The influence of stitch length of weft knitted fabrics on the sewability

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Abstract: The sewing needle penetration force, the feed of the sewing material, sewing needle size are very important parameters during the sewing of knitted fabric. This paper is studying the effect stitch length, yarn count, and needle size on the penetration force which indicates the fabric sewability. Some physical and mechanical properties of these fabrics were also tested. From the results of this study obtained, we can conclude that, the sewability (which is indicated by penetration force) of 100% cotton single jersey fabric is inversely proportional to its stitch length. In the same time the fabric with coarser yarn count gives the higher penetration force. Also we can conclude that, fabrics with coarser yarn counts and shorter stitch length have better functional performance characteristics.

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Key Words: stitch length-weft knitted fabric-sewability- abrasion resistance- Air Permeability

1. Introduction:

Knit fabrics are having wider use in time since they can be produced more easily for a lower cost, and they are more flexible .However, knit fabrics are less than woven fabrics since they are produced with low twist yarn and have a slack construction, as a result of which they have a low abrasion resistance.

Abrasion resistance and pilling performance are two of the most important mechanical characteristics of fabric. The resistance of a fabric against the force of friction is known as the abrasion resistance. [1]

There are many factors, such as yarn spinning system, fabric construction and finishing processes that affect in the abrasion resistance. With certain precautions taken in fabric production, the abrasion resistance of knit fabrics can be developed positively. [1]

In the case of weft knitting, the dimensional properties of staple weft knitted fabrics depend mainly on the average loop length. In an earlier work, many attempts were made by researchers to analyze the relationships among the dimensions of knitted fabrics, the properties of the constituent yarns and the variable factors in knitting. It was noticed that the dimensional and weight related properties of knitted in relaxed state were determined uniquely by length of yarn in the stitch [2].

T. Ogulata and S. Mavruz have shown that the fabric with the lowest course count per cm and yarn count in Tex has the highest air permeability values. Moreover, increasing the loop length produced a looser surface in the fabric and decreased air permeability. As the yarn gets thinner and the pores between loops gets larger, the air permeability will increase accordingly. According to some formulations, when the stitch density, stitch length or yarn diameter increase, pore size values decreases. [3].

The sewing needle penetration force, sewing thread tension the feed of the sewing material, as well as selection of the sewing thread, sewing needle size and shape of the sewing needle point are very important parameters during the sewing of knitted fabric.

Sewing thread plays an influential role in seam design; it should be stretchable since knitted fabric has elastic properties in the direction of courses and Wales .The size of the needle eyelet and thread thickness should be mutually adjusted in order for the thread to pass through the eyelet with as little friction as possible.

The quality of a sewn seam depends on these two factors, therefore it is necessary to match the thickness and density of the knitted fabric with the fineness of sewing thread and needle.

The penetration force of a sewing needle is mostly based on the friction occurring between the sewing work pieces and sewing needle, and the highest penetration force of the sewing needle occurs at the moment when the sewing needle penetrates the sewing material, which should be taken into consideration, especially with knitted fabrics.(4)

The sewing needle penetration force is one of the most significant technical parameters in the sewing process affected by various factors such as: type, number of layers of the sewing material, and needle size [4].

The stitch length for each fabric was calculated as the ratio of course length to the number of needles [5].

Doyle and Hurd (1953) found that the stitch density of plain knitted fabrics in the dry relaxed state is dependent only on the loop length, and independent of other yarn and knitting variables [6].

This paper is studying the effect of stitch length, yarn count, and needle size on the penetration force which indicates the fabric sewability

2- Experimental work:

1-The knitted fabric samples were made of 100% cotton.

Produced 9 sample fabrics from single jersey, machine (circular knitting) gouge 24 Diameter of cylinder 26/inch by using combed cotton with 3 English counts 20/1, 24/1, 30/1 at different stitch length (1.3 -1.8 -2.7mm) and rate of feeding 135, 155, 175

- The physical properties test:

- Fabric weight/g square meter according to ASTM D3776
- Air permeability/ $Cm^3/cm^2/sec$ according to ASTM D 737-96
-Thickness/ mm according to ASTM according to ASTM D1777-96
-stitch length using Huttra course length tester according to ASTM D 3887.

The mechanical properties test:
The L&M sew ability tester:

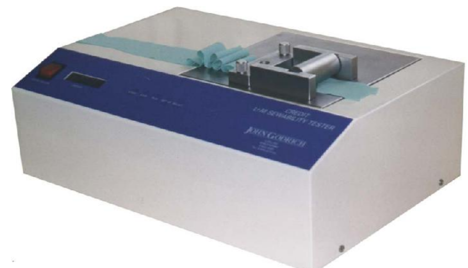

Fig 1 The L+M sewability Tester [8,9]

Testing fabric sewing properties, US patent 3979951, 1976), a device used in many studies on needle penetration force. This equipment simulates a sewing machine by penetrating the tested fabric with an unthreaded needle, at a rate of 100 penetrations per min., with needle count 70, 80.

-Abrasion resistance / cycle according to ASTM D 4966

-Burst strength/ Kg/cm^2 according to ASTM D 3786-01

The physical and mechanical properties of these fabrics were tested under standard condition.

3-Result and discussion:

The results of tested samples are shown in table (1).

Table (1) The Average results for Tested Samples

S	Ne	S.L/ mm	Sewability/N		Thickness/ mm	Air permeability / $Cm^3/cm^2/sec$	Abrasion / cycle	Weight/g	Burst Kg/cm^2
			N70	N80					
1	20	1.3	38	55	58	23.8	410.0	240.4	11.00
2	20	1.8	36	26	62	54.3	350.0	212.4	9.20
3	20	2.7	18	12	63	112.0	300.0	207.1	9.00
4	24	1.3	32	27	56	52.90	290.0	199.7	8.40
5	24	1.8	26	14	60	107.9	175.0	177.5	7.70
6	24	2.7	8	7	54	118.4	193.3	155.0	6.40
7	30	1.3	7	11	59	126.6	123.3	150.6	7.70
8	30	1.8	6	8	89	136.7	163.3	128.2	6.30
9	30	2.7	6	5	79	272.6	124.0	118.4	5.93

S : Sample number
Ne : Count 20 24 30
S.L : stitch length
Sew ability :Sewing needle penetration force/N
N : needle number 70-80

3.1. Effect of stitch length on Sewability:

a. Sewing needle penetration force; Sewability (for needle number N70):

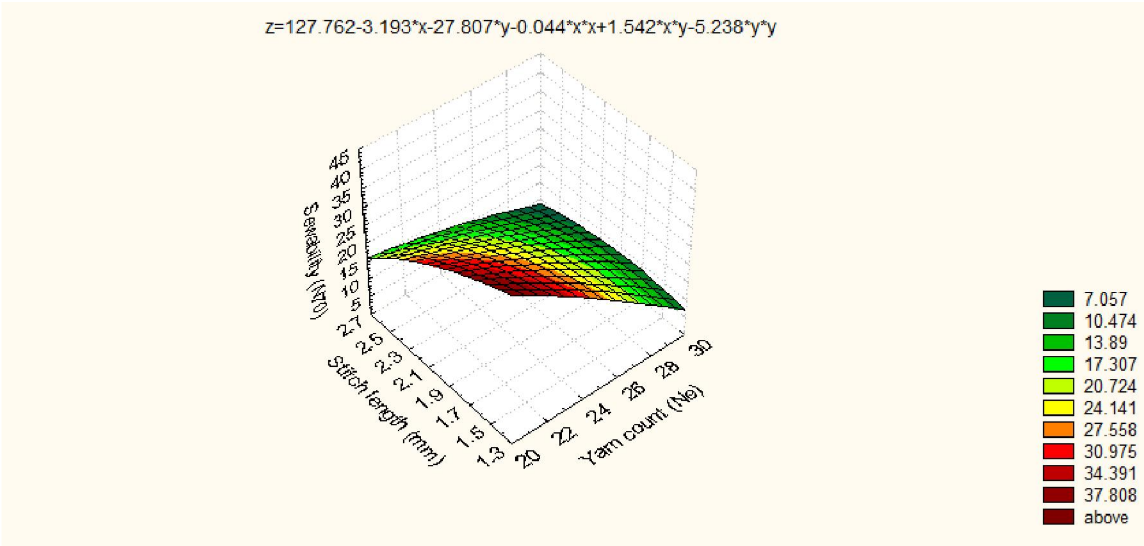

Fig (1) The Relation between Stitch Length and Sew ability (N70) for Different Yarn Counts

From figure (1) it is observed the relation between stitch length and sewability by using (Needle 70) that stitch length of 100% cotton single jersey fabric is inversely proportional to its sewability. In the same time the fabric with coarser yarn count gives the higher penetration force and vise versa. This result may be explained by the fabric thickness and tightness factor which are decreased with the finer count and longer stitch length which allows the needle to penetrate easily.

b. Sewing needle penetration force; Sewability (for needle number N80):

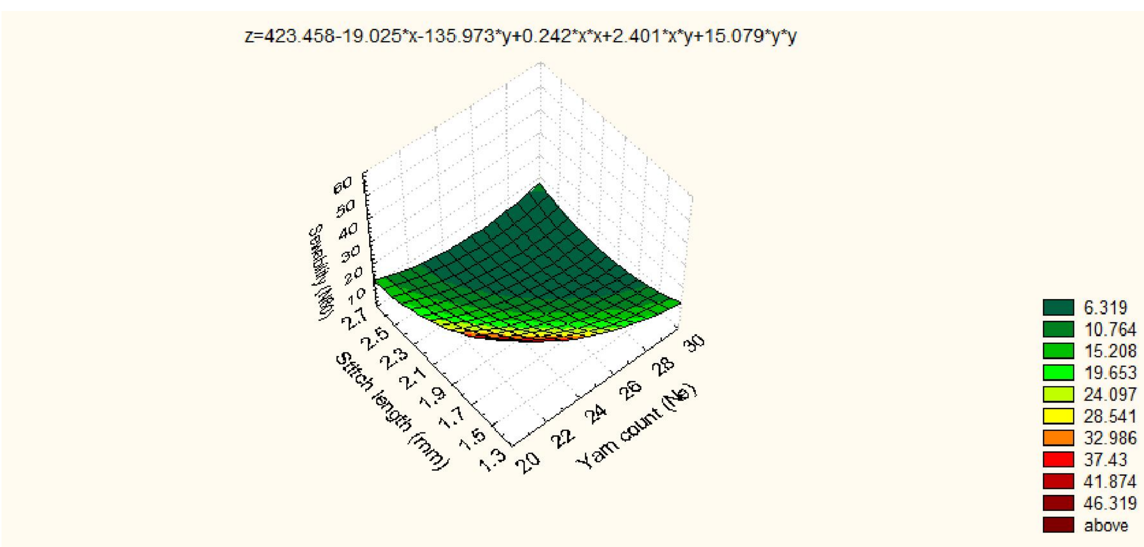

Fig (2) The Relation between Stitch Length and Sew ability (N80) for Different Yarn Counts

3.2. Effect of stitch length on some fabric Properties:

a. Fabric thickness:

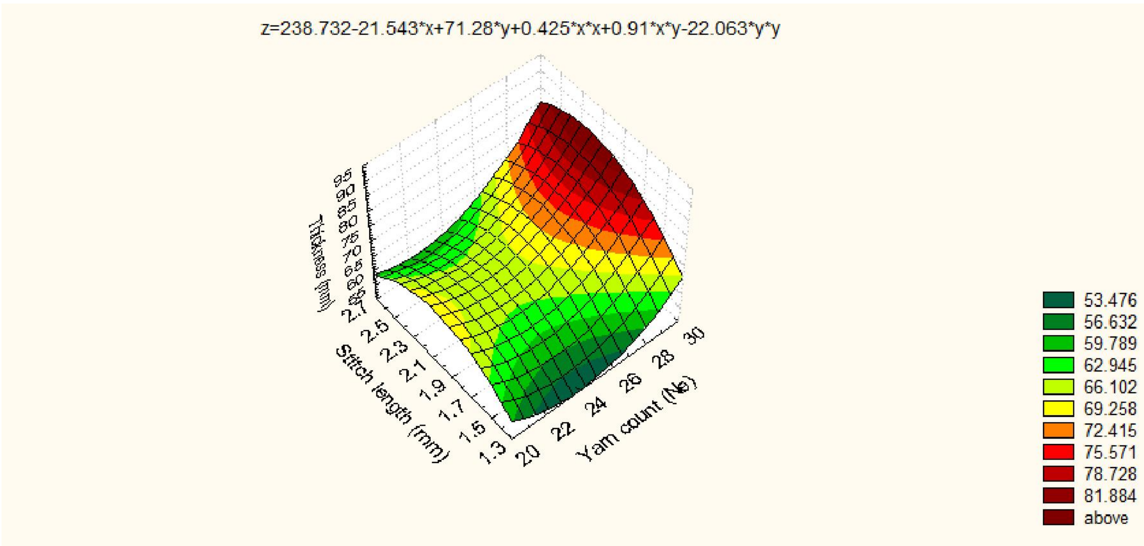

Fig (3) the Relation between Stitch Length and Fabric Thickness for Different Yarn Counts

Figure (3) shows the relation between stitch lengths and the fabric thickness, which indicates that stitch length, is inversely proportional to its measured thickness. In the same time the fabric with coarser yarn count gives the higher fabric thickness and vise versa.

b. Fabric weight:

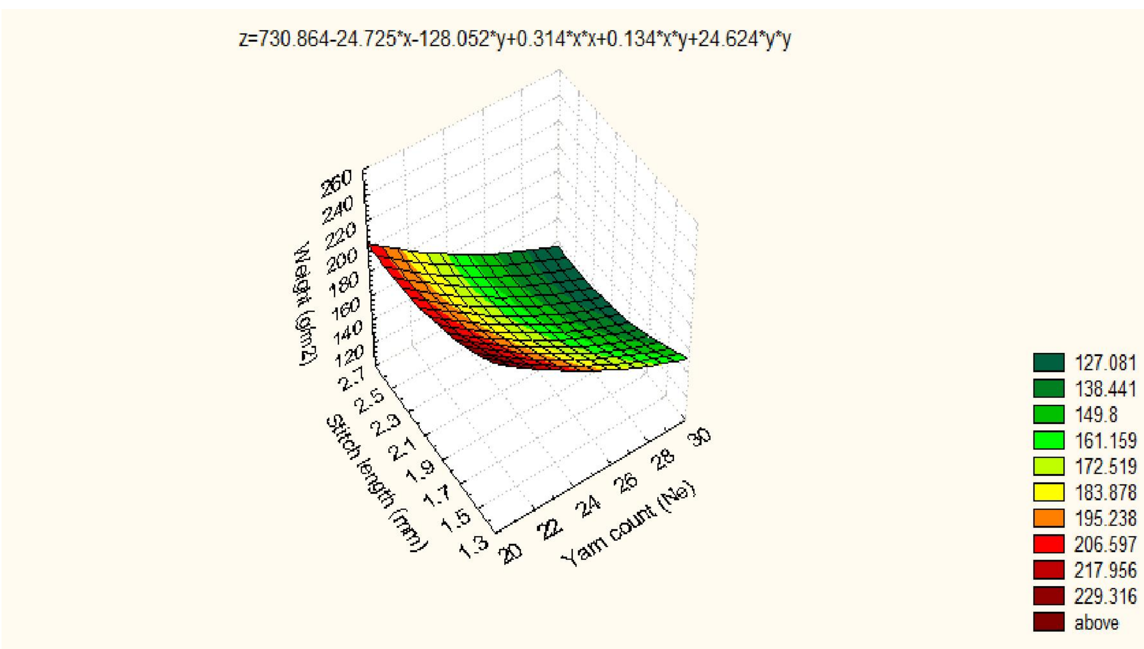

Fig (4) the Relation between Stitch Length and Fabric Weight for Different Yarn Counts

Figure (4) shows the relation between stitch lengths and the fabric weight, which indicates that stitch length, is inversely proportional to its measured weight. In the same time the fabric with coarser yarn count gives the higher fabric weight and vise versa.

a. Fabric Air Permeability:

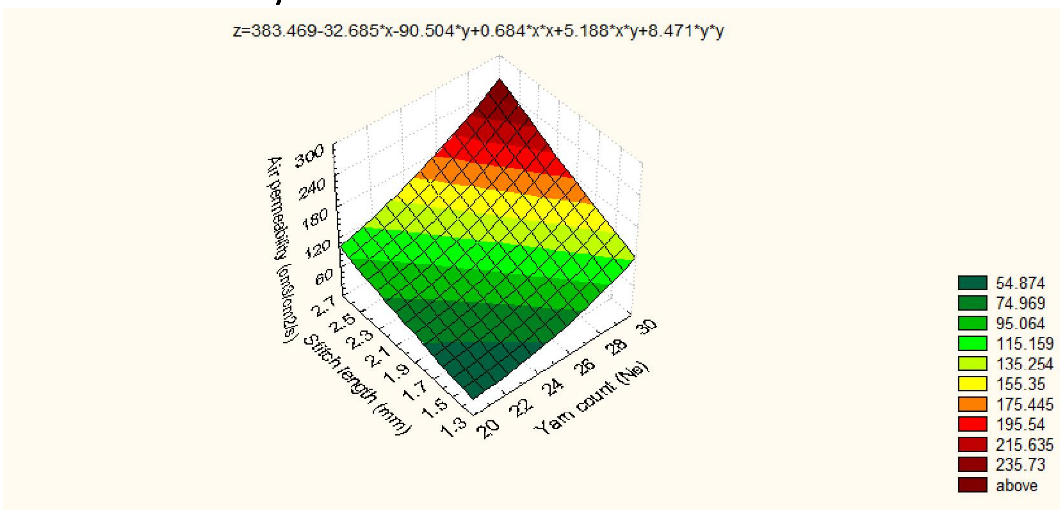

Fig (5) the Relation between Stitch Length and Air Permeability for Different Yarn Counts

Figure (5) shows the relation between stitch lengths and the fabric air permeability, which indicates that stitch length, is directly proportional to its measured air permeability. In the same time the fabric with finer yarn count gives the higher fabric air permeability. This result may be explained by the tightness factor which is decreased with the finer count and longer stitch length which allows the air flow to penetrate easily thru the fabric.

b. Fabric abrasion resistance:

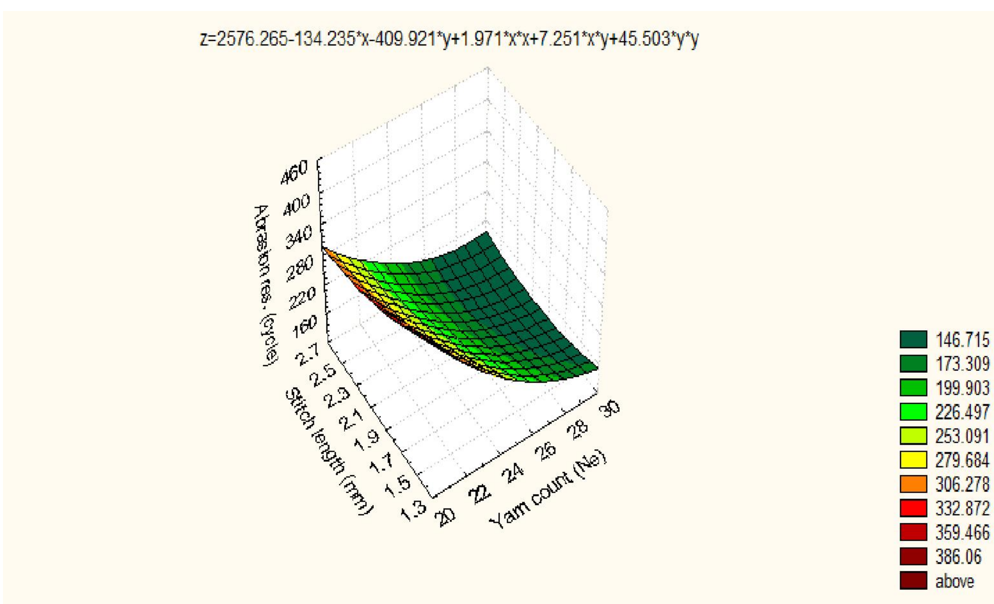

Fig (6) the Relation between Stitch Length and Fabric Abrasion for Different Yarn Counts

Figure (6) shows the relation between stitch lengths and the fabric abrasion resistance, which indicates that stitch length, is inversely proportional to its measured abrasion resistance. In the same time the fabric with coarser yarn count gives the higher fabric abrasion resistance.

c. Fabric bursting strength:

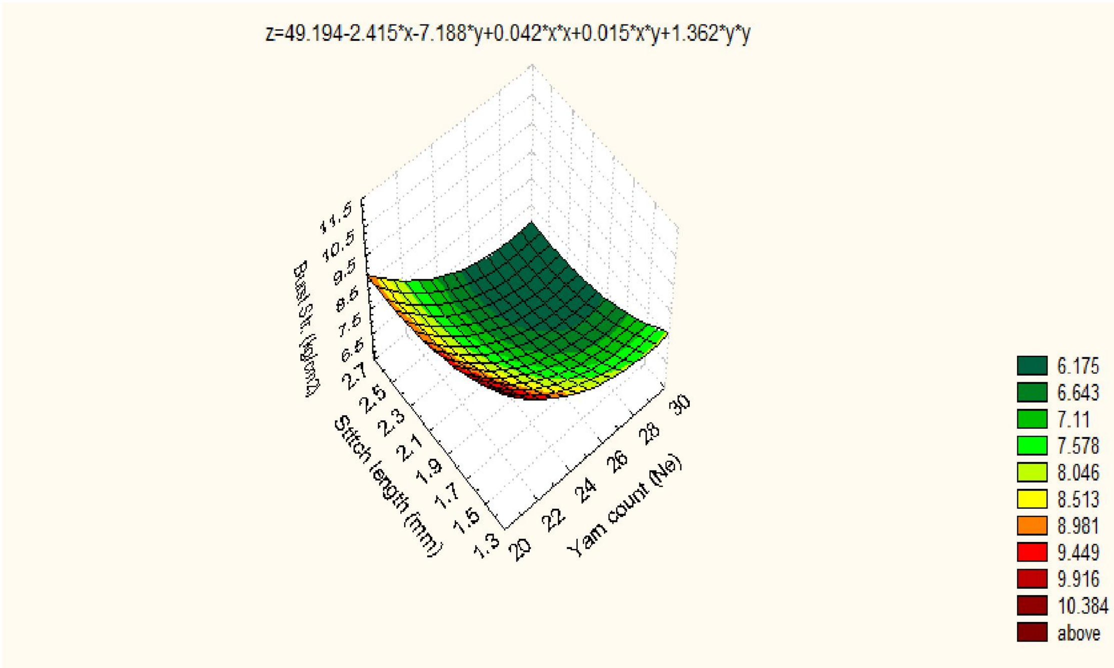

Fig (7) the Relation between Stitch Length and Fabric bursting strength for Different Yarn Counts

Table (2) quality factors of the fabrics under study

	Bursting Strength	Abrasion Strength	Air permeability	Sewability N80	Sewability N70	Quality Factor
Ne 20, SL 1.3mm	100	100	98	55	58	82.2
Ne 20, SL 1.8mm	92	93	71	60	58	74.7
Ne 20, SL 2.7mm	91	87	60	71	67	75.1
Ne 24, SL 1.3mm	88	85	72	59	59	72.8
Ne 24, SL 1.8mm	85	71	61	68	62	69.3
Ne 24, SL 2.7mm	79	74	60	86	88	77.1
Ne 30, SL 1.3mm	85	65	59	73	93	74.9
Ne 30, SL 1.8mm	79	70	58	81	100	77.6
Ne 30, SL 2.7mm	77	65	54	100	100	79.3

Figure (7) shows the relation between stitch lengths and the fabric bursting strength, which indicates that stitch length, is inversely proportional to its measured bursting strength. In the same time the fabric with coarser yarn count gives the higher fabric bursting strength.

3.3. Assessment of fabric quality with different stitch lengths and yarn counts:

An assessment approach to the quality of fabrics under study was carried out to indicate the overall quality level of the fabrics based on the performance characteristics of these fabrics when manufactured as knitwear.

This assessment is done by recalculating the measured values of these quality attributes according to a new dimensionless scale between 0 and 100. This way helps to compare between different samples.

Figure (8) shows radar chart of each fabric, and table (2) shows their quality factors.

From these figures and table we can conclude that, fabrics with coarser yarn counts and shorter stitch length have better functional performance characteristics, while fabrics with finer yarn counts and longer stitch length have better sewability characteristics.

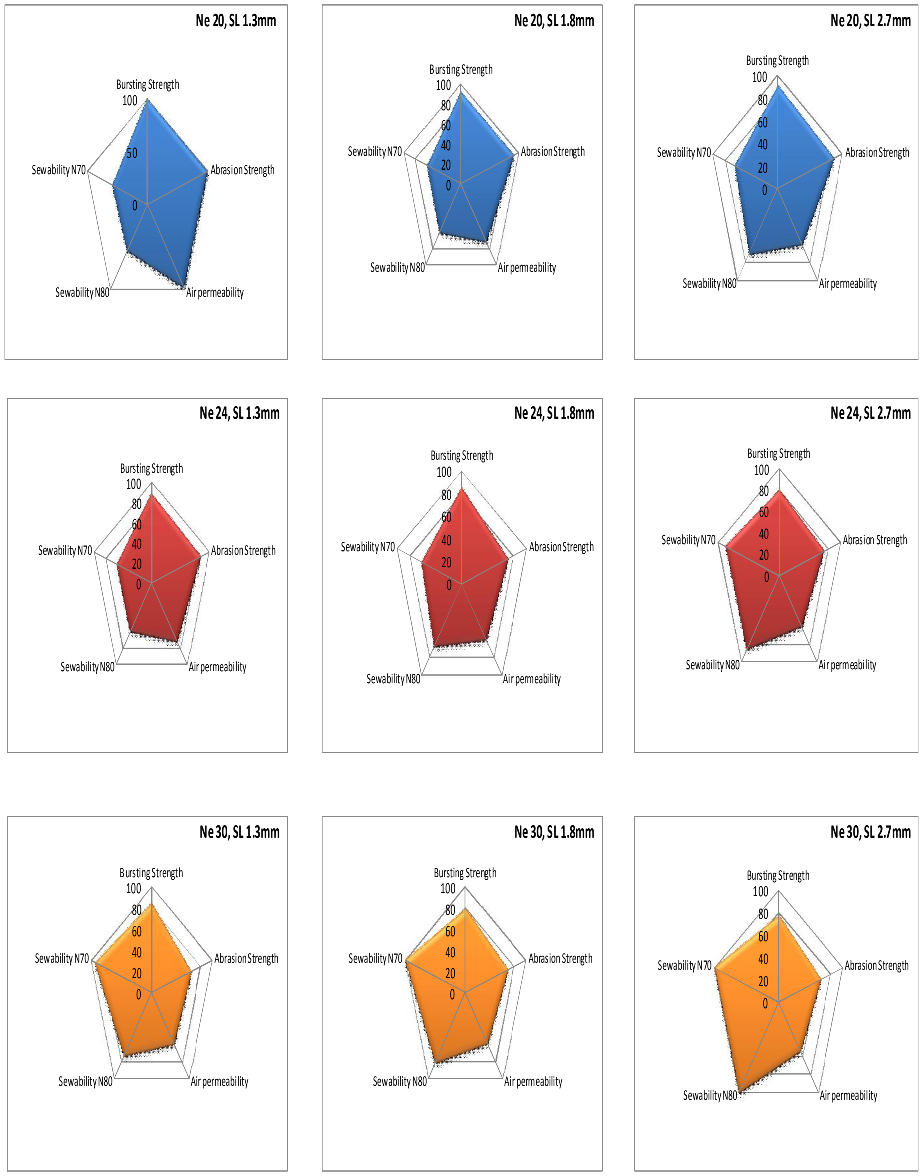

Fig (8) the Radar charts of the nine fabrics with different Stitch Lengths and Yarn Counts

Conclusion:

From results we can conclude that, the sewability (which is indicated by penetration force) of 100% cotton single jersey fabric is inversely proportional to its stitch length. In the same time the fabric with coarser yarn count gives the higher penetration force. Also we can conclude that, fabrics with coarser yarn counts and shorter stitch length have better functional performance characteristics.

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