48	21	16
2	single jersey	170	0.53	21	16
3	Rib	200	0.89	23	14
4	Rib	230	0.82	23	14

Table 2. Experimental design for the Parameters (factorial design).

Parameters	-1	+1
Fabric structure (X1)	single jersey	Rib
Weight/unit area (X2)	Light	Heavy

Methods

Some physical and mechanical properties were tested which will have final effect on children clothes properties according to fig. 1. The tested properties like Mass per Unit Area, thickness, stitch density, needle penetration force, bursting strength, wicking test and air permeability for each sample according to the standard methods.

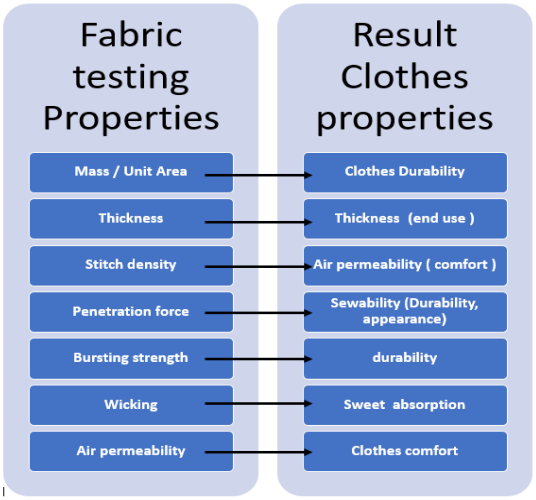

Fig. 1. Chart of clothes result properties from fabric testing properties

Mass per Unit Area

Mass per unit area is the key parameter of the knitted fabric for the negotiation between supplier and buyer. Therefore, it is very important to control it through various possible parameters. The GSM cutter method was used to calculate the mass per unit area of the fabric according to ASTM-D-3776 [28]. The weight of the cut fabric sample was done through digital weight balance. The mass per unit area (GSM) of fabric was calculated by Equation (1).

Mass per unit area (GSM)=Sample Weight ×100 (1)

Thickness

The thickness test of the sample was performed according to ASTM D1777-96, Standard Test Method for Thickness of Textile Materials [29].

Stitch density

It was measured wales/cm and courses/cm by using textile analysis glasses referring to EN 14970 [30].

Penetration force test

Penetration force is a property that was used as an indication of the Sewability of fabrics. this process is carried on L&M Sewability Tester according to ASTM D5646-13 [31, 32].

Bursting strength

The samples were Bursting strength tested refers to the standard test method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method ASTM-D-3786 [33]. the sample was cut to the size of 112 mm^2.

Wicking test

Wicking of the samples was determined regarding to vertical wicking of textiles standard AATCC Test Method 197 [34], which describes the movement of water or liquid through fabrics.

Air permeability

The air permeability of the samples was tested according to ASTM D 737 [35].

Result and Discussion

Fabrics testing results of properties in wales and courses direction are shown in Table (3). The result data were statistically analysed by Anova Two-Factor to find significant effects by illustrating the P-value and the F-test calculated, Table (4) shows the statistical analysis data. Then bar charts for each property were drawn to show and discuss samples' behaviours related to the experimental design.

Table 3. fabrics testing results

samples	parameters		Penetration force(gm)		Wikability (min)		Air permeability ($Cm^3/cm^2.s$) (Y5)	Bursting strength (gf/cm^2) (Y6)
	X1	X2	Wale (Y1)	course (Y2)	Wale (Y3)	course (Y4)		
1	single jersey	Light	24	20	1,2	1	147.5	6.1
2	single jersey	Heavy	21	19	6,6	10	99.84	10.5
3	Rib	Light	53	65	0,3	0,8	110.2	6.1
4	Rib	Heavy	25	25	2,2	10,25	124.4	6.7

Table 4. The statistical analyses data

property	Direction	variables	p - value	F-test (calculated)
Penetration force(gm)	(Y1) wale	Fabric structure (X1)	5.4E-06 **	112.7
		Weight/unit area (X2)	1.97E-07 **	240.7
	(Y2) course	Fabric structure (X1)	0.006 **	13.56
		Weight/unit area (X2)	5.02E-05**	61.56
Wikability (min)	(Y3) wale	Fabric structure (X1)	1.76E-09**	885.9
		Weight/unit area (X2)	2.47E-08**	454.3
	(Y4) course	Fabric structure (X1)	3.19E-014**	13683.5
		Weight/unit area (X2)	0.84***	0.043
Air permeability (Cm^3/cm^2 .s)	(Y5)	Fabric structure (X1)	7.26E-09**	619.5
		Weight/unit area (X2)	1.33E-05**	88.7
Bursting strength	(Y6)	Fabric structure (X1)	6.03E-09**	649.3
		Weight/unit area (X2)	1.11E-07**	309.4

* p- value ≤ 0.05 is significant at confidence limit 95 %
** p- value ≤ 0.01 is significant at confidence limit 99 %
*** insignificant

F-critical (tabulated) is 5.317 that is means all results are significant except for the effect of Weight/unit area on the wikability property in course direction , from P - value all results are significant at confidence limit 99 %, where the less values is the more effective factor on the testing property and the vies versa . Also the values of **F(calculated**) are pointed to the higher values are more effective parameter on the testing property. The following charts show the relations between the two parameters fabric structure (x1), and weight/unit area (X2) versus the testing properties (Y_i).

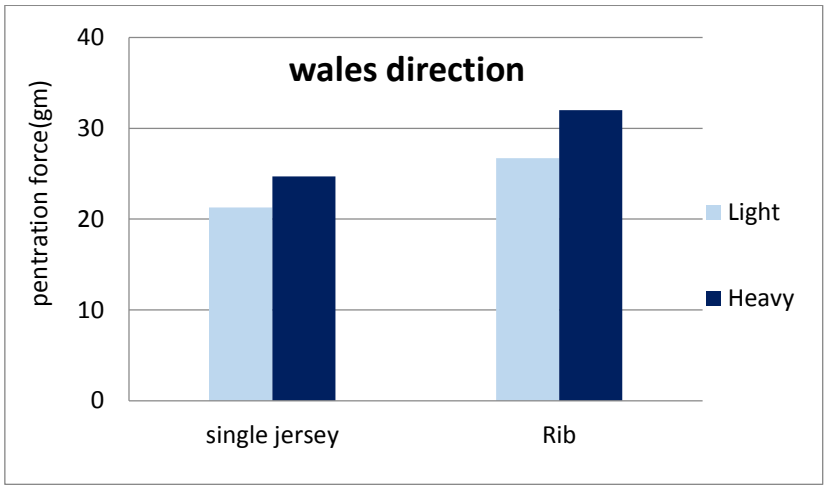

Fig. 2. Relation between the penetration force in wales direction with fabric structure at the two levels of fabric weight (light and heavy)

From Fig.(2) it is clear that penetration force in the wale direction increases in the rib fabric than in single jersey and increases in heavy fabrics than light one in both structures. That is because of the resistance against needle penetration in two-face fabrics rather than one-face and the same in heavy fabrics than the light fabrics, so the Sewability in light single jersey is better if we choose the suitable needles.

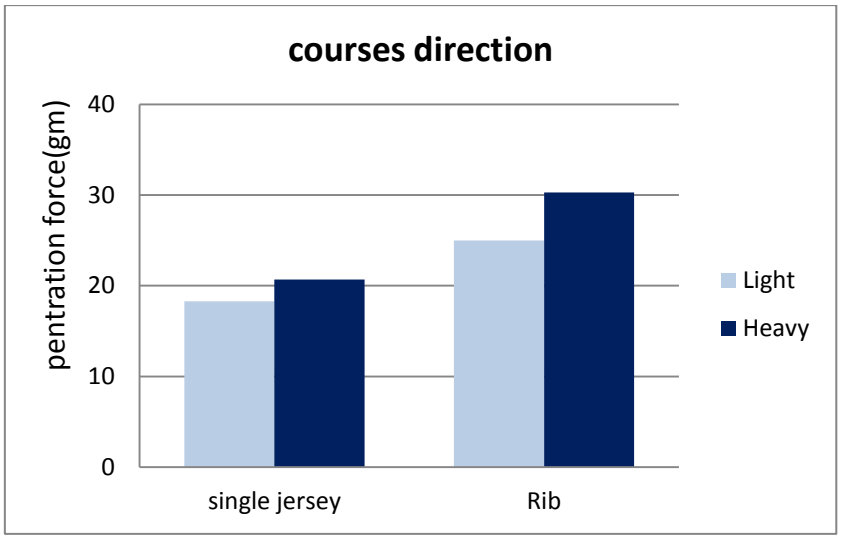

Fig. 3. Relation between the penetration force in courses direction with fabric structure at the two levels of fabric weight (light and heavy).

From Fig.(3) it is clear that penetration force in the weft direction increases in the rib fabric than in single jersey and increase in heavy fabrics than light one in both structures. But if we compared Fig (2) and Fig(3), it was noticed that the values of penetration force in the wales direction are higher than in the weft direction. This result may be due to wales' density being more than course density.

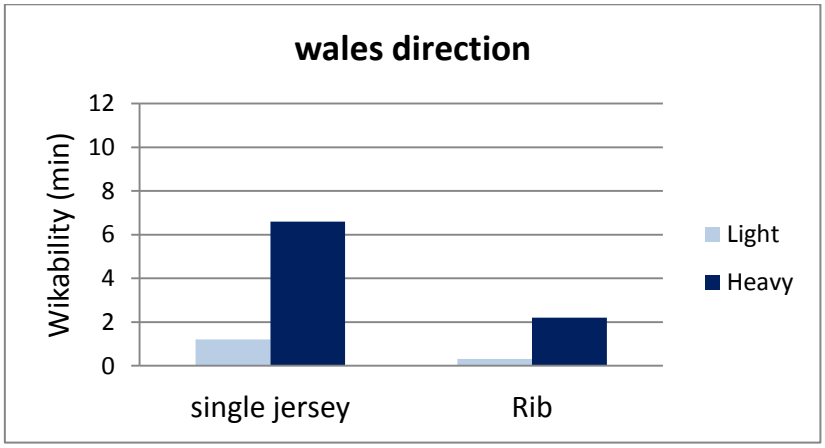

Fig. 4. Relation between the wikability in warp direction With fabric structure at the two levels of fabric weight (light and heavy).

From Fig.(4) it is clear that wikability in the wales direction increases in the single jersey fabric than rib and increases in heavy fabrics than the light one in both structures. This result may be due to the number of stitches which is less in one-face knitted fabrics than in two-face fabrics, so the water spreading is faster. This result means the water spreading in single jersey fabrics is more than in rib which means water spreading (i.e. sweat absorption) in one-face fabrics is better than in two-face, So one-face samples are more suitable for children clothes than two-face knitted fabric samples.

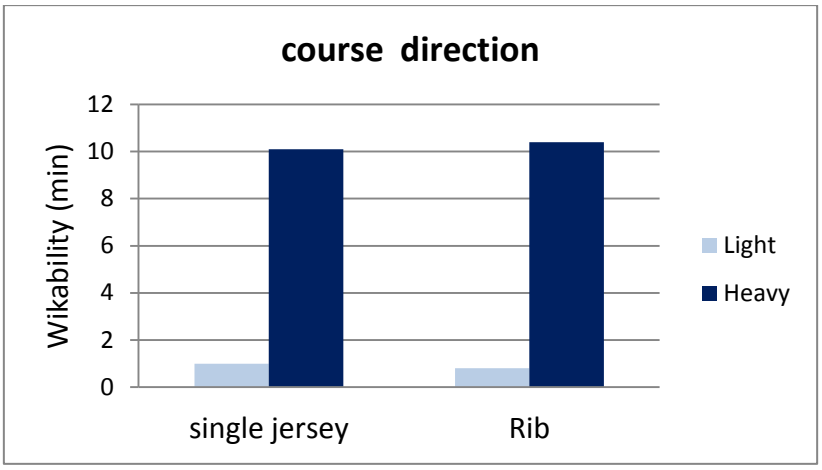

Fig. 5. Relation between the wikability in course direction with fabric structure at the two levels of fabric weight (light and heavy).

From Fig.(5) it is clear that wikability in course direction is almost nearly in both structures single jersey and rib at light and heavy weight fabrics. Also, the values of the property in course direction are more than in wales direction

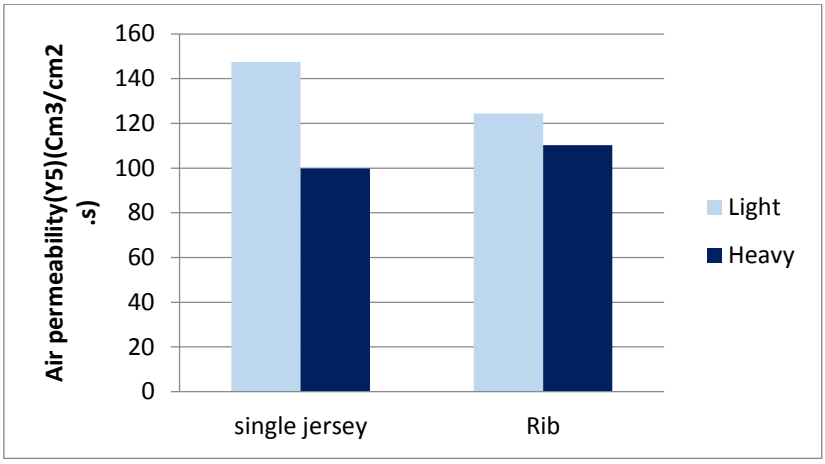

Fig. 6. Relation between the air permeability with fabric Structure at the two levels of fabric weight (light and heavy)

From Fig.(6) it is clear that air permeability in single jersey knitted fabrics is better than rib fabrics (light and heavy), this result may be due to more porosity in single jersey fabrics. So, one face Knitted fabrics are more effort clothes.

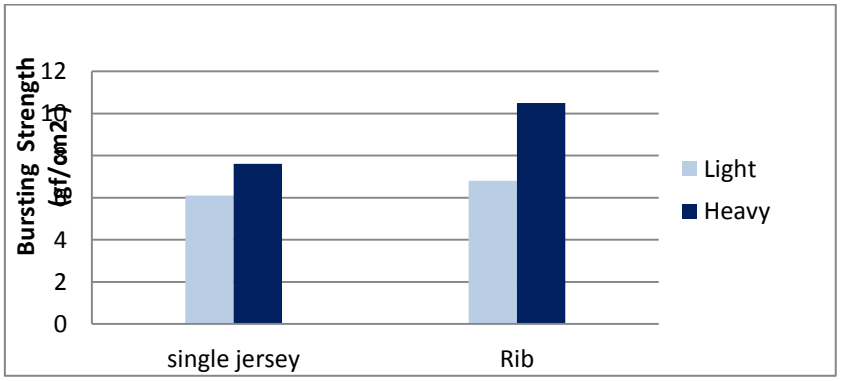

Fig.7. Relation between bursting strength with fabric structure at the two levels of fabric weight (light and heavy)

From Fig.(7) it is clear that the bursting strength in rib knitted fabrics is higher than single jersey knitted fabrics in both light and heavy weight, that is So one face Knitted fabrics are more effort clothes the durability of heavy rib So one face Knitted fabrics are more effort clothes fabrics is better than for single jersey.

Conclusions

From data analysis, it can be concluded that both of two parameters Fabric structure (X1) and Weight/unit area (X2) have significant effect on all tested properties at confidence limit 99 % except for the effect of Weight/unit area (X2) on the wikability property in course direction. But the effect of Fabric structure is more than Weight/unit area in properties wikability, air permeability, bursting. But in case of penetration force fabric weight is more effective than fabric construction. The result of tested properties point to the Single jersey sample with heavy weight is better than other tested samples. So, it is recommended that heavy weight single jersey fabrics are more suitable for children clothes according to the tested properties.

Conflicts of interest

"There are no conflicts to declare".

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تأثير متغيرات اقمشة التريكو على الأداء الوظيفي لملابس الأطفال

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تعتبر أقمشة التريكو من الأقمشة الخاصة والأكثر حساسية لأي تغير في مواصفات تشغيلها والتي تؤثر تأثير مباشر في خواص الأقمشة المنتجة والملابس ايضا. كما تعتبر أقمشة تريكو اللحمة الأكثر استعمالا في الحياة اليومية وخاصة ملابس الأطفال وذلك بسبب خواص النعومة والمطاطية والتي تجعل الملابس سهلة التشكيل. ومن أكثر العوامل المؤثرة في خواص أقمشة التريكو التركيب النسجي والوزن، لذلك تم في هذا البحث دراسة تأثير هذين العاملين علي الخواص المختلفة طبقا للغرض النهائي للملبس واي العاملين اكثرهم تأثيرا. وانتهي البحث بعد التحليل الاحصائي ان تأثير التركيب النسجي لأقمشة تريكو اللحمة اكثر من تأثير وزن المتر المربع وكلاهما له تأثر معنوي عل خواص القماش المنتج.

الكلمات الافتتاحية : أقمشة تريكو اللحمة ، اختبار انتشار الماء ، قابلية الحياكة ، قوة الانفجار ، نفاذية الهواء ، الراحة ، التحمل.