Egypt. J. Chem. **Vol. 68**, No. 12 pp. 563 - 582 (2025)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Impact of Various Factors on the Performance of Sewing Weft Knitted Fabrics with Broadcloth Fabric

Doaa Abdul Qader Ibrahim Al-Qatry[1], Asmaa Glal AbdelazezAborady[1], Kawther Taher Rizk Mohammed[1], Amany Moustafa Ibrahim Khalaf[1*]

[1]*Department of Clothing and Textile, Faculty of Home Economics, Al-Azhar University, Gharbia – Egypt*

Abstract

Knitting is widespread in outerwear because of its characteristics like comfort, stretchability, and breathability. Moreover, knitted fabrics are integrated with woven fabrics in clothing, especially winter apparel. Two rib-knitted fabrics were produced on a flat knitting machine with a 5 n/inch gauge from polyacrylic yarn with a tuck stitch. 54 samples were sewn in two groups with the following variables: Knitted fabrics were sewn in three directions (courses, wales, and 45°) with broadcloth fabrics in three directions (warp, weft, and bias). Two types of seams with three types of sewing stitches were used: the SSa seam with the 514 stitch, the SSa seam with the 516 stitch, and the LSq seam with the 516 stitch + the top stitch 301.

The sewing properties of the study samples were examined. The finding showed that the sewing direction of broadcloth fabrics had a significant effect on the seam pucker and had no significant effect on the seam stiffness for the two sample groups, while the sewing direction of broadcloth fabrics had a significant effect on seam appearance for group 2 samples and had no significant effect on it for group 1 samples. Moreover, the sewing direction of knitted fabrics had a significant effect on the seam pucker and had no significant effect on the stiffness and appearance of seams for group 1 samples, while it had no significant effect on all sewing properties for group 2 samples. Both the stitch and seam type had a significant effect on the seam stiffness and had no significant effect on the puckering and appearance of seams for the two sample groups.

Keywords: Weft knitted, Low- gauge knitted fabric, Broadcloth fabric, Seam performance.

1. Introduction

Knitting is the second most popular fabric construction method, offering superior ease, speed, and cost-effectiveness compared to woven fabrics. The knitting sector is known for its ability to rapidly adapt to changing styles and fashion trends. Over the past ten years, knitted fabrics have experienced a significant rise in popularity. Nowadays, knitted fabrics are utilized in products such as outerwear, intimate apparel, sportswear, and hosiery (1), (2), (3), (4), (5). Knitted fabrics are known for their stretchability and high resilience due to their looped construction. Furthermore, their inherent resistance to wrinkling contributes significantly to their widespread appeal. Overall, knitted fabrics are popular for their exceptional comfort due to their flexibility, softness, breathability, and ability to transmit moisture away from the body, making them suitable for various apparel types (6), (7). (2), (8), (9), (10), (11).

Knitting machines are available in various gauges to support the diverse array of yarns currently on the market. The machine gauge refers to the number of needles per inch, significantly impacting the structure of the fabric. It is essential to recognize that not every yarn count can be utilized with the same machine gauge. Typically, as the machine gauge increases, the yarn must be finer. Low-gauge knitted fabrics are produced using flat weft knitting machines, leading to heavier fabrics compared to those produced by circular knitting machines. Therefore, they are usually used in the production of outerwear fabrics and sweaters [(2), (12)].

The weft-knitted fabrics foundational structures include plain, rib, interlock, and purl. These structures, along with their derivatives, constitute the core elements of all weft knitted fabrics and garments. The rib-knitted fabric has been produced by meshing the stitches in neighbouring wales in opposite directions. This is achieved by knitting with two needle systems, which are placed opposite to each other. As such, these fabrics are also known as double jersey or double-face fabrics. On both sides of a relaxed rib-knitted fabric, only face stitches are presented. Knitted fabric structures vary according to production factors, such as needle arrangement, stitch type, and thread type. There are four key stitches that determine all knitted fabric structure. These stitch types include the knit, miss, tuck and transfer stitches. The tuck stitch is a notable decorative stitch that enhances the fabric's surface texture. This stitch significantly affects the properties of the fabric, leading to an increase in weight, thickness, and width, while also enhancing its porosity compared to other fabric types. The formation of the tuck stitch occurs when the needle tucks the yarn into the structure rather than creating a loop. This technique results in a reduction of fabric length and lengthwise elasticity, as the increased tension on the tuck and held loops draws yarn from neighboring knitted loops, thereby diminishing their size and enhancing stability and shape retention. The width of the fabric

*Corresponding author e-mail: Amanykhalaf1879.el@azhar.edu.eg.;(Amany Moustafa Ibrahim Khalaf).
Received date 13 March 2025; revised date 05 May 2025; accepted date 06 May 2025
DOI: 10.21608/ejchem.2025.367925.11444

expands due to the downward pull of the tuck loops on the held loops, which causes them to spread outward and provides additional yarn for widthwise elasticity (13), (14), (12), (15).

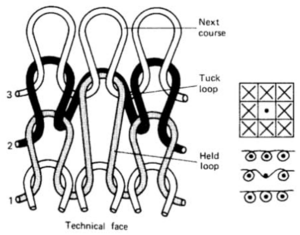


Figure 1: Tuck stitch (13)

Recently, knitted fabrics have been integrated with different types of fabrics to enhance the aesthetic and functional aspects of clothing. Broadcloth is one of the most important fabrics that are combined with knitted fabrics to produce various types of winter clothing, most notably coats and jackets. Broadcloth is a dense fabric woven from carded woolen threads mixed with a percentage of synthetic fibers or made from any type of fiber for both warp and weft; then, it is felted and shaved. However, clothes produced from broadcloth face many difficulties and problems during the operating stages due to some broadcloth fabric's natural properties, such as thickness and extra hardness during sewing, which requires choosing the suitable seams, especially when sewing it with other fabrics. Since the performance of the clothing manufactured from the integration of various fabrics is an important element during the design, production and manufacturing processes which requires dealing with them in a technical manner that is consistent with their natural and mechanical properties (16),(17),(18).

The ready-made garment industry, at every stage of its production, is essential to the economies of numerous countries globally, as it meets people's needs and achieves their well-being. The sewing process is essential in the productivity and overall quality of garments. The apparel performance is primarily reliant on the quality of its seams(19), (20), (21), (22),(23).

Seams are formed by stitching two or more plies of materials together. The stitch constitutes the base component of a seam, and the choice of stitch types is influenced by the functional or aesthetic requirements of the seam.Seam quality is evaluated based on several criteria, such as seam strength, seam puckering, and seam efficiency. (24), (25), (26), (27), (28).

Numerous studies have examined sewing standards and their influence on the quality and aesthetics of garments, including the study of Al-Sawy (2017) (16), which aimed to study the effect of some sewing variables (seam type, presser foot pressure, needle size, sewing thread size, and stitch density per centimeter) on the sewing properties of broadcloth fabric (seam strength, seam elongation, seam efficiency, and seam slippage). The study concluded that there is an effect of these variables on the sewing properties of broadcloth fabric, and the most influential of them were presser foot pressure, needle size, thread number.

Another study by Nasr Eldeen (2018) (29) examines the impact of both the type of seam and stitch used in sewing knitted fabrics with artificial leather on the quality and sewing efficiency. Three different weights of interlock fabrics were sewn with artificial leather fabric covered with 100% polyester single jersey fabric from the back, 100% cotton sewing threads were used for the seam face and 100% polyester threads for the seam back, and four different types of seams were used. The results showed that the (FSa) seam gave the best values for the seam properties for interlock fabrics of different weights when sewn with artificial leather.

The study of Al-Qatry (2019)(30) aimed to study the effect of seam type, stitch type, and stitch density on the sewing performance of interlock fabrics produced from viscose fibers mixed with polyester and spandex. Three different types of seams were used in addition to two types of stitches at three levels of stitch density per cm. The most important study findings were that seam strength, seam elongation, and seam stiffness were affected by seam type, stitch type, and stitch density per cm. Additionally, the SSa seam with the 514 stitch and 4 stitches per cm had the highest value for the overall quality of seam properties.

The study of Rabie & Hashem. (2020) (31) aimed to determine the appropriate sewing parameters for lace and jersey fabrics in terms of needle size, stitch length, and tension level. Twenty-seven samples were sewn using a zigzag stitch and 100% spun polyester yarn No. 40/2. Ne Three needle sizes, three stitch lengths, and three tension levels were used. The results of the sewing properties tests showed that the sample with the variables (needle No. 12, stitch length 2 mm, tension level 1) achieved the best quality of sewing properties.

Besides, the study of Diab et al. (2021) (32) aimed to investigate the effect of knitting structure and mixing ratios of cotton and Tencel fibers on the sewing properties. It was also planned to look into how the type of seam, stitch, and stitch density per cm affected the sewability of rib and interlock fabrics made from cotton and Tencel fibers mixed in different ratios. The finding showed that the interlock fabric made of 100% Tencel fibers with the SSa seam, the overlock 514 stitch, and the stitch density of 5/cm was the best in terms of sewing properties.

It is clear from previous studies that most of them were concerned with studying the knitting variables of knitted fabrics or high-gauge knitted fabrics stitched with some other fabrics, so this study aimed to determine the knitting variables of low-gauge knitted fabrics with woven fabrics, especially thick ones such as broadcloth. The research hypotheses were as follows:

There are statistically significant differences for the influence of the woven fabric sewing direction on the sewing properties.

There are statistically significant differences for the influence of the Knitted fabric sewing direction on the sewing properties.

There are statistically significant differences for the influence of the seam & stitch type on the sewing properties.

2. Experimental

Rib knitted fabrics were produced from polyacrylic (1800 denier) on flat knitting machine with 5 n/inch gauge with a tuck stitch construction as shown below:

The first structure is rib 1/1 with a tuck stitch arranged in 1/1 in the front needles, and the stitch is held in 2 rows to make a tuck stitch, and the back needles do knit stitches for all rows.

.

Figure 2: 1st structure face **Figure 3:** 1st structure back

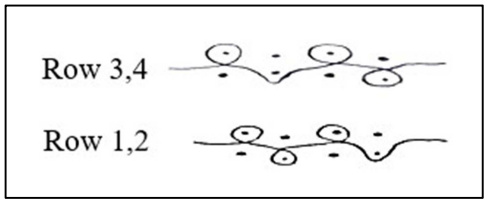


Figure 4: Frist structure Rib 1/1 with tuck stitch

The second structure is rib 1/2, 1/2, 1/4 with a tuck stitch arranged in 1/1 in the front needles, and the stitch is held in 4 rows to make a tuck stitch, and the back needles do knit stitches for all rows.

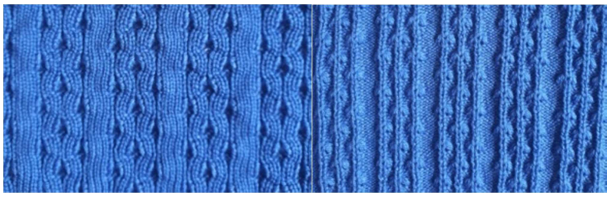


Figure 5: 2nd structure face **Figure 6:** 2nd structure back

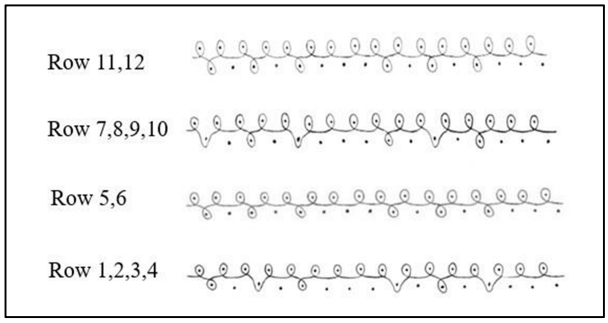


Figure 7: Second structure Rib 1/2, 1/2, 1/4 with tuck stitch

The fabric specifications were determined by preliminary testing prior to the sewing process, as indicated in Table 1. The two knitted fabric structures were sewn with the broadcloth fabric; the fabric properties are shown in Table 1.

Table 1: The properties of the fabrics study

Fabrics Structural difference		Weight per square meter Gm	Material	Structure
Knitted fabrics	First structure	485 Gm	Polyacrylic 1800 denier	Rib 1/1 Tuck stitch
	Second structure	572 Gm	Polyacrylic1800 denier	Rib 1/2, 1/2, 1/4 Tuck stitch
Broadcloth fabric	Fixed	444 Gm	Polyester 100%	Commercial fabric

54 study samples were sewn in two groups: the first group (27 samples for the first structure, 27 samples for the second structure) with the following variables:

- Fabric sewing direction

Knitted fabrics were cut in three directions (courses, wales, and 45°).
Broadcloth fabrics were cut in three directions (warp, weft, and bias).

- Seam and Stitch type

Two types of seams with three types of sewing stitches were used: the seam type SSa with the 514 stitch, the seam type SSa with the 516 stitch, and the seam type LSq with the 516 + 301 top stitch. Seam shapes are shown in Table 2, and the used machine models are shown in Table 3.

Table 2: Seams shapes

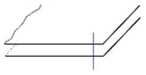
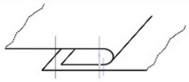
	Seam Type	Seam shape
1	SSa Superimposed seam	
2	LSq Lapped seam	

Table 3: The specifications of sewing machines

	Stitch type	**Machine Model**
1	514	Sewpower-SP-900D-4
2	516	Sewpower-SP-900D-6-H
3	301	Typical Gc6925A-MD4

Table 4: the study variables

Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type	Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type
s1	Warp	Courses	SSa 514	s28	Warp	Courses	SSa 514
s2			SSa 516	s29			SSa 516
s3			LSq 516 + 301 top stitch	s30			LSq 516 + 301 top stitch
s4		Wales	SSa 514	s31		Wales	SSa 514
s5			SSa 516	s32			SSa 516
s6			LSq 516 + 301 top stitch	s33			LSq 516 + 301 top stitch
s7		45○	SSa 514	s34		45○	SSa 514
s8			SSa 516	s35			SSa 516

s9			LSq 516 + 301 top stitch	s36			LSq 516 + 301 top stitch
s10	Weft	Courses	SSa 514	s37	Weft	Courses	SSa 514
s11			SSa 516	s38			SSa 516
s12			LSq 516 + 301 top stitch	s39			LSq 516 + 301 top stitch
s13		Wales	SSa 514	s40		Wales	SSa 514
s14			SSa 516	s41			SSa 516
s15			LSq 516 + 301 top stitch	s42			LSq 516 + 301 top stitch
s16		45○	SSa 514	s43		45○	SSa 514
s17			SSa 516	s44			SSa 516
s18			LSq 516 + 301 top stitch	s45			LSq 516 + 301 top stitch
s19	Bias	Courses	SSa 514	s46	Bias	Courses	SSa 514
s20			SSa 516	s47			SSa 516
s21			LSq 516 + 301 top stitch	s48			LSq 516 + 301 top stitch
s22		Wales	SSa 514	s49		Wales	SSa 514
s23			SSa 516	s50			SSa 516
s24			LSq 516 + 301 top stitch	s51			LSq 516 + 301 top stitch
s25		45○	SSa 514	s52		45○	SSa 514
s26			SSa 516	s53			SSa 516
s27			LSq 516 + 301 top stitch	s54			LSq 516 + 301 top stitch

Laboratory tests

The samples were conditioned for 24 hours under standard atmospheric conditions (20±2° C, 65±2% RH) in accordance with ASTM standards prior to testing. . (33)

The following tests were performed:

- Tests of the fabrics before sewing

Measurement of weight per square meter: This test was conducted according to the American Standard ASTM D3776/D3776M-09a Standard Test Methods for Mass Per Unit Area (Weight) of fabric. (34)

This test was conducted in the textile laboratory of the Clothing and Textile Department at the Faculty of Home Economic, Al-Azhar University.

-Tests of the study samples after sewing

Seam stiffness test

This test was conducted using a Shirley fabric stiffness tester according to the American Standard ASTM 1388-96. (35)

This test was conducted in the textile laboratory of the Clothing and Textile Department at the Faculty of Home Economic, Al-Azhar University.

Seam Pucker test

This test was conducted using the five standard images according to the specification AATCC Test Method (TM) 88B. (36)

Seam appearance test

The study samples were judged by a group of specialists in the field of clothing and textile industry (14 judges). The samples were presented to each of them separately, and each sample was given a score out of 10.

Statistical analysis

- Descriptive statistics and bar graphs: To display and compare the average results of sewing properties.
- One-way analysis of variance (ANOVA): To verify the significance of differences between the averages of sewing properties results (seam stiffness, seam puckering, and seam appearance) for every variable.
- Quality coefficients: To determine the overall properties of samples, rank the samples according to the percentages of these properties combined, and identify the highest and lowest quality samples in terms of overall sewing properties.

2. Results and Discussion

3.1. The effect of study factors on sewing properties for the broadcloth fabric sewn with the first knitting structure (group 1)

The findings of the sewing properties tests for group 1 (the broadcloth fabric sewn with the first knitting structure) are shown in Table 5.

Table 5: Results of seam properties tests for the study samples (group 1)

Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type	Seam Stiffness mg\cm	Seam Pucker	Seam appearance
s1	Warp	Courses	SSa 514	411.86	4.00	6.85
s2			SSa 516	428.89	4.00	8.28
s3			LSq 516 + 301 top stitch	627.08	4.00	8.53
s4		Wales	SSa 514	430.44	5.00	8.42
s5			SSa 516	439.73	4.67	7.78
s6			LSq 516 + 301 top stitch	613.14	4.67	7.53
s7		45°	SSa 514	411.86	4.00	6.14
s8			SSa 516	435.08	4.00	6.64
s9			LSq 516 + 301 top stitch	617.79	5.00	7.85
s10	Weft	Courses	SSa 514	373.15	4.00	8.21
s11			SSa 516	414.95	4.00	9.78
s12			LSq 516 + 301 top stitch	611.59	3.67	9.28
s13		Wales	SSa 514	354.57	4.00	8.00
s14			SSa 516	418.05	4.33	7.32
s15			LSq 516 + 301 top stitch	571.34	4.00	9.46
s16		45°	SSa 514	374.70	4.00	6.92
s17			SSa 516	390.18	4.00	6.00
s18			LSq 516 + 301 top stitch	569.79	4.00	9.07
s19	Bias	Courses	SSa 514	359.21	4.00	7.42
s20			SSa 516	391.73	4.00	7.32
s21			LSq 516 + 301 top stitch	507.85	5.00	7.60
s22		Wales	SSa 514	377.79	5.00	6.60
s23			SSa 516	377.79	5.00	9.21
s24			LSq 516 + 301 top stitch	517.14	4.67	6.85
s25		45°	SSa 514	404.12	5.00	7.32
s26			SSa 516	377.79	4.33	7.32
s27			LSq 516 + 301 top stitch	545.01	5.00	8.07

3.1.1. The effect of Study factors on seam stiffness for group 1

Table 5 and Figures 8,9, and 10 clearly indicate thatseam stiffness was affected by both seam type and stitch type, but not by sewing direction for either broadcloth fabric or knitted fabric. It also indicates that the LSq seam demonstrated the greatest seam stiffness across all sewing directions of broadcloth and knitted fabrics. This is due to the increase in fabric layers in the seam area influencing seam stiffness; moreover, there is a correlation between the number of stitch rows and the enhancement in the seam stiffness value.(24), (25), (37), (38)

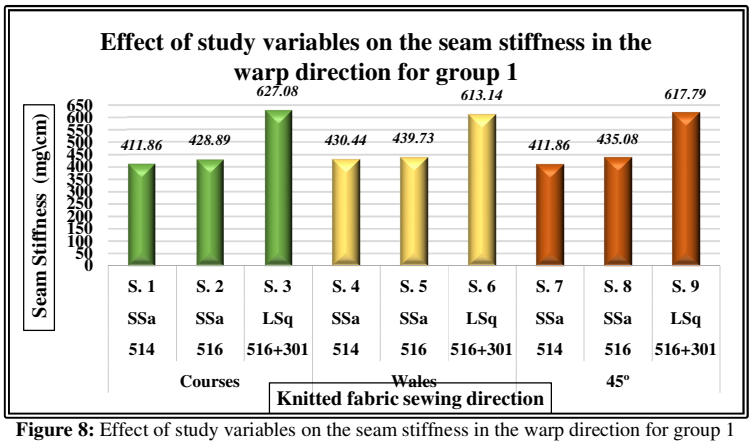


Figure 8: Effect of study variables on the seam stiffness in the warp direction for group 1

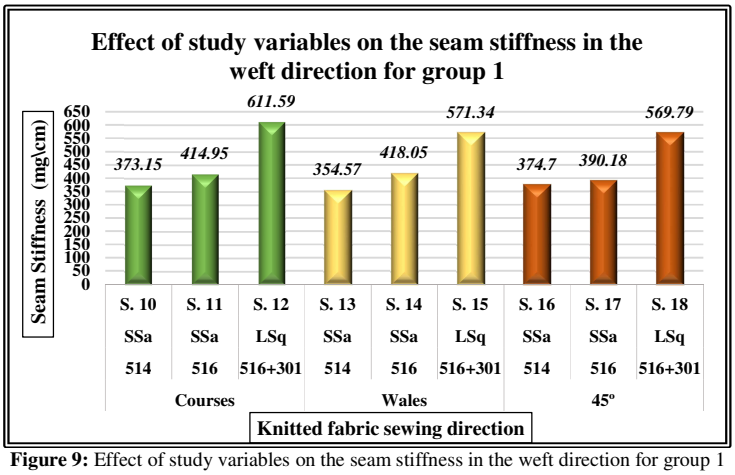


Figure 9: Effect of study variables on the seam stiffness in the weft direction for group 1

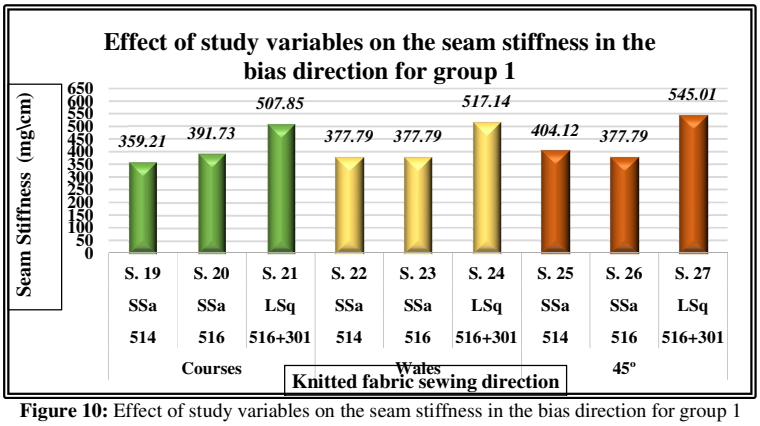


Figure 10: Effect of study variables on the seam stiffness in the bias direction for group 1

3.1.2. The effect of Study factors on seam pucker for group 1

It is observed from Table 5 and Figures 11, 12, and 13 that when the knitted fabric is in the direction of courses, the seam pucker resistance values are close for all sewn samples across all sewing directions of the broadcloth fabric. Furthermore, it is evident that the LSq seam attained the most elevated pucker resistance value when the broadcloth fabric is in the bias direction. This can be attributed to the inherent high elasticity of the tuck stitch in the course direction, coupled with the broadcloth fabric's significant elasticity in the bias direction[39] When these fabrics are stitched together using the LSq seam, which is characterized by its stiffness, this results in increasing the cohesion of the fabric and reducing deformation in the sewing area. Consequently, this leads to better shape for the consistency of the stitch, thereby augmenting the pucker resistance. (25)

It is also notable from Table 5 and Figures 11, 12, and 13 that when sewing the knitted fabric in the wales direction, the seam pucker resistance values are at high levels for all samples across all sewing directions of the broadcloth fabric, and the SSa seam exhibited the highest value of pucker resistance in all sewing directions of the broadcloth fabric. This can be attributed to the characteristics of the tuck stitch in the knitted fabric, which restricts the length in the wales direction; such properties are consistent with the features of the SSa seam, thereby resulting in the superior pucker resistance observed in the samples constructed with it.

Table 5 and Figures 11, 12, and 13 also indicate that when the knitted fabric is at an angle of 45°, the seam pucker resistance values are close at all samples in all sewing directions of the broadcloth fabric. It is also observed that the samples with the bias direction are superior in pucker resistance compared to other sewing directions. This may be due to the compatibility of the elasticity in the bias direction with the overall elasticity of the knitted fabric. As the disparity in the elasticity between two layers of the fabric, seam puckering may manifest in the layer exhibiting an increase in elasticity.

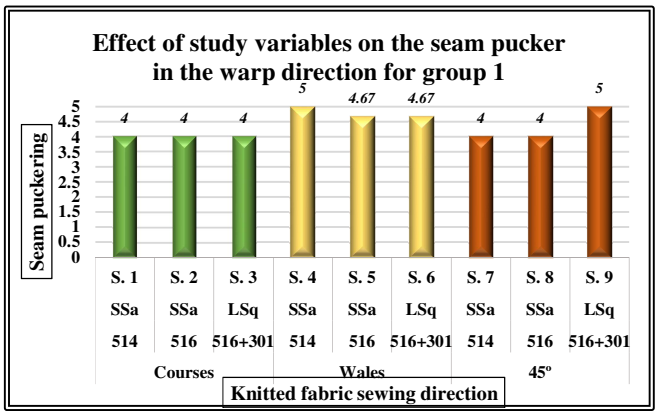


Figure 11: Effect of study variables on the seam pucker in the warp direction for group 1

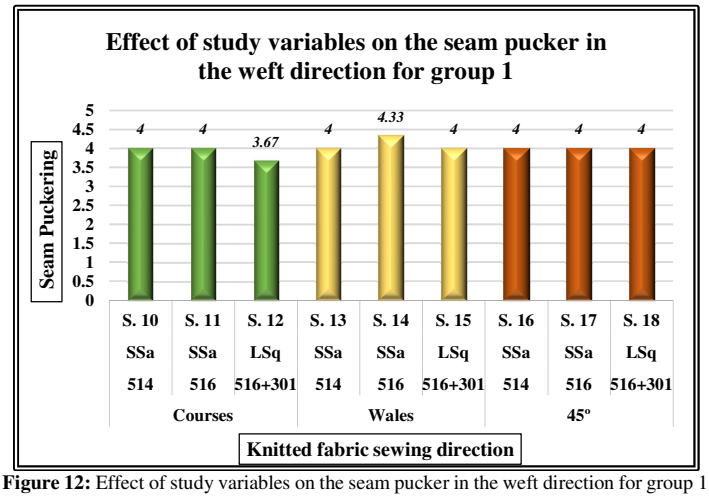


Figure 12: Effect of study variables on the seam pucker in the weft direction for group 1

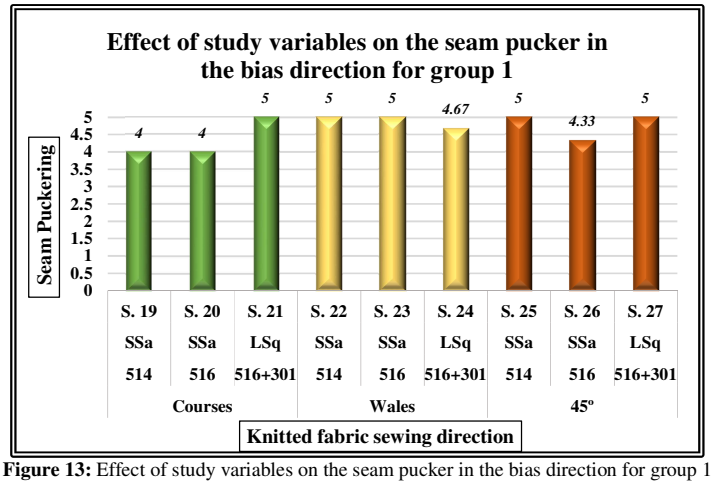


Figure 13: Effect of study variables on the seam pucker in the bias direction for group 1

3.1.3. The effect of Study factors on seam appearance for group 1

Table 5 and Figures 14, 15, and 16 demonstrate that when knitted fabric is sewing along the course direction, the LSq seam exhibits the highest value of seam appearance when the broadcloth fabric is in the direction of warp or bias, while the SSa seam is superior when the broadcloth fabric is in the direction of weft. Moreover, when knitted fabric is along thewales direction, the SSa seam achieves the highest value of seam appearance when the broadcloth fabric is in the direction of warp and bias, while in the direction of weft the LSq seam is superior to it. Additionally, when the knitted fabric is at an angle of 45°, the LSq seam achieves the highest value of seam appearance in all directions of the broadcloth fabric.

This is because the increase of stitch rows and fabric layers in the seam gives a better appearance, especially with elastic fabrics, as the appearance values were generally better with the use of the LSq seam (24).

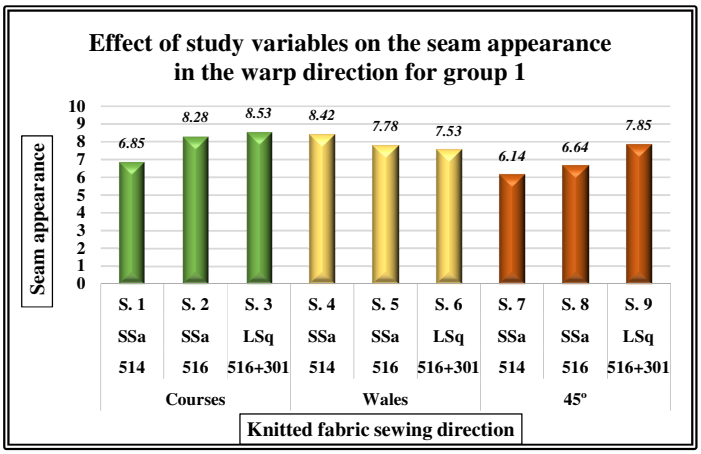


Figure 14: Effect of study variables on the seam appearance in the warp direction for group 1

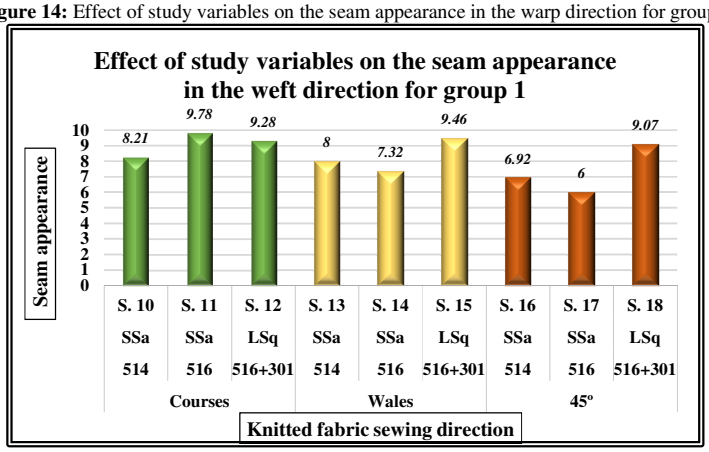


Figure 15: Effect of study variables on the seam appearance in the weft direction for group 1

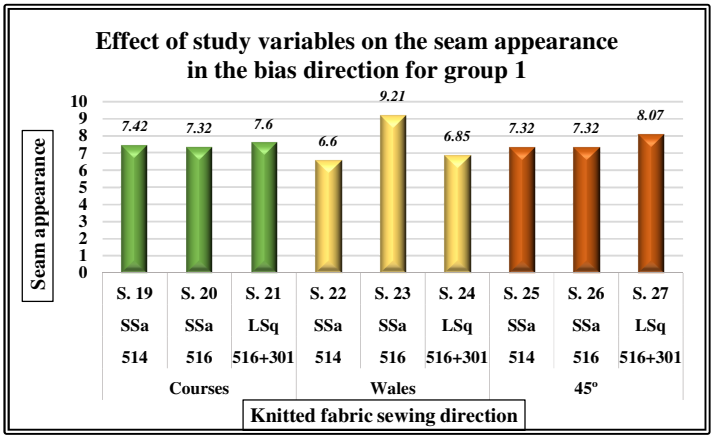


Figure 16: Effect of study variables on the seam appearance in the bias direction for group 1

3.1.4. The ONE WAY ANOVA of the study variables effect on the sewing properties for group 1 samples

Table 6 shows the results of the statistical analysis (ONE WAY ANOVA) to clarify the effect of the study variables on the sewing properties for group 1 samples. ANOVA analysis for the first group results showed that the sewing direction of knitted and broadcloth fabrics had a significant effect on the seam pucker and had no significant effect on the stiffness and appearance of seams, while both the stitch and seam type had a significant effect on the seam stiffness and had no significant effect on the puckering and appearance of seams for the first group samples.

Table 6: The ONE-WAYANOVA results of group 1

Parameters	P-value		
	Seam Stiffness	Seam Pucker	Seam appearance
Woven fabric sewing direction	0.364	0.004**	0.257
Knitted fabric sewing direction	0.997	0.048*	0.158
Seam & Stitch type	0.000**	0.701	0.147

** Significant at thep-value 0.01 .
* Significant at the p-value 0.05.

3.1.5. Relative Value and Quality Coefficient for group 1 samples

Table 7 shows the relative values and quality coefficients of the sewing properties of the first group samples. It is evident from this table that sample 23 (broadcloth fabric in the warp direction, knitted fabric in the wales direction, 516 stitch, SSa seam) exhibits the highest value of quality coefficient of 95.32%, and sample 3 (broadcloth fabric in the warp direction, knitted fabric in the courses direction, 516+301 stitch, LSq seam) is the lowest value with a quality coefficient of 73.95%. The following graphs illustrate this.

Table 7: Relative value and quality coefficient for the sewing properties results of group 1

Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type	Seam Stiffness (%)	Seam Pucker (%)	Seam appearance (%)	Quality coefficient (%)	Ranking of quality coefficient
s1	Warp	Courses	SSa 514	86.09	80.00	68.50	78.20	19
s2			SSa 516	82.67	80.00	82.80	81.82	13
s3			LSq 516 + 301 top stitch	56.54	80.00	85.30	73.95	27
s4		Wales	SSa 514	82.37	100.00	84.20	88.86	2
s5			SSa 516	80.63	93.40	77.80	83.94	10
s6			LSq 516 + 301 top stitch	57.83	93.40	75.30	75.51	25
s7		45○	SSa 514	86.09	80.00	61.40	75.83	24
s8			SSa 516	81.50	80.00	66.40	75.97	23
s9			LSq 516 + 301 top stitch	57.39	100.00	78.50	78.63	18
s10	Weft	Courses	SSa 514	95.02	80.00	82.10	85.71	7
s11			SSa 516	85.45	80.00	97.80	87.75	3
s12			LSq 516 + 301 top stitch	57.98	73.40	92.80	74.73	26
s13		Wales	SSa 514	100.00	80.00	80.00	86.67	5
s14			SSa 516	84.82	86.60	73.20	81.54	14
s15			LSq 516 + 301 top stitch	62.06	80.00	94.60	78.89	17
s16		45○	SSa 514	94.63	80.00	69.20	81.28	15
s17			SSa 516	90.87	80.00	60.00	76.96	21
s18			LSq 516 + 301 top stitch	62.23	80.00	90.70	77.64	20
s19	Bias	Courses	SSa 514	98.71	80.00	74.20	84.30	9
s20			SSa 516	90.51	80.00	73.20	81.24	16
s21			LSq 516 + 301 top stitch	69.82	100.00	76.00	81.94	11
s22		Wales	SSa 514	93.85	100.00	66.00	86.62	6
s23			SSa 516	93.85	100.00	92.10	95.32	1
s24			LSq 516 + 301 top stitch	68.56	93.40	68.50	76.82	22
s25		45○	SSa 514	87.74	100.00	73.20	86.98	4
s26			SSa 516	93.85	86.60	73.20	84.55	8
s27			LSq 516 + 301 top stitch	65.06	100.00	80.70	81.92	12

The highest value of the quality coefficient.
The lowest value of the quality coefficient.

Figure 17 indicates that when sewing the broadcloth fabric in the warp direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it

is imperative to employ the 514 stitch and the SSa seam. Furthermore, when sewing it with the knitted fabric at a 45° angle, it is essential to utilize the 516 + the 301 stitches and the LSq seam, as they exhibit the highest quality coefficient for all sewing properties.

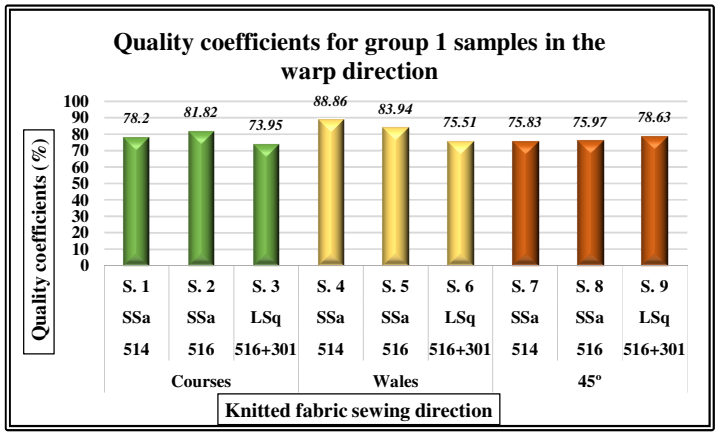


Figure 17: Quality coefficients for the frist group samples (in the warp direction)

Figure 18 demonstrates that during the process of sewing broadcloth fabric in the weft direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

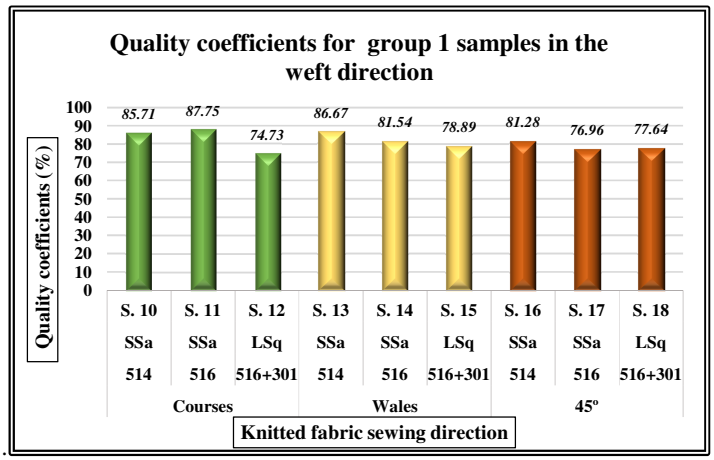


Figure 18: Quality coefficients for the frist group samples (in the weft direction)

Figure 19 shows that during sewing the broadcloth fabric in the bias direction with the knitted fabric in both the course and 45° angle directions, it is essential to utilize the 514 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it is imperative to employ the 516 stitch and the SSa seam.

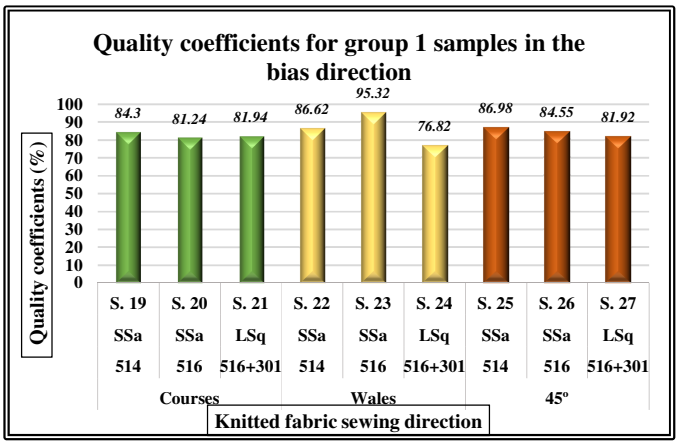


Figure 19: Quality coefficients for the frist group samples (in the bias direction)

3.2. The effect of study factors on sewing properties for the broadcloth fabric sewn with the second knitting structure (group 2)

The findings of the sewing properties tests for group 2 (the broadcloth fabric sewn with the second knitting structure) are shown in Table 8.

Table 8: Results of seam properties tests for the study samples (group 2)

Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type	Seam Stiffness mg\cm	Seam Pucker	Seam appearance
s28	Warp	Courses	SSa 514	470.75	4.00	6.00
s29			SSa 516	482.60	4.00	6.71
s30			LSq 516 + 301 top stitch	663.79	4.33	7.14
s31		Wales	SSa 514	496.15	4.67	6.42
s32			SSa 516	518.16	4.00	6.71
s33			LSq 516 + 301 top stitch	683.26	4.00	8.60
s34		45°	SSa 514	443.65	4.00	6.85
s35			SSa 516	482.60	4.00	6.21
s36			LSq 516 + 301 top stitch	672.25	4.00	7.21
s37	Weft	Courses	SSa 514	396.24	4.00	7.42
s38			SSa 516	447.04	4.00	7.67
s39			LSq 516 + 301 top stitch	631.61	4.00	7.85
s40		Wales	SSa 514	472.44	4.00	7.67
s41			SSa 516	480.91	4.33	7.60
s42			LSq 516 + 301 top stitch	611.29	4.00	7.46
s43		45°	SSa 514	419.95	4.00	6.14
s44			SSa 516	453.81	3.00	7.28
s45			LSq 516 + 301 top stitch	631.61	4.00	6.53
s46	Bias	Courses	SSa 514	389.47	4.33	8.00
s47			SSa 516	389.47	4.33	8.32
s48			LSq 516 + 301 top stitch	568.96	4.67	8.67
s49		Wales	SSa 514	428.41	5.00	9.07
s50			SSa 516	475.83	4.00	8.28
s51			LSq 516 + 301 top stitch	568.96	5.00	8.67
s52		45°	SSa 514	423.33	4.67	6.71
s53			SSa 516	472.44	4.00	8.60
s54			LSq 516 + 301 top stitch	579.12	5.00	7.42

3.2.1. The effect of Study factors on seam stiffness for group 2

Table 8 and Figures 20, 21, and 22 clearly indicate that the LSq seam exhibited the highest seam stiffness in all sewing directions of broadcloth and knitted fabrics. This can be attributed to the increase in fabric layers and stitch density in the seam area, which influences the seam stiffness(29),(30),(37),(38).

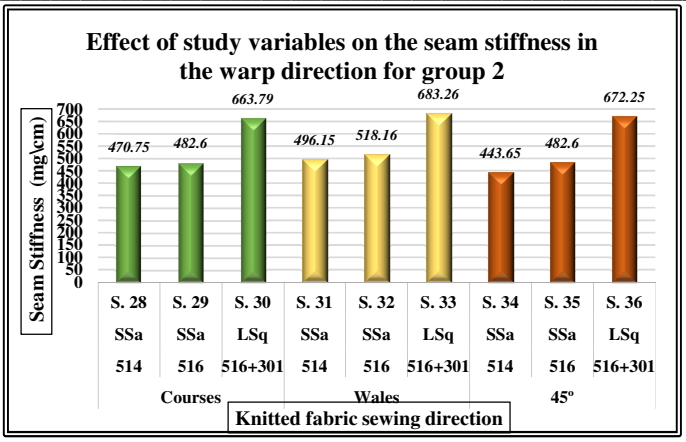


Figure 20: Effect of study variables on the seam stiffness in the warp direction for group 2

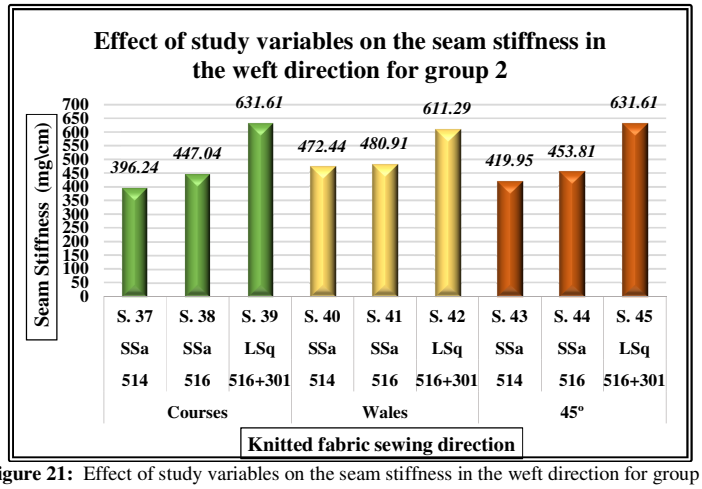


Figure 21: Effect of study variables on the seam stiffness in the weft direction for group 2

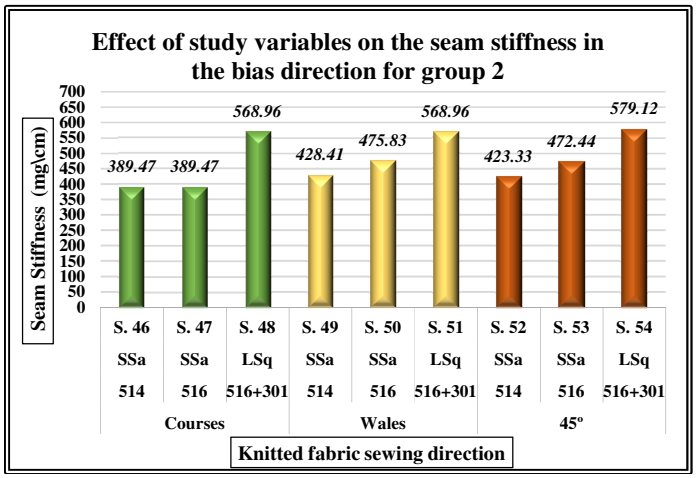


Figure 22: Effect of study variables on the seam stiffness in the bias direction for group 2

3.2.2. The effect of Study factors on seam pucker for group 2

Table 8 and Figures 23, 24, and 25 reveal that when the knitted fabric is in the course direction, the seam pucker resistance values are high for all sewn samples across all sewing directions of the broadcloth fabric. Notably, the LSq seam demonstrates the highest pucker resistance when the broadcloth fabric is in the bias direction. As indicated in Table 8 and Figures 23, 24, and 25, when sewing the knitted fabric in the wales direction, the seam pucker resistance values are at high

levels for all samples across all sewing directions of the broadcloth fabric, and the SSa seam exhibited the highest value of pucker resistance in all sewing directions of the broadcloth fabric.

Notably, when sewing the knitted fabric at an angle of 45°, the seam pucker resistance values are close at all samples in all sewing directions of the broadcloth fabric. It is also observed that when the direction of the broadcloth fabric is on the bias, the pucker resistance is superior compared to other sewing directions.

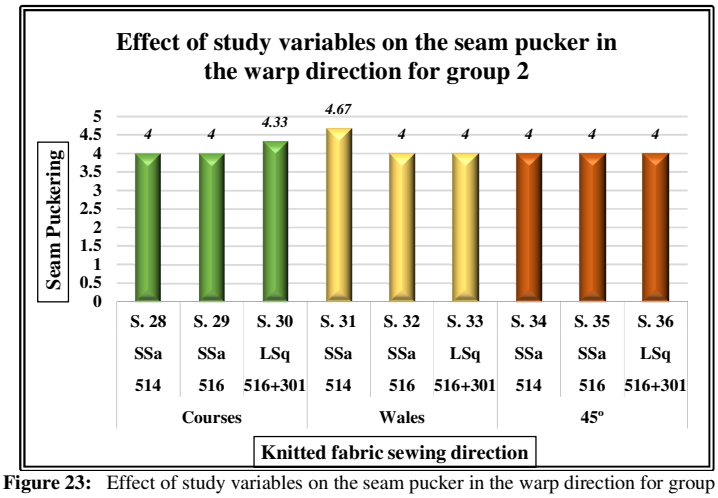


Figure 23: Effect of study variables on the seam pucker in the warp direction for group 2

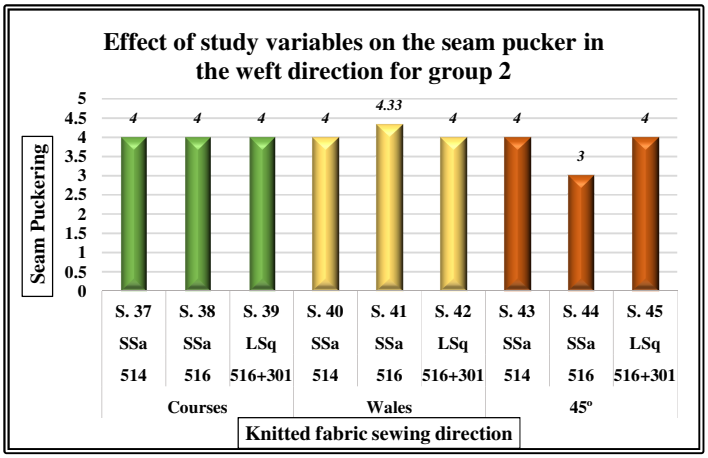


Figure 24: Effect of study variables on the seam pucker in the weft direction for group 2

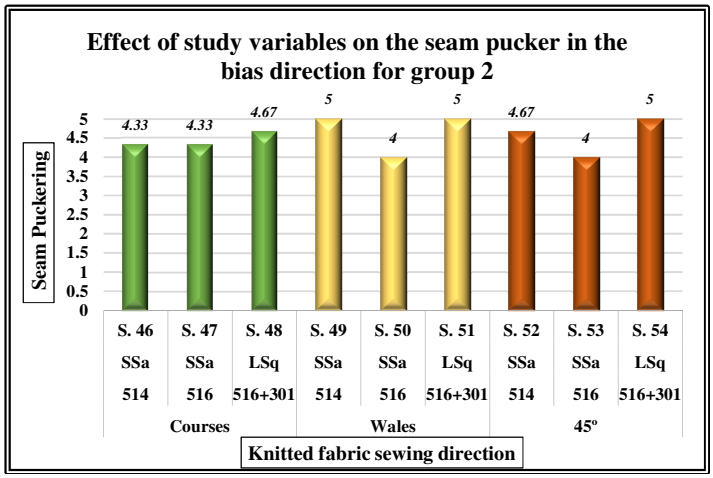


Figure 25: Effect of study variables on the seam pucker in the bias direction for group 2

3.2.3. The effect of Study factors on seam appearance for group 2

Table 8 and Figures 26, 27, and 28 indicate that when the knitted fabric is sewing along the course, the LSq seam exhibits the highest value of seam appearance when the broadcloth fabric is in all sewing directions. Moreover, when knitted fabric is along the wales direction or at an angle of 45°, the SSa seam achieves the highest value of seam appearance when the sewing of the broadcloth fabric is in the direction of weft and bias, while in the direction of warp the LSq seam is superior to it. It was found that stitch rows and fabric layers enhance the seam appearance, particularly with elastic fabrics, as the appearance values were generally better with the LSqseam (25).

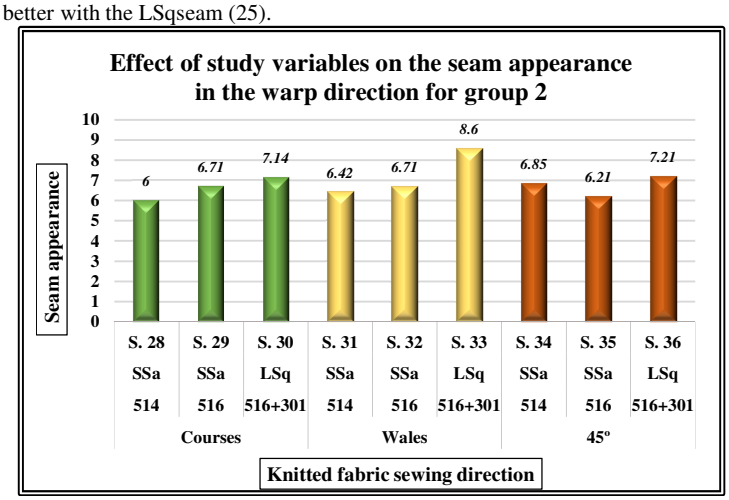


Figure 26: Effect of study variables on the seam appearance in the warp direction for group 2

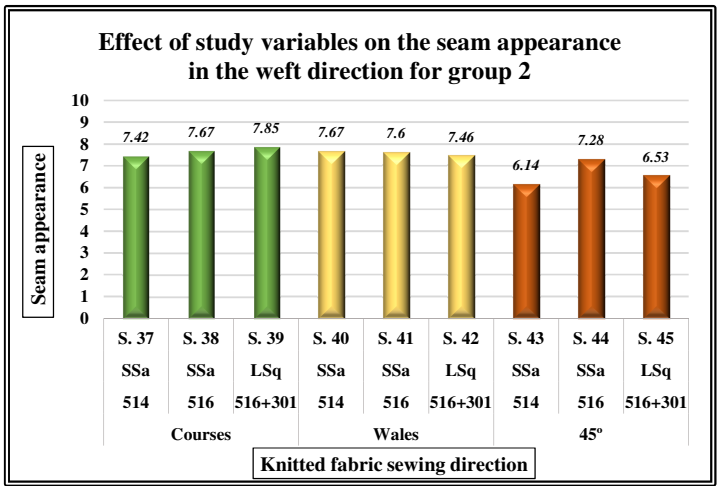


Figure 27: Effect of study variables on the seam appearance in the weft direction for group 2

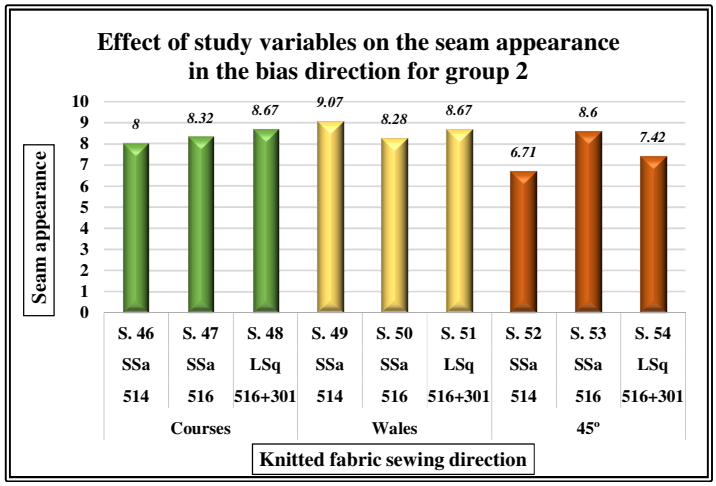


Figure 28: Effect of study variables on the seam appearance in the bias direction for group 2

3.2.4. The ONE WAY ANOVA of the study variables effect on the sewing properties for group 2 samples

Table 9 shows the results of the statistical analysis (ONE WAY ANOVA) to clarify the effect of the study variables on the sewing properties for group 2 samples.

ANOVA analysis for the second group results showed that the sewing direction of broadcloth fabric had a significant effect on both the seam pucker and appearance and had no significant effect on the seam stiffness, while both the stitch and seam type had a significant effect on the seam stiffness and had no significant effect on the puckering and appearance of seams. Moreover, the sewing direction of knitted fabric had no significant effect on all sewing properties.

Table 9: The ONE-WAYANOVA results of group2

Parameters	P-value		
	Seam Stiffness	Seam Pucker	Seam appearance
Woven fabric sewing direction	0.285	0.002**	0.002**
Knitted fabric sewing direction	0.761	0.451	0.117
Seam & Stitch type	0.000**	0.125	0.372

** significant at the 0.01 level.

3.2.5. Relative value and Quality coefficient for group 2 samples

Table 10 shows the relative values and quality coefficients of the sewing properties of the second group samples. It is clear from this table that sample 49 (broadcloth fabric in the warp direction, knitted fabric in the wales direction, 514 stitch, SSa seam) exhibits the highest value of quality coefficient of 93.87, and sample 45 (broadcloth fabric in the weft direction, knitted fabric at a 45° angle, the LSq seam, and the 516 stitch + the 301 top stitch), is the lowest value with a quality coefficient of 68.99%. The following graphs illustrate this.

Table 10: Relative value and quality coefficient for the sewing properties results of group 2

Sample number	Woven fabric sewing direction	Knitted fabric sewing direction	Seam & Stitch type	Seam Stiffness (%)	Seam Pucker (%)	Seam appearance (%)	Quality coefficient (%)	Ranking of quality coefficient
s28	Warp	Courses	SSa 514	82.73	80.00	60.00	74.24	21
s29			SSa 516	80.70	80.00	67.10	75.93	18
s30			LSq 516 + 301 top stitch	85.71	86.60	71.40	81.24	11
s31		Wales	SSa 514	78.50	93.40	64.20	78.70	16
s32			SSa 516	75.16	80.00	67.10	74.09	22
s33			LSq 516 + 301 top stitch	57.00	80.00	86.00	74.33	19
s34		45°	SSa 514	87.79	80.00	68.50	78.76	15
s35			SSa 516	80.70	80.00	62.10	74.27	20
s36			LSq 516 + 301 top stitch	57.94	80.00	72.10	70.01	26
s37	Weft	Courses	SSa 514	98.29	80.00	74.20	84.16	6
s38			SSa 516	87.12	80.00	76.70	81.27	10
s39			LSq 516 + 301 top stitch	61.66	80.00	78.50	73.39	23
s40		Wales	SSa 514	82.44	80.00	76.70	79.71	14
s41			SSa 516	80.99	86.60	76.00	81.20	12
s42			LSq 516 + 301 top stitch	63.71	80.00	74.60	72.77	25
s43		45°	SSa 514	92.74	80.00	61.40	78.05	17
s44			SSa 516	85.82	60.00	72.80	72.87	24
s45			LSq 516 + 301 top stitch	61.66	80.00	65.30	68.99	27
s46	Bias	Courses	SSa 514	100.00	86.60	80.00	88.87	3
s47			SSa 516	100.00	86.60	83.20	89.93	2
s48			LSq 516 + 301 top stitch	68.45	93.40	86.70	82.85	7
s49		Wales	SSa 514	90.91	100.00	90.70	93.87	1
s50			SSa 516	81.85	80.00	82.80	81.55	9
s51			LSq 516 + 301 top stitch	68.45	100.00	86.70	85.05	4
s52		45°	SSa 514	92.00	93.40	67.10	84.17	5
s53			SSa 516	82.44	80.00	86.00	82.81	8
s54			LSq 516 + 301 top stitch	67.25	100.00	74.20	80.48	13

The highest value of the quality coefficient.
The lowest value of the quality coefficient.

Figure 29 demonstrates that when sewing the broadcloth fabric in the warp direction with the knitted fabric in the course direction, it is essential to utilize the 516 + the 301 stitches and the LSq seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

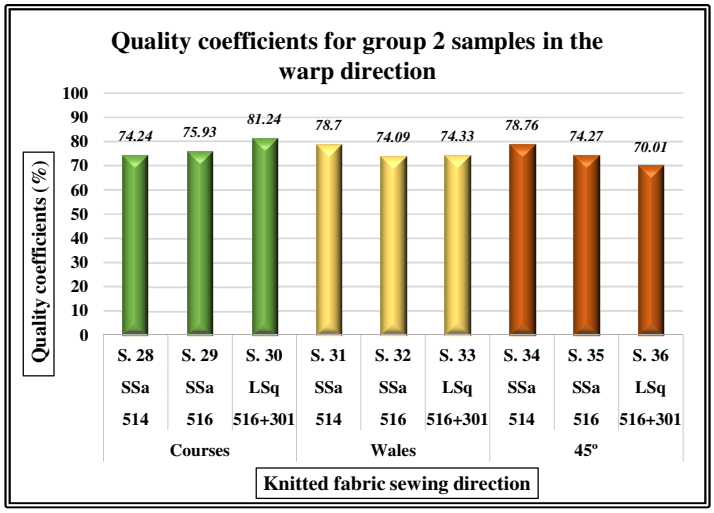


Figure 29: Quality coefficients for the second group samples (in the warp direction)

Figure 30 indicates that during the process of sewing broadcloth fabric in the weft direction with the knitted fabric in both the course and 45° angle directions, it is necessary to use the 514 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it is imperative to employ the 516 stitch and the SSa seam.

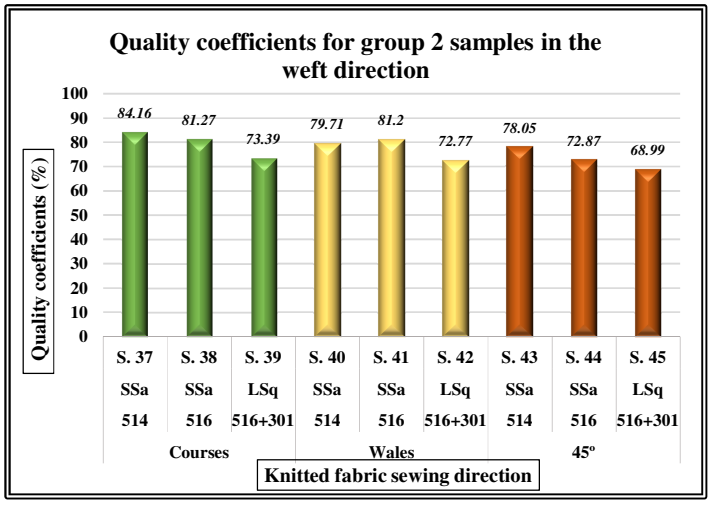


Figure 30: Quality coefficients for the second group samples (in the weft direction)

Figure 31 shows that during sewing the broadcloth fabric in the bias direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

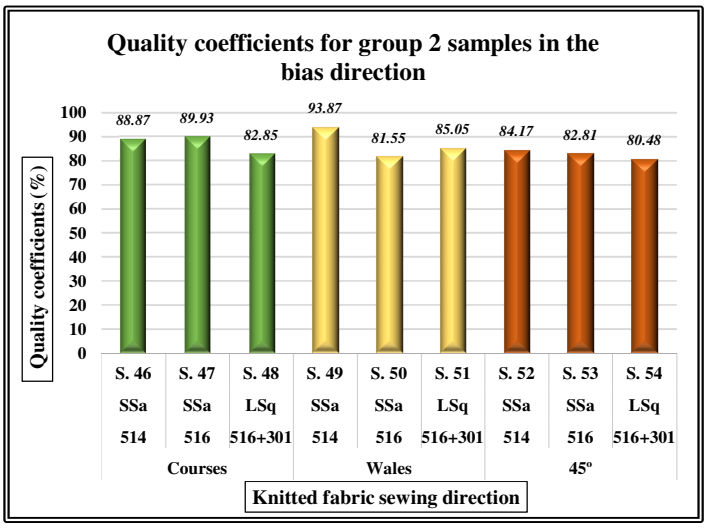


Figure 31: Quality coefficients for the frist group samples (in the bias direction)

3. Conclusions

After referring to previous studies and reviewing the study results, it is clear that most studies were concerned with studying the sewing variables of knitted fabrics or high-gauge knitted fabrics sewn with some other fabrics, so this study aimed to determine the sewing variables of low-gauge knitted fabrics with woven fabrics, especially thick ones such as broadcloth fabric.

The ANOVA analysis for the sewing properties of the first knitted fabric structure sewn with broadcloth fabric (group 1) showed that the sewing direction of knitted and broadcloth fabrics had a significant effect on the seam pucker and had no significant effect on the stiffness and appearance of seams, while both the stitch and seam type had a significant effect on the seam stiffness and had no significant effect on the puckering and appearance of seams for the first group samples.

The ANOVA analysis for the sewing properties of the second knitted fabric structure sewn with broadcloth fabric (group 2) showed that the sewing direction of broadcloth fabric had a significant effect on both the seam pucker and appearance and had no significant effect on the seam stiffness, while both the stitch and seam type had a significant effect on the seam stiffness and had no significant effect on the puckering and appearance of seams. Moreover, the sewing direction of knitted fabric had no significant effect on all sewing properties.

A series of recommendations and suggestions were provided during the sewing of low-gauge knitted materials with broadcloth to enhance sewing performance and quality, benefiting the ready-made garments industry. These recommendations were as follows:

- Sewing the broadcloth fabric with the first knitted fabric:

When sewing the broadcloth fabric in the warp direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it is imperative to employ the 514 stitch and the SSa seam. Furthermore, when sewing it with the knitted fabric at a 45° angle, it is essential to utilize the 516 + the 301 stitches.

Furthermore, when sewing broadcloth fabric in the weft direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

It was also indicated that when sewing the broadcloth fabric in the bias direction with the knitted fabric in both the course and 45° angle directions, it is essential to utilize the 514 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it is imperative to employ the 516 stitch and the SSa seam.

- Sewing the broadcloth fabric with the second knitted fabric:

When sewing the broadcloth fabric in the warp direction with the knitted fabric in the course direction, it is essential to utilize the 516 + the 301 stitches and the LSq seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

Moreover, when sewing broadcloth fabric in the weft direction with the knitted fabric in both the course and 45° angle directions, it is necessary to use the 514 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in the wale direction, it is imperative to employ the 516 stitch and the SSa seam.

It was also noted that when sewing the broadcloth fabric in the bias direction with the knitted fabric in the course direction, it is necessary to use the 516 stitch and the SSa seam. Whereas when sewing it with the knitted fabric in both the wale and 45° angle directions, it is imperative to employ the 514 stitch and the SSa seam.

4. Conflicts of interest

No conflicts need to be disclosed.

5. Formatting of funding sources

This research is self-funded by the researchers and does not receive any external funding.

6. Acknowledgments

The authors extend their gratitude to all individuals who contributed to or assisted with this study.

7. References

[1] Maity, S., Rana, S., Pandit, P., & Singha, K. (Eds.). (2021). Advanced Knitting Technology. Woodhead Publishing.
[2] Islam, M. A., & Haque, A. N. M. A. (2014). Selection of suitable machine gauge by considering the GSM, shrinkage and spirality of single jersey knit fabric. Research Journal of Science and IT Management, 3(3), 50-55 (1).
[3] Khalaf, A., & Al-Qatry, D. (2024). The Effect of Embroidery Machines' Variables with Decorative Cords on the Properties of Knitted Fabrics. *Egyptian Journal of Chemistry*, *67*(13), 1665-1674. doi: 10.21608/ejchem.2024.301403.9948
[4] Salman, D. M., El-Aziz, A., & Ismail, M. Y. (2024). Effect of an eco-friendly treatment on wetting resistance of knitted cellulosic fabrics. Egyptian Journal of Chemistry, 67(1), 89-99.
[5] Abo El Naga, H. T. E. S., & Abd El-Aziz, M. Y. I. (2024). Eco-friendly materials knitting by different yarn ply for high-performance garments. Research Journal of Textile and Apparel, 28(4), 1051-1065
[6] Morgham, A. E. H., El-Aziz, A., Ismail, M. Y., El-Fallal, A. A., & Abo El Naga, H. T. E. S. (2023). Utilizing Sustainable KOMBUCHA SCOBY Laminated with Knitted and Woven Cellulosic Fabrics for Anti-microbial Headboard. Egyptian Journal of Chemistry, 66(13), 2101-2117.
[7] Shawky, M. M., El-Gabry, L. K., & Abd El-Aziz, M. Y. I. (2024). Analytical Study of Comfortability, Dyeability, and UPF of Sports Wear Interlock Fabrics. Egyptian Journal of Chemistry, 67(13), 259-285.
[8] Rezk, E., Elwan, N., Elkelany, M., & Khalaf, A. (2023). Design and Heat Setting of 3D-Weft Jacquard Knitted Effect on some properties related to Thermal Insulation. Egyptian Journal of Chemistry, 66(13), 1247-1258. doi: 10.21608/ejchem.2023.203586.7809
[9] Elgory, Z., seddik, K., Yahia, M., & El-Gabry, L. (2020). The Enhancement of the Functional Properties of Polyester Microfiber Single Jersey Using Some Nano-materials. Egyptian Journal of Chemistry, 63(1), 145-154. doi: 10.21608/ejchem.2019.2868.1804
[10] Elgory, Z. M., & Elghandour, N. (2024). Study the weft circular knitted fabrics behaviour with Repeated laundering cycles. Egyptian Journal of Chemistry, 67(13), 387-392.
[11] Darwish, H., Elgory, Z., El-Gabry, L., & Geiheini, A. (2020). Eco-friendly Treatment on Rib Knitting Fabrics Part 2. Effect of the Treatments with natural compounds on Comfort Properties. Egyptian Journal of Chemistry, 63(8), 3159-3165.doi:10.21608/ejchem.2020.18540.217
[12] Khalaf, A. M. I. Benefit from some weft knitted stitches in producing double face clothes،2019, Faculty of Specific Education, Mansoura University, Annual Conference (14th Arab - 11th International), Qualitative Education and Developing Competitiveness and Informatics for Scientific Research in Egypt and the Arab World (Future Visions)
[13] Spencer, D. J. (2001). Knitting technology: a comprehensive handbook and practical guide (Vol. 16). CRC press
[14] Gabriel, N. (2024). Construction Knitting: Knitwear Design with Geometric Shapes. Bloomsbury Publishing.
[15] Uyanik, S., & Topalbekiroglu, M. (2017). The effect of knit structures with tuck stitches on fabric properties and pilling resistance. The Journal of The Textile Institute, 108(9), 1584–1589. https://doi.org/10.1080/00405000.2016.1269394
[16] Al-Sawy, S.M.M.A. Effect of some Sewing Variables on the Seam Properties for the Baize Fabrics,(2017), International Design Journal, 7(3e), 251-256. https://doi.org/10.21608/IDJ.2017.87350
[17] Salman,A. A & Hamoda,R. M.& Al sheshtawy, A. A. (2016) Culture textile Dictionary.
[18] Shehata, Sh., M. & Abdelrahman, K. , A. , (2019), Effect of different textile structures on Modern sewing seam, Journal of architecture, arts, and humanistic sciences,17, 285- 301.
[19] Slama, H., H. A. Rezk, E.; M. I. Elkelany, M.; S. E. A. Abdelaal, H.; and A. M. Madian, F. (2023) "The Effectiveness of a Suggested E-learning Program Using Keeler's Strategy to Build a Basic Model for a Girl's Dress in an Innovative Way," Information Sciences Letters: Vol. 12: Iss. 8 PP-.
[20] Nasef, S. M. A., Alsakhawy, S. A. E., Madian, F. A. M., Rezk, E. H. A., Elkelany, M. M. I., Abdeen, M. E. M., & Slama, H. A. (2023). An Artistic Vision of Using Polyurethane Foam in Drapping Fictional Costumes Designs to Achieve Sustainable Development.
[21] Slama, H., Abodief, H., Nasef, S. A., Hegazy, A., Salh, H., & Mohsen, A. (2024). Using Shabby Chic Style in Contemporary Clothing Accessories to Achieve the Principles of Sustainable Development.
[22] Al-Samahi, & Mahmoud Muhammad Mustafa. (2022). (Clothing terms in Islamic civilization through the book of genealogies by Al-Sam'ani (d. 562 AH/1167 AD). Journal of the Faculty of Arabic Language in Assiut, 41(3), 2923-3010.
[23] Al Abry, KH. H. (2024), The Muhtasib's Dress. An Analytical Study. Journal of the Faculty of Islamic and Arabic Studies for Girls, Al-Azhar University, Kafr El-Sheikh Branch, 8(1), 359-388.
[24] Elghandour, N., Al gory, Z., El-Gabry, L., & Abd El-Aziz, M. (2022). Study the Seam Stitch of Silk Garment Properties Dyed with Natural dyes. Journal of Textiles, Coloration and Polymer Science, 19(2), 339-347. doi: 10.21608/jtcps.2022.175736.1142
[25] Karthik, T., Ganesan, P., & Gopalakrishnan, D. (2016). Apparel manufacturing technology. CRC Press.
[26] Admassu, Y., Edae, A., Getahun, G., Senthil Kumar, S., Saravanan, K., & Sakthivel, S. (2022). Experimental analysis on the effect of fabric structures and seam performance characteristics of weft knitted cotton apparels. Journal of Engineered Fibers and Fabrics, 17, 15589250221113479.
[27] Al-Alfi, & Abdul Majeed Hassan Abdul Majeed. (2024). The influence of the Persian language on the names of Arabic clothes. Journal of the Faculty of Arabic Language in Itay Al-Baroud, 37(2), 901-976
[28] Nayak, R., & Padhye, R. (Eds.). (2015). Garment manufacturing technology. Elsevier.

[29] Nasr Eldeen, N., (2018), Sewing and Embroidering of Knitted Garments by Adding Artificial Leather, Journal of architecture, arts, and humanistic sciences, 12, 634- 648.
[30] Al-Qatry, D., (2019), Standards for sewing interlock fabrics produced from viscose fibers mixed with polyester and spandex, Al-Mağallah Al-ʿilmiyyaï Li Kulliyyaï Al-Tarbiyyaï Al-Nawiyyat, Gamiat Al-Munufiyya, Volume 6, part 1.
[31] Rabea, E. H.& Hashem, M., M, A. ., (2020), Study the most suitable quality link for the knitting of Lingerie fabrics 189-159. doi: 10.21608/jedu.2020.37471.1035
[32] Diab, W., A. & Al-Qatry, D. & Badr, A., A., & Ali, A., A. (2021). Effect of fabric properties knitted from Tencel and Tencel/Egyptian cotton blends with different fabric structure on fabric sewability, Journal of Arts & Applied Sciences (JAAS), 8(4), 47-57.
[33] ASTM D1776/D1776M-20 Standard Practice for Conditioning and Testing Textiles.
[34] ASTM D3776/D3776M-09a Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
[35] ASTM D3776/D3776M - 09 The American Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
[36] The specification AATCC Test Method (TM) 88B
[37] Yıldız, E. Z., & Pamuk, O. (2022). A novel method of identifying sewing damage in single jersey fabrics. International Journal of Clothing Science and Technology, 34(5), 782-794.
[38] Al-Qatry, D., Aborady, A., Elshiekh, R., Alnawawy, H., & Mohammed, K. (2025). Impact of Different Parameters on Sewing Performance of Denim Sewed with Organza. Egyptian Journal of Chemistry. doi: 10.21608/ejchem.2025.349908.11092
[39] Öztaş, H., & Gürarda, A. (2019). Investigation of the effects of different bias angles of stitching on seam performance of wool suits. Autex Research Journal, 19(4), 324-331.