Innovating New Weaving Structural Components to Create Woven Jacquard Sports Footwear Fabrics

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Abstract:
This study aims to Produce jacquard woven fabrics using innovative textile structures components adequate for woven sports footwear fabrics that compete with similar ones produced from knitted fabrics in terms of cost and physical and mechanical properties such as comfort and durability of the sports footwear. Hence, this study represents (4) samples produced from (Polyester filament, chenille P.E., chenille P.E. (micro flat), and polyester spun by using double weave wadding structure techniques depending on some different structural components such as weft density/inch, end density/inch and their sequences. The results of statistical analysis for correlation coefficients show that the different structural components of the woven jacquard sports footwear fabrics have a strong correlation that affects the functional performance properties such as tensile strength, elongation, pilling, friction resistance, and air permeability in addition to reducing the production cost, which reflects positively on the annual expenditure of foreign currency required to meet the market's need for sports footwear fabrics.

Keywords:
Weaving Structure; Woven Jacquard; Knitting Sports Footwear Fabrics

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Introduction:
Every day, individuals wear sports footwear, a vital and indispensable item. Sports footwear offers comfort to the wearer while safeguarding their feet from challenging conditions like cold, wet, and rugged surfaces. [Silva et al., 2007] [Murley and Landorf, 2012]. Footwear fabrics are a very important part of sports footwear; however, they directly affect durability and comfort. Two types of machines cover the Egyptian market for this kind of fabric; the first is circular jacquard knitting machines, which are not available in the Egyptian market, so foreign countries cover the market demand and cost the government a large budget from the foreign currency. The other one is the flat knit machine, which is a low production rate machine and can only cover some of the market demand for sports footwear fabric, so the materials produced on those machines are expensive. This study aims to produce jacquard woven fabrics using innovative textile structure components adequate for sports footwear fabrics to compete with similar ones produced from knitted fabrics in terms of cost and physical and mechanical properties, such as increasing the comfort and durability of the sports footwear.

Problem Statement:
Producing sports footwear fabrics on a flat knitting machine is very expensive and cannot cover all the market share from the sports footwear fabrics needed by the Egyptian market. Intentions to produce this kind of fabric on woven jacquard machines could be more profitable than flat knitting machines because of the higher speed of the woven jacquard machines, so the central question of this research is: Is there any new approach could be appropriate to produce sports footwear fabrics on jacquard machines, and giving them the appearance and characteristics of the knitted footwear fabrics?. However, this could reduce the total amount of foreign currency spent to save the total needed quantity of that product from the foreign countries.

Aims and objectives:
This research aims to build an innovative production method with the help of the textiles CAD/CAM systems and the superior facilities of the woven jacquard machines to help the sports footwear fabric designers build their own customers perspective products to reduce the cost of the sports footwear fabrics and increasing the total amount production of it.

Hypothesis:
1- Textiles CAD/CAM software, woven jacquard machines, and making use of the new materials and the innovative weaving structures could help in producing a new type of sports footwear fabrics that could be more profitable and more reliable than the knitted sports footwear fabrics produced on flat knitting machines.
2- Using the woven jacquard machines, a new approach methodology could significantly reduce the production cost of the sports footwear fabrics produced on flat-knit machines.

Methodology:

The research follows the statistical analysis experimental method.

1. Theoretical Framework:

1.1 Sports Footwear:

The primary function of the human foot is supporting weight. Based on the foot's anatomy and adaptability to individual differences, sports footwear must be crafted to meet the requirements of comfort, protection, and functionality [Chan, 2013]. The comfort of sports footwear is affected by various factors, including material properties, structural design, fit, weight, insoles, and the internal temperature of the footwear [Au, and Goonetilleke, 2007]. Knitted fabrics constitute a textile category that demonstrates suitability for producing sports footwear fabric. Due to the extensive product range given by diverse combinations of geometry, shape, yarns, and finishing techniques as in fig. (1) [Blage et al., 2011]. In addition, Sports footwear necessitates robust construction, dependable closures, and a prolonged lifetime that withstands deterioration in any environmental conditions [Wang, 2013].

Fig. 1. Flat-knitted upper of sports footwear [Ozdemir et al, 2020].

1.2 Structural composition factors of Sports footwear:

Compositional textile design results from design element's interaction, such as colour, texture, yarn patterns, and weaving structure controlling the fabric's qualities [Rowe, 2009] [Ahmed et al., 2022] [Mathur and Seyam, 2011] [Yoo and Barker, 2005]. Comfort is one of the required ones in the world's sports textiles. Several scientists have focused their work on sports footwear [Rajan et al., 2016]. The comfort of wearable products can be anticipated by considering factors such as weight, thickness, air permeability, and thermal resistance of the material. Furthermore, durability is associated with the product's lifetime, while comfort controls the material's performance and aesthetics. Consequently, optimal configuration and a better understanding of a multi-layered material's properties can serve unique purposes in sports footwear design and development and enhance wearers' thermal comfort [Nam, 2019] [Song, 2011].

1.3 Woven jacquard sports footwear:

Among the many types of textile fabrics, the jacquard fabric is highly graded due to its higher technological requirements in design and production and its often-intriguing Figure and coloured textures. These fabrics are available in various compositions and weights and serve various purposes [Watson and Grosicki, 1975]. Regarding weaving structures, the jacquard fabric can be categorised into four main types: single-layer, backed structure (weft-backed, warp-backed), double-layer, and multi-layer. Jacquard machines are used to weave fabrics with large designs of all kinds that could be completed. The flat knitted machines produce the others because of their ability to interlace hundreds of warp threads to create unique designs, while flat knitting machines have only one gauge. The advantages of jacquard materials heavily depend on their composition, yet they share several common characteristics. Jacquard fabrics are durable, stable, strong, and resilient. Wear- and wrinkle-resistant, pleasant to the touch, and boast decorative aesthetics, making them a preferred choice in various applications [Seyam, 2011].

1.4 Double weave:

This study holds significant importance in woven fabric production, particularly in creating two-layered fabric, commonly known as double fabric. The threads' movement between the layers allows complex patterns and surface textures [Shenton, 2014]. The Purpose of making double fabrics: To improve the fabric's thermal resistance value, improve the fabric's air permeability, and increase the appearance and hand feel of the fabric [Akter and Chowdhury, 2018].

1.5 Textile Materials in Sports footwear:

Textile materials have become increasingly important in the design and production of sports footwear due to their numerous benefits [Bullon et al, 2017]. Synthetic materials such as nylon and polyester became more common in sports footwear production [Staikos et al, 2006]. Polyester is known for its lightweight and durable nature. Its moisture-wicking and quick-drying properties, dimensional stability, and excellent wear resistance make it an excellent material for sports shoes, which provide a better fit and greater comfort for athletes [Ahmad et al, 2023] [Tambunan et al, 2022] [Özdil and Anand, 2014] [Mia et al., 2017].

1.6 Functional components in sports footwear:

Functional sports footwear typically consists of distinct sections, including the upper section, lining section, and reinforced pieces between the lining and upper. Sports footwear often has an insole, and almost every footwear has a loose in-sock or foot-bed as in (Fig.2) [Roy et al., 2023].

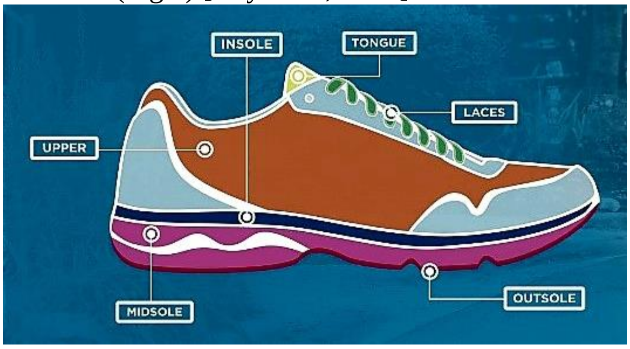


Fig. 2. Different components of sports footwear [Roy et al, 2023].

Materials and components in sports footwear have properties that ensure comfort, fit, protection, stability, and support. These materials and components can also maximize prolonged wear and retention of the shoe shape. These include the upper, which covers the top of the foot [Roy et al., 2023]. It acts as a protective and supportive layer, helping to keep the foot securely in place and facilitating proper movement during various physical activities [Zhiwen et al., 2016]. The upper is a crucial component influencing sports footwear's functional aspects and aesthetics [Nebo, 2005].

Indeed, textile properties are frequently employed in the upper of sports footwear, offering a range of benefits:

- Breathability: This characteristic allows air to flow freely in and out of footwear, which helps to regulate foot temperature and prevent sweating [Ning et al., 2022] [Duane, 2022].
- Flexibility: This flexibility facilitates better foot movement and range of motion during athletic activities [Yick and Tse, 2013].
- Durability: Helping to protect the foot from injuries or other impacts during sports activities [Nebo, 2005].
- Comfort: They provide comfort, ensuring the foot feels comfortable and cushioned during sports activities.

Each part of sports footwear is critical in ensuring optimal performance and comfort. The insole provides cushioning and support for the sole. The midsole serves as a shock absorber, and the outsole is the bottom layer that comes in direct contact with the ground and provides traction, stability, and durability. [Roy et al., 2023].

The materials and components of sports footwear increasingly meet the performance requirements, with more future-oriented technology and more functional characteristics. It seems that technology enables sport sports footwear to be designed and produced to meet the more specialized demands of an athlete [Nebo, 2005].

2. Experimental Work:

2.1. Creating sports footwear designs: [Salah and Eletreby, 2021]

All fabrics were designed on Nedgraphics CAD/CAM software according to the following steps:

2.1.1. Putting the design ideas for sports footwear fabrics:

This step has to be done with the aid of one of the most famous Textile CAD/CAM software (Nedgraphics - Texcell).

<u>The most common workflow usually follows the sequenced steps:</u>

1- Digitisation of croquis.
2- Colour reduction and cleaning.
3- Finishing design in step and repeat.
4- Assigning technical production information.

2.1.2. Graphic design preparation (Texcell):

A- Design input:

To open a file containing an existing image, which will be used to create the repeat for a new design. Alternatively, it could be executive by clicking the corresponding toolbar button or using the keyboard shortcut CTRL+O .Upon using the Open command, a typical dialogue window will open as follows:

B- Design cropping:

Reducing the design to just a selected area and working with it as a new design is the next step after inputting the design, and this could be applied by selecting the area of the design to be cropped, followed by using the cropping order from the transform menu.

C- Design resizing:

Resizing the design is a vital process, which could be applied to give the design the amended properties to be suitable for weaving, whereas the function of this process is to define the following properties:

- Pixel X number of warp ends/Repeat.
- Pixel Y number of weft yarns/Repeat.
- Size X Repeat width/ (Cm, mm, inch, or pixels).
- Size Y Repeat High/ (Cm, mm, inch, or pixels).
- Resolution X number of warp ends/Cm.
- Resolution Y number of weft yarns/Cm.

2.1.3. Weaving structures preparation (Weave editor):

This process is about creating the amended weaving structures, which will be used to create the specific needed fabrics. Figure (3) illustrates an example from the used structures (Double weave), which is produced on weave editor CAM software. However, figure (4) shows the simulation for the same structure.

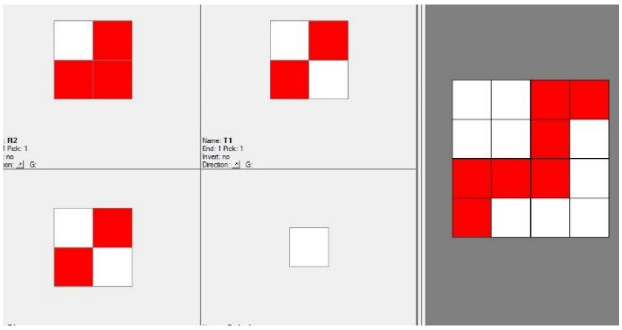


Fig. 3. Double weave structure

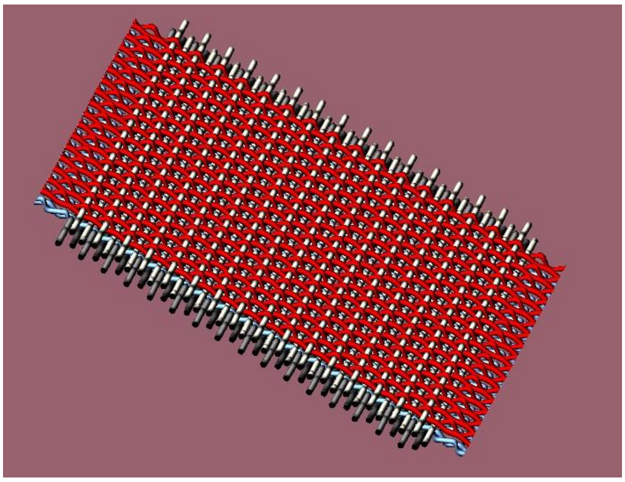


Fig. 4. Double weave simulation

2.1.4. Jacquard harness Preparation (Loom Editor):

The machine or the harness layout must be created before proceeding to the final step (product creator), whereas describing the map of the jacquard hooks and its capacity is essential information to create the amended fabric.

2.1.5. Executive Design preparation (product creator):

By reaching this stage, all the data and information had to be prepared and saved in the program archive as: Design, weaving structures, and harness system, whereas starting to produce the executive design has to be applicable according to the following procedures:

Design properties:

By selecting the new order from the file menu, the properties dialogue box will be opened automatically, asking to input the information needed to produce the amended fabric.

Card production:

Once the weave structures are finished, the fabric electronic card is ready to be produced, and this could be done simply by refreshing the card view.

2.2. Materials and Methods

2.2.1. The produced sports footwear fabrics are using the following specifications:

The jacquard sports footwear fabrics were prepared at (Home Fashion Factory for upholstery fabrics, Qalyub City, Egypt), using a Rapier loom with the specifications in Table (1). Yarn of count 150 Denier, 120 EPI was used as warp, and Yarns of seven different counts such as (2000 dn, 2250 dn, 1800 dn, 3000 dn,600 dn, and 20/1 ne) were used as Wefts, with weft sequence (3F, 2W, 1 B), three types of weft yarns were used (Polyester filament, chenille P.E., chenille P.E. (micro flat and polyester spun), All fabrics were produced in Double weave wadded structure with 120 EPI, and 128 PPI. Tables (2), (3), (4), and (5) show the fabric specifications of samples.

Table 1. Specifications of the machine used for preparing samples

Loom	Specifications
Machine type	Somet
Date of Manufacturing	1994
Country of manufacture	Italy
Machine speed	230 pick/min.
Jacquard type	Staubli cx860
Jacquard capacity	2688 hooks
design hooks	2400 hooks.
Repeat width	35 cm.
Harness	Straight.
Fabric width	2300 cm.
Repeats/fabric width	6 Repetitions.
Reed density	16 Dent/cm
Denting	3 Ends/dent
Weft Insertion	Rapiers

2.2.1.1: Sample (S1a) Fabric specifications:

Table (2) shows the fabric specifications of sample S1a:

Table (2): Fabric specifications

Sample code	Weft Sequence	Weave	Densities		Count (Td)		Materials		Fabric Finished Wight (g/m^2)
			EPI	PPI	Warp	Weft	Warp	Weft	
S1a	(3F:2w:1B)	Double weave	120	128	150/1	600, (2000,1800) 150/40	P.E. filament	P.E. (P.E., PE), Lycra	654.9

Design S1a

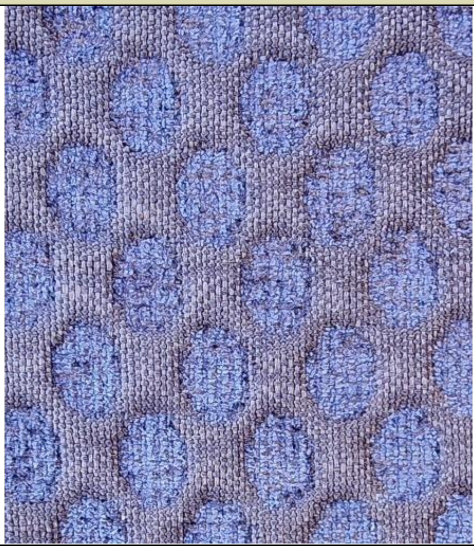
2.2.1.2: Sample (S1b) Fabric specifications:

Table (3) shows the fabric specifications of sample S1b:

Table (3): Fabric specifications

Sample code	Weft Sequence	Weave	Densities		Count (Td)		Materials		Fabric Finished Wight (g/m^2)
			EPI	PPI	Warp	Weft	Warp	Weft	
S1b	(3F:2w:1B)	Double weave	120	128	150/1	600, (2000,2000) 150/40	P.E filment	P.E, (Chflat, chflat) Lycra	654.9

Design S1b



2.2.1.3: Sample (S1c) Fabric specifications:

Table (4) shows the fabric specifications of sample S1c:

Table (4): Fabric specifications

Sample code	Weft Sequence	Weave	Densities		Count (Td)		Materials		Fabric Finished Wight (g/m²)
			EPI	PPI	Warp	Weft	Warp	Weft	
S1c	(3F:2w:1B)	Double weave	120	128	150/1	20/1, (2250,1800) 150/40	P.E. filament	P.E. spun, (Ch, PE), Lycra	555.3

Design S1c

2.2.1.4: Sample (S1d) Fabric specifications:

Table (5) shows the fabric specifications of sample S1d:

Table (5): Fabric specifications

Sample code	Weft Sequence	Weave	Densities		Count (Td)		Materials		Fabric Finished Wight (g/m²)
			EPI	PPI	Warp	Weft	Warp	Weft	
S1d	(3F:2w:1B)	Double weave	120	128	150/1	300, (2000,1800) 150/40	P.E. filament	P.E., (Ch, PE), Lycra	581.4

Design S1d

3. Results and Discussion:

A new method for developing high-performance functional woven sports footwear fabrics has been designed to improve the functional performance of fabrics using innovative textile structural components.

3.1. Weight:

Table 6. Weight of the analysed samples

Sample No.	Sample Code	Fabric Weight g/m^2
1	S1a	658.1
2	S1b	654.96
3	S1c	555.3
4	S1d	581.43

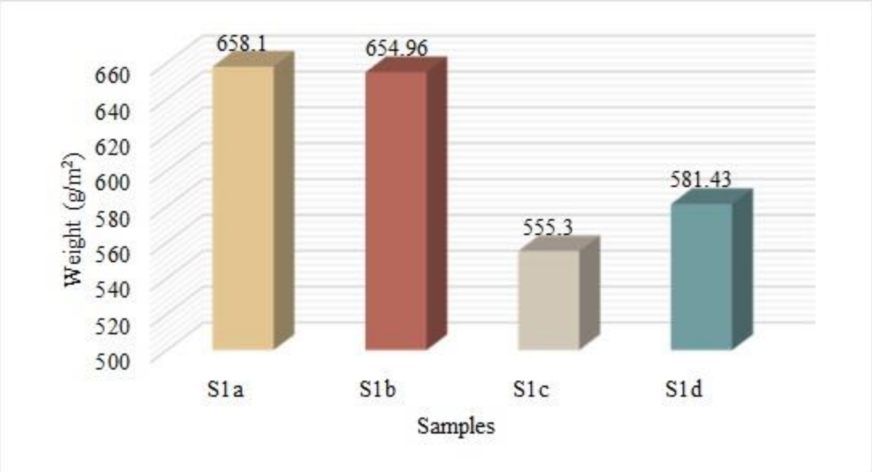


Fig. 5. Shows the average weight test scores in the samples

Table (6) and Figure (5) show statistically significant differences in the weight test for the four samples at a significance level of 0.01. Lightweight fabrics are considered one of the advantages of sports footwear fabrics, which reduce the overall weight, providing comfort and ease of movement, as sample S1c represents the lowest weight per meter square, followed by S1d, S1b, then S1a. As a result, we used weft yarns that are 40% thinner on the face of the fabric than those used in the rest of the samples.

3.2. Thickness:

Table 7. The thickness of the analysed samples

Sample No.	Sample Code	Fabric Thickness (mm)
1	S1a	1.86
2	S1b	1.99
3	S1c	1.67
4	S1d	1.676

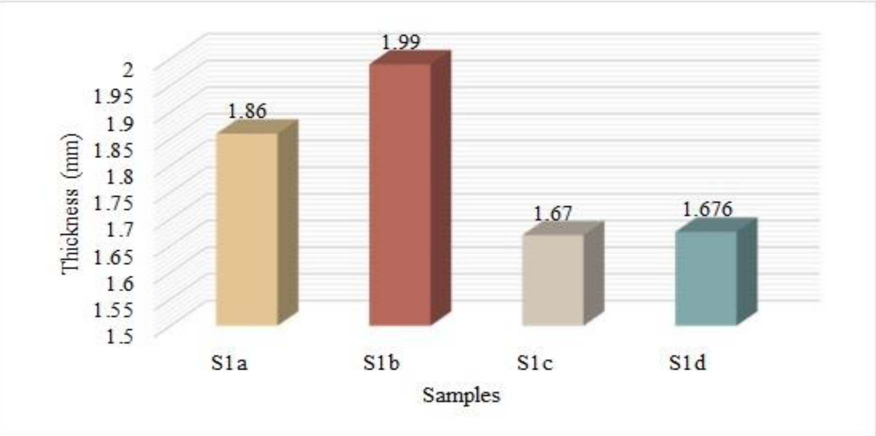


Fig. 6. Shows the average thickness test scores in the samples

Table (7) and Figure (6) show statistically significant differences in the thickness test for the four samples at a significance level of 0.01. Thickness properties are considered an advantage of sports footwear fabrics. The fabric thickness affects the flexibility property where sports footwear is supposed to flex and bend during wear, as sample S1b represents the largest thickness of the fabric, followed by S1a, S1d, and then S1c. as a result, using coursed weft yarns for wadded between layers of the fabrics.

3.3. Air permeability

Table 8. Air permeability of the analysed samples

Sample No.	Sample Code	Air permeability ($cm^3/cm^2/s$)
1	S1a	8.56
2	S1b	19.8
3	S1c	37.3
4	S1d	30.8

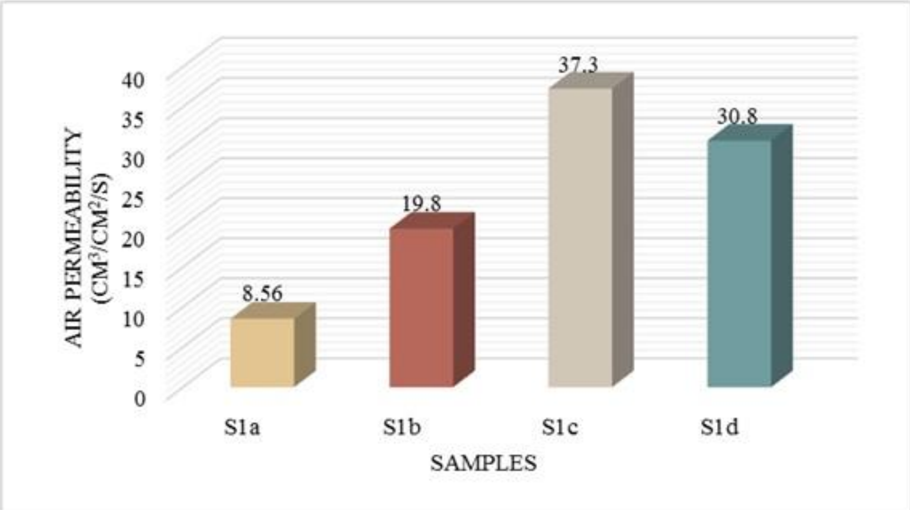


Fig. 7. Shows the average air permeability test scores in the samples.

Table (8) and Figure (7) show statistically significant differences in the air permeability test for the four samples at a significance level of 0.01. Air permeability is one of the essential qualities required for sports footwear fabrics because it provides great comfort to the wearer, as it plays a role in transporting moisture vapour from the skin to the outside atmosphere. Sample S1c represents the highest air permeability, followed by S1d, S1b, and then S1a, because of using the spun-polyester thin weft yarns on the face of the fabric, which increases air permeability.

3.4. Tensile Strength:

Table 9. Tensile strength of the analysed samples

Sample No.	Sample Code	Tensile Strength (N)
1	S1a	1620.07
2	S1b	1614.76
3	S1c	1693.24
4	S1d	1402.58

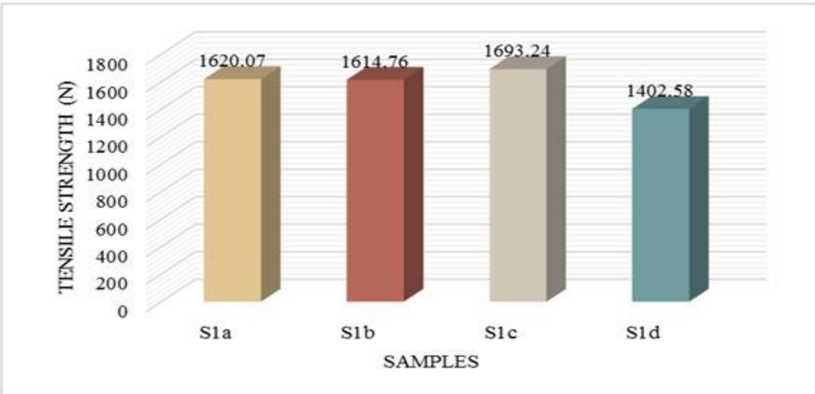


Fig. 8. Shows the average tensile strength test scores in the samples.

Table (9) and Figure (8) show statistically significant differences in the tensile strength test for the four samples at a significance level of 0.01. High tensile strength is one of sports footwear fabrics' most important desirable properties. Sample S1c represents the highest tensile strength, followed by S1a, S1b, and then S1d. As a result, using coursed weft yarns for wadding between the layers increases the fabric's durability.

3.5. Elongation:

Table 10. Elongation of the analysed samples

Sample No.	Sample Code	Elongation (%)
1	S1a	32.76
2	S1b	34.01
3	S1c	30.87
4	S1d	32.36

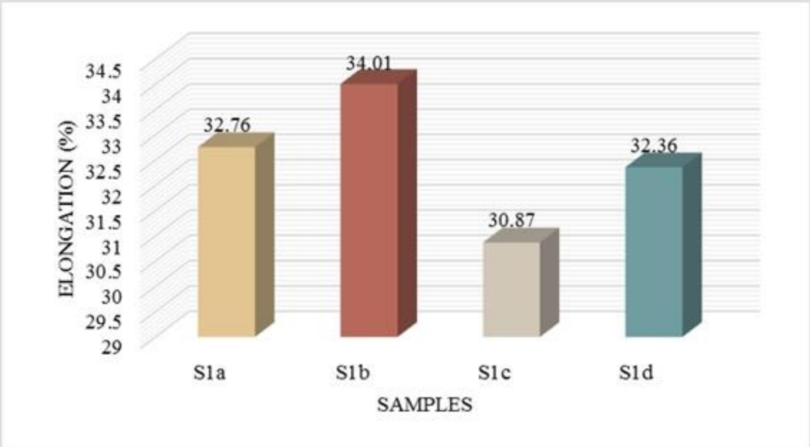


Fig. 9. Shows the average elongation test scores in the samples.

Table (10) and Figure (9) show statistically significant differences in the elongation test for the four samples at a significance level of 0.01. High elongation is a desirable property for sports footwear fabrics; it must be stretched adequately before the breaking point is reached to increase the lifetime of the sports footwear. Sample S1b represented the highest elongation, followed by S1a, S1d, and S1c, due to increasing warp floats by using coursed weft yarns in both faces and wadded between layers of the fabrics.

3.6. Friction Resistance:

Table 11. Friction resistance of the analysed samples

Sample No.	Sample Code	Friction Resistance (g)
1	S1a	17
2	S1b	5
3	S1c	3
4	S1d	4

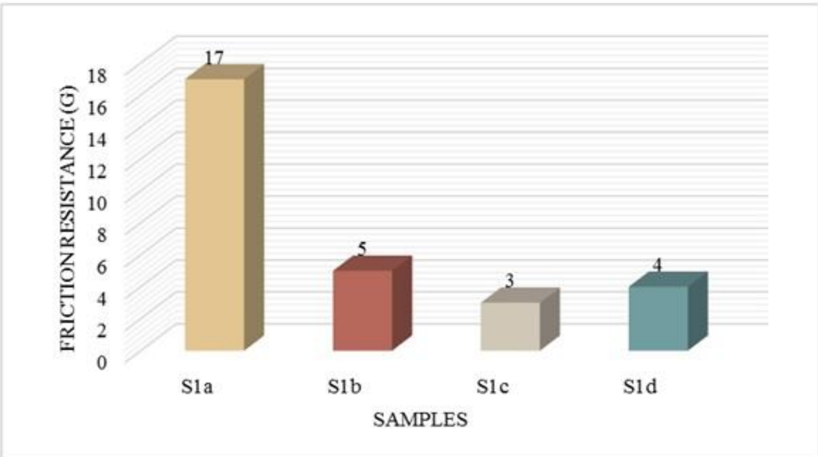


Fig. 10. Shows the average friction resistance test scores in the samples

Table (11) and Figure (10) show statistically significant differences in the friction resistance test for the four samples at a significance level of 0.01. High friction resistance is essential in sports footwear's mechanical properties. To increase durability, Sample S1c represents the highest friction resistance, followed by S1d, S1b, then S1a; as a result, using coursed weft yarns of spun-polyester on the face of the fabric, which reduces the percentage of weight loss in the layer exposed to friction.

3.7. Pilling Resistance:

Table 12. Pilling resistance of the analysed samples

Sample No.	Sample Code	Pilling Resistance
1	S1a	4.5
2	S1b	4.6
3	S1c	2.5
4	S1d	4.4

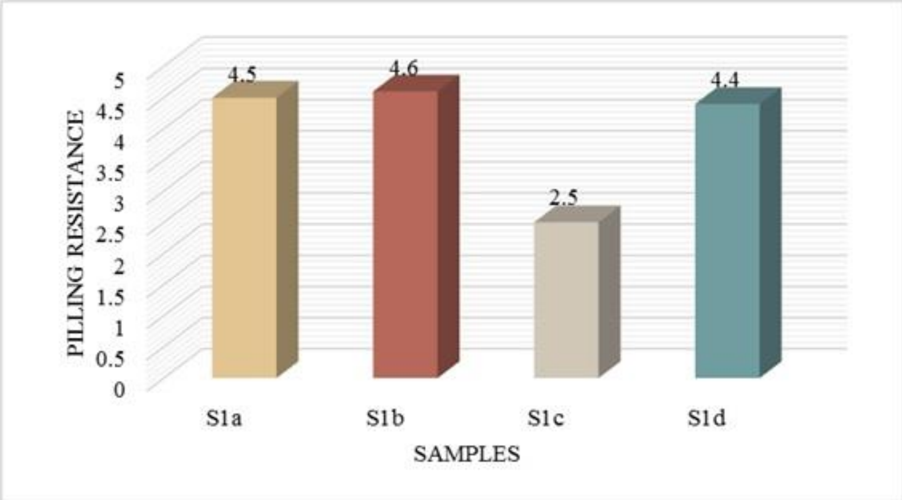


Fig. 11. Shows the average pilling resistance test scores in the samples

Table (12) and Figure (11) show statistically significant differences in the pilling resistance test for the four samples at a significance level of 0.01. High pilling resistance is a desirable property for sports footwear fabrics, dramatically affecting the fabric's appearance. Sample S1c represents the highest pilling resistance sample, followed by S1d, S1a, then S1b; as a result, using weft thin-counts yarns of spun polyester on the face of the fabric.

3.8 The Statistical Analysis:

The impact of innovative textile structure components of jacquard woven sports footwear fabrics on the physical and mechanical properties (weight, thickness, air permeability, tensile strength, elongation, friction resistance, and pilling resistance) was tested using analysis of variance (ANOVA).

Table 13. Results of one-way ANOVA

ANOVA for Weight Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	29238.505	1	9746.168	3	52.563	0.01
Between Groups (without or with)	1483.344	1	185.418	8		
ANOVA for Thickness Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	44213.642	1	14737.881	3	7.550	0.01
Between Groups (without or with)	15616.207	1	1952.026	8		
ANOVA for Air Permeability Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	31016.780	1	10338.927	3	32.120	0.01
Between Groups (without or with)	2575.087	1	321.886	8		
ANOVA for Tensile Strength Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	28633.966	1	9544.655	3	65.396	0.01
Between Groups (without or with)	1167.620	1	145.952	8		

ANOVA for Elongation Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	32951.467	1	10983.822	3	21.962	0.01
Between Groups (without or with)	4001.072	1	500.134	8		
ANOVA for Friction Resistance Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	34923.679	1	11641.226	3	16.429	0.01
Between Groups (without or with)	5668.461	1	708.558	8		
ANOVA for Pilling Resistance Results						
Source of Variation	S.S.	df	M.S.	F	P-value	D
Between Groups	39579.199	1	13193.066	3	10.262	0.01
Between Groups (without or with)	10285.421	1	1285.678	8		

(The differences are statistically significant at ($p \leq 0.01$))

Sum-of-squares (S.S.) column with no repeated measures, degrees of freedom (df), mean squares (M.S.), F-ratio (F), p-value, (D) indication.

3.9 The Correlation Coefficients:

Table 14. Results of the Correlation Coefficients between the four samples and "weight, thickness, air permeability, tensile strength, elongation, friction resistance, pilling resistance"

Sample Code	Weight (g/m^2)	Thickness (mm)	Air permeability ($cm^3/cm^2/s$)	Tensile Strength (N)	Elongation %	Friction Resistance (g)	Pilling resistance
S1a	**0.946	*0.614	**0.765	**0.777	**0.929	**0.836	**0.748
S1b	**0.705	**0.914	**0.857	*0.643	**0.804	*0.637	**0.891
S1c	*0.640	**0.738	**0.796	**0.864	*0.625	**0.903	**0.787
S1d	**0.829	**0.883	*0.629	**0.958	**0.718	**0.819	*0.607

Table (14) shows that there is a direct correlation between the four samples and "weight, thickness, air permeability, tensile strength, elongation, Friction resistance, pilling resistance" at a significance level of 0.01, 0.05.

Discussions:

- There is a strong direct correlation between weight (g/m^2) and using coursed weft yarns in both the face and the wadded between layers of the fabrics.
- There is a strong direct correlation between thickness (mm) and using coursed weft yarns for wadding between layers of the fabrics.
- There is a strong direct correlation between air permeability ($cm^3/cm^2/s$) and using the spun-polyester thin weft yarns on the face of the fabric, which increases air permeability.
- A strong direct correlation between tensile strength (N) and using coursed weft yarns for wadding between the layers increases the fabric's durability.
- There is a strong direct correlation between elongation % and increasing warp floats by using coursed weft yarns in both faces and wadded between layers of the fabrics.
- There is a strong direct correlation between friction resistance (g) and using coursed weft yarns of spun polyester on the face of the fabric, which reduces the weight loss percentage in the layer exposed to friction.
- There is a strong direct correlation between pilling resistance and using weft thin-counts yarns of spun polyester on the face of the fabric.

4. Conclusion:

The experimental result indicates that woven sports footwear fabrics could be produced on a woven jacquard machine with high-speed production that could compete with the production rate of the flat knitting machine. It was also found that using different materials and structural components such as weft density/inch, end density/inch, and their sequences strongly affected the physical and mechanical properties of the produced fabrics. The statistical analysis results for correlation coefficients show a robust direct correlation between weight, thickness, tensile strength, and elongation properties using coursed weft yarns in both the face and the wadded between layers of the fabrics. However, using thin weft yarns of spun polyester on the face of the fabric has a substantial direct correlation with friction, pilling, and air permeability properties. In conclusion, the different structural components of the woven jacquard sports footwear fabrics have a strong correlation that affects the physical and mechanical properties in addition to reducing the production cost, with the help of the superior facilities of the woven jacquard machines especially the high production in comparison with the flat knit machines.

Recommendations:

In light of these findings, the researcher recommends the following:

- Find a new approach to increase the maximum quantity of footwear fabrics the Egyptian market needs.

- Searching for new innovative materials could be produced in more designs to give the produced fabrics the amended physical and mechanical properties of footwear fabrics.
- Adding some chemical finishing to improve the functional properties of footwear fabrics.
- Increasing the sustainable development with the benefit from the simple handicrafts required to produce a finished product of sports footwear, thus increasing job opportunities and reducing the foreign currency required to provide the needs of the local market for sports footwear.

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