The Effect of Different Structural Formations of Innovative Yarns on Fabric Comfort Properties

Marwa Mostafa Mostafa Mohamed qotb
Assistant Lecturer at Spinning and Weaving Dept., qotbmarwa@gmail.com
Prof. Osama Ezz El-Din Ali
Professor of Textile Design, Spinning and Weaving Dept., Faculty of Applied Arts, Helwan University, drosezzhalawa@yahoo.com
Prof. Mohamed Abd-El Gawad
Professor of Textile Structures, Spinning and Weaving Dept., Faculty of Applied Arts, Helwan University, mohamed.abdelgawad@buc.edu.eg
Dr. Ayman El Saied Ibrahim
Assistant Prof., Spinning and Weaving Dept., Faculty of Applied Arts, Helwan University.

Abstract:
The aim of the research is to investigate the effect of different structural formations of Innovative yarns on Fabric functional and comfort properties. The constructional specification is one of the most important fabric characteristics that affects the comfort properties of cloth. Thickness, weight per square meter, weave pattern, yarn count and aesthetic value are all parameters to consider However, it also determines its air and liquid permeability, as well as its thermal insulation. **The aim of the research** is to investigate the effect of different structural formations of Innovative yarns on Fabric functional and comfort properties. The constructional specification is one of the most important fabric characteristics that affects the comfort properties of cloth. Thickness, weight per square meter, weave pattern, yarn count and aesthetic value are all parameters to consider However, it also determines its air and liquid permeability, as well as its thermal insulation. The structural composition of the textile design, which is the scientific premise of the artistic creativity, is due to the aesthetic appearance of the woven (color - surface effect - tactile effect - decorative design) where it stems from the ability of the designer to create the structural elements of the fiber and threads forming the textile product. **Research problem:** The textile industry is facing a stagnation in export volume, so a new design vision must be thought of with variations in raw materials and yarns used within the textile product. Although there has been a significant expansion in the production of garments, there are few locally manufactured fabrics of decorative yarn that have the esthetic and functional effect of attracting consumers and competing with the imported product from the external markets. The technical and technological capabilities of the machines intended for the production of the newest decorative threads must be optimized. **Research importance:** The importance of the research is due to the development of decorative yarn design to produce a product with innovative esthetic effects, which is used to produce garments that achieve the aesthetic and functional range of competition in global markets and the Egyptian textile product returns to the forefront as it was before. **Methodology:** The experimental analytical method is used in the study. **Results**: Based on the previous results and discussions, some conclusions were reached that could be used to benefit the production of different structural formations of innovative yarns and the use of this yarn as weft in produced fabrics, which could increase the functional and comfort of those fabrics. **Conclusions**: Fabric's physical and constructional specifications have been studied in order to determine the comfort characteristic of the produced fabric. the importance of weave structure and material as the basic constituents of fabric, as well as the two main types of fibers, natural fibers (cotton) and man-made fibers (polyester).

Keywords:
Fancy yarn, Slub yarn, knop yarn, comfort, Air permeability.

Paper received 18th November 2021, Accepted 15th January 2022, Published 1st of March 2022

1. Introduction

The variety of fancy yarn effects is unlimited, Fancy yarns are a type of yarn that is actually designed for its aesthetic appearance rather than its performance.

A fancy yarn is defined by the Textile Institute (Textile Terms and Definitions) as **"**a yarn that differs from the normal construction of single and folded yarns by way of deliberately produced irregularities in its construction. These irregularities relate to an increased input of one or more of its components, or to the inclusion of periodic effects, such as knops, loop, curls, and Slubs.**"** (Goswami, 2018) Application of fancy yarns includes Denim, knitted wear, formal wears and home textiles. (Shaikh Tasnim Nisarahmed, June 2012)

1.1 The structure and formation of fancy yarns

The basic structure of a fancy doubled yarn consists of 'core' threads, an 'effect material', and a 'binder' which, ensures that the entire structure holds together. (Gong, 2011)

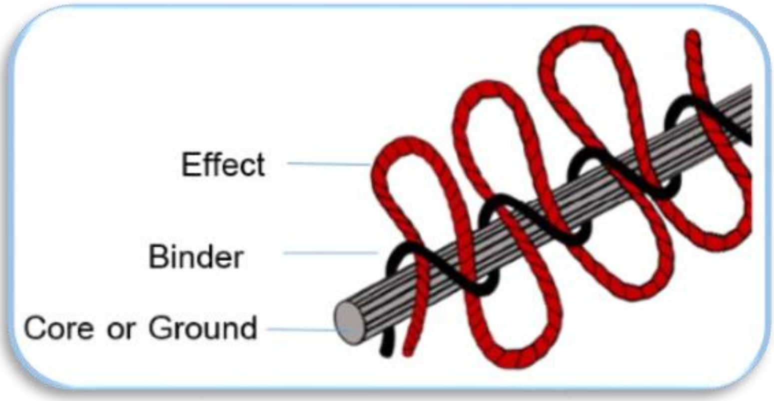


Figure 1 **Basic Components of Fancy Yarn (Said, 2011)**

1.2 TYPES OF NOVELTY YARNS

1.2.1 Slub yarn

A Slub yarn is one in which Slubs (thick places in the yarn) have been deliberately created to produce the desired effect, which may be slow and subtle or strong
and sudden see Fig [3]. (Gong, 2011)

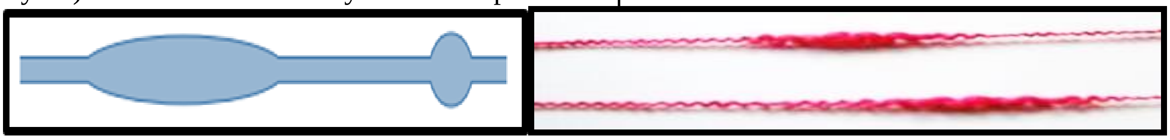


Figure 2 Slub yarn structure *(Co, 2020)*

1.2.2 Knop yarn

A knop yarn is one that contains prominent bunches of one or more of its component threads, arranged at regular or irregular intervals along its length, as shown in very simplified form in Fig [4].

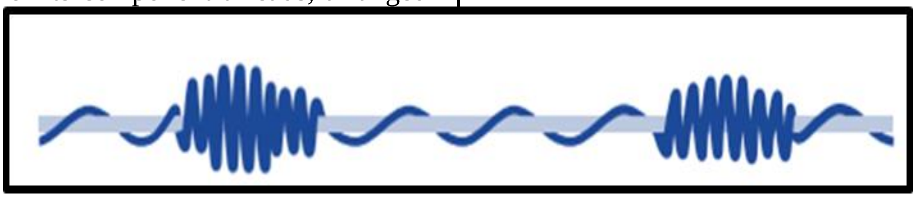


Figure 3 Knop yarn structure

1.3 The properties of the fancy yarn

The properties that might be of interest specifically to commercial users of fancy yarns. Tensile Strength, Wear resistance (that is, resistance to wear during use, as well as the effects of that wear on yarn strength, color, or other physical properties; and the differential changes in particular yarn components as a result of wear)

Flexibility, Comfort (especially, if final product is to be used as apparel fabric or upholstery), Stretch properties, Suitability for a specific manufacturing or dyeing method. (Wright, 2002)

Comfort is a multidimensional subject which is very difficult to define. In general, clothing comfort refers to how the human feels. It is difficult to describe clothing comfort positively while discomfort can be easily defined by wearers with terms including: hot, cold, wet, prickly, itchy, heavy, not breathing, non-absorbent, chill, stiff, sticky, clammy, clingy, and rough. (Song, 2011)

2. Experimental Work

The main purpose of the research is to investigate the effect of different structural formations of Innovative yarns on Fabric functional and comfort properties.

Performance through these different parameters

1. Different material for (core and effect) structure.
2. Novelty yarn structure with different effects.
3. Fabric Weave structure.

2.1 Samples specifications of different material for (core and effect)

Yarn structures of the innovative cotton Slub yarn are made up of a core material [cotton yarn 60/2 N_e], an effect material [cotton yarn 60/2 N_e], and a binder [polyester 70/1 denier] that holds the yarn together, with additional effect by twisting different color for core and effect yarn are folded together, as shown in Figure [4], polyester and blended fancy yarn sample shown in figure [5-6-7-8-9] other structure Specifications of innovative fancy yarn as shown in Table [1]

Table 1 Basic Specifications of Slub and knop fancy yarn Samples Material

Yarn structure	Core	Effect	Binder
1	Cotton 60/2 N_e	Cotton 60/2 N_e	Polyester 70/1 D
2	Polyester 150/1 D	Polyester 150/1 D	Polyester 70/1 D
3	Cotton 60/2 N_e	Polyester 150/1 D	Polyester 70/1 D

2.2 Samples specifications of Novelty yarn structure.

Fancy yarns in this research are created in **BR1/BR2 Novafil Twisting Machine/fancy yarn Twister, it provided with** computer control systems which allow the programmed control of the machine for producing fancy effects, program for Slub and knop yarn as shown in Table [2].

Table 2 Editor Window for Innovative Yarn Effects in the Novafil Machine's Programmed Control

Slub yarn				
Step	**Length**	**Twists**	**Front Feed**	**Rear Feed**
1	200	R 600	R1.10	R 1.10
2	40	R 2324	R 2.50	R 1.10
3	200	R 600	R 1.10	R 1.10
4	40	R 2324	R 1.10	R 4.00
Knop yarn				
1	120	R 800	R 1.06	R 1.006
2	33	R Stop	R 1.90	R 1.006
3	120	R 800	R 1.06	R 1.006
4	33	R Stop	R 1.90	R 1.006

Figure 4 cotton Slub yarn effect

Figure 7cotton knop yarn effect

Figure 5 polyester Slub yarn effect

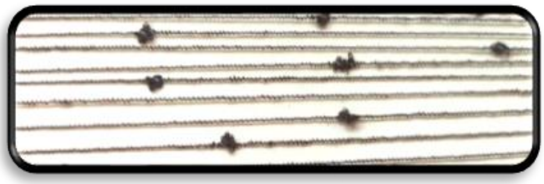


Figure 8 polyester knop yarn effect

Figure 6 Blending Slub yarn effect

Figure 9 Blending knop yarn effect

2.3 Samples specifications of woven fabric

2.3.1 Warp yarns

Warp yarns for all samples were used cotton yarns with count 50/2 N_e - density 36 yarns/cm.

2.3.2 Weft yarns

Weft yarns for al samples were used (fancy yarn 36/3 N_e and cotton yarn 30/1N_e), **wefts arrangement —** (1 Fancy yarn:1cotton yarn)density 20 weft/cm.

2.4 Fabric structures

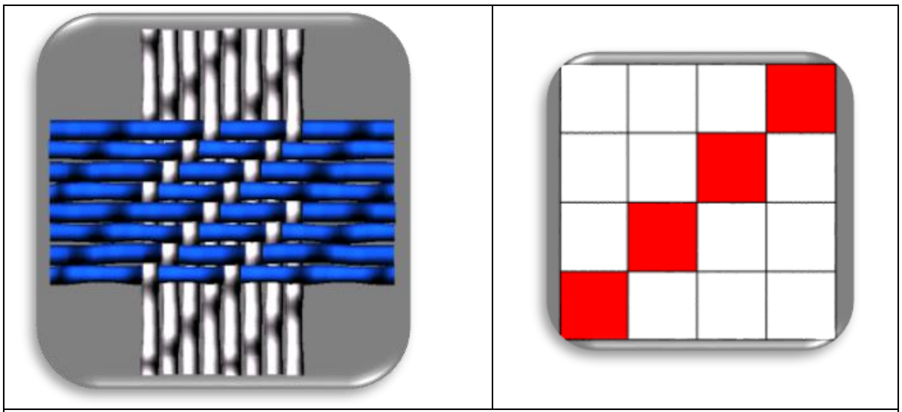
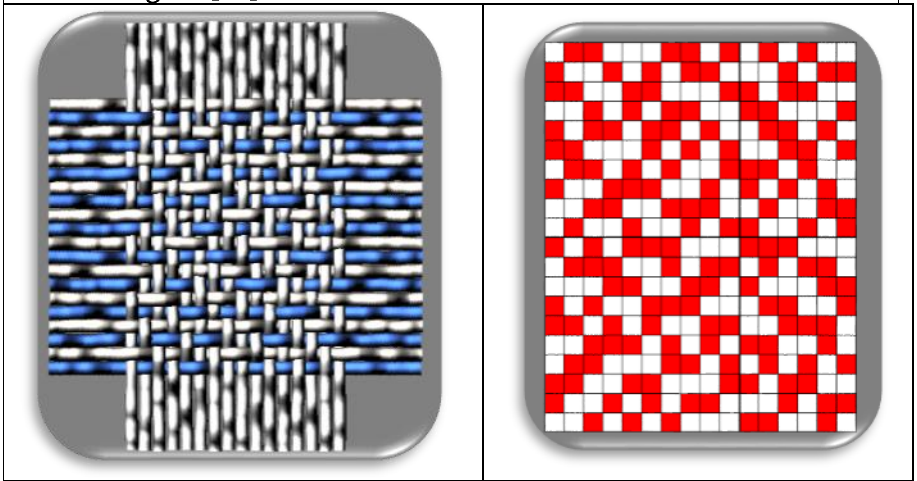


Figure [10] Twill weave 1/3 Simulation and structure



Figure[11] crepe weave Simulation and structure

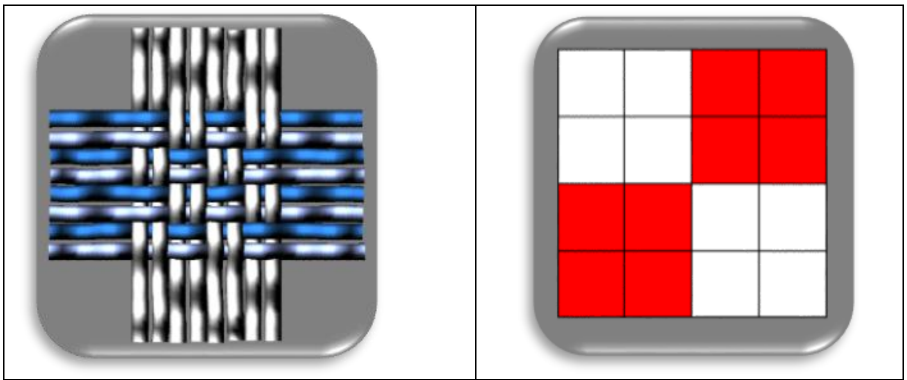


Figure [12] Matt Weave 2/2 simulation and structure

3 Results and Discussion

The following data presents the results of tests applied to the produced samples.

Table [3] Tests Results of Produced Fabric Samples

Fabric No.	Fabric Weft Material	Structure Weave	Fabric Weight (gm/m2)	Fabric thickness (mm)	Air permeability (l/m2/sec
First Innovative Slub Yarn					
1	Cotton	Twill 1/31/3	164	0.49	1156
2	Polyester	Twill 1/31/3	167	0.5	1103
3	Blending	Twill 1/31/3	164	0.47	1080
4	Cotton	Crepe	161	0.46	1163
5	Polyester	Crepe	165	0.48	959
6	Blending	Crepe	175	0.49	979
7	Cotton	Matt 2/2	169	0.48	882
8	Polyester	Matt 2/2	176	0.52	785

9	Blending	Matt 2/2	173	0.49	788
second Innovative Knop Yarn					
10	Cotton	Twill 1/31/3	165	0.6	1423
11	Polyester	Twill 1/31/3	166	0.69	1382
12	Blending	Twill 1/31/3	167	0.59	1400
13	Cotton	Crepe	166	0.56	1360
14	Polyester	Crepe	189	0.69	1173
15	Blending	Crepe	167	0.53	1333
16	Cotton	Matt 2/2	169	0.53	1004
17	Polyester	Matt 2/2	184	0.66	910
18	Blending	Matt 2/2	180	0.56	970

3.1 Fabric Weight of produced Fabric samples

Table [4] shows the results of weight test carried out on the produced samples using the following parameters:

1- Innovative fancy yarn effect.
2- Different material for (core and effect) structure
3- Fabric weave structure.

Table [4] Results of Weight Test (gm. /m2)

Fancy yarn weft Material	Structure A Slub yarn			Structure B knop yarn		
	Twill 1/3	**Crepe**	**Matt2/2**	**Twill 1/3**	**Crepe**	**Matt2/2**
Cotton	164	169	161	165	169	166
polyester	164	176	165	166	189	184
Blended	164	175	173	167	180	167

In general, it can be seen from table [5] and figure [13] that fabrics produced from polyester knop weft recorded the highest values in fabric weight, the difference between Slub and knop yarn structure on the weight of the square meter was affected by the difference in knop structure formation and distance between dots due to an increase in the number of dots on the yarn.

From table [5] it can be seen that; crepe weave shows higher fabric weight than Matt and Twill 1/3. The observed difference was due to an increase in the number of intersections in the produced fabrics, which causes the weft crimp to increase, thus also increasing the fabric weight.

Table [6] shows that there is a significant relationship between cotton weft material and polyester weft material depending on ANOVA results.

Table 5 ANOVA statistical analysis for Fabric weight value

ANOVA					
Fabric weight					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	237.444	2	118.722	2.372	.127
Within Groups	750.833	15	50.056		
Total	988.278	17			

Multiple Comparisons			
Dependent Variable:	Fabric weight		
LSD			
(I) Fabric weft material		Mean Difference (I-J)	Sig.
Cotton	polyester	8.83333*	.047
	Blended	5.33333	.211
Polyester	cotton	8.83333*	.047
	Blended	3.50000	.405
Blended	cotton	5.33333	.211
	polyester	3.50000	.405
***. The mean difference is significant at the 0.05 level.**			

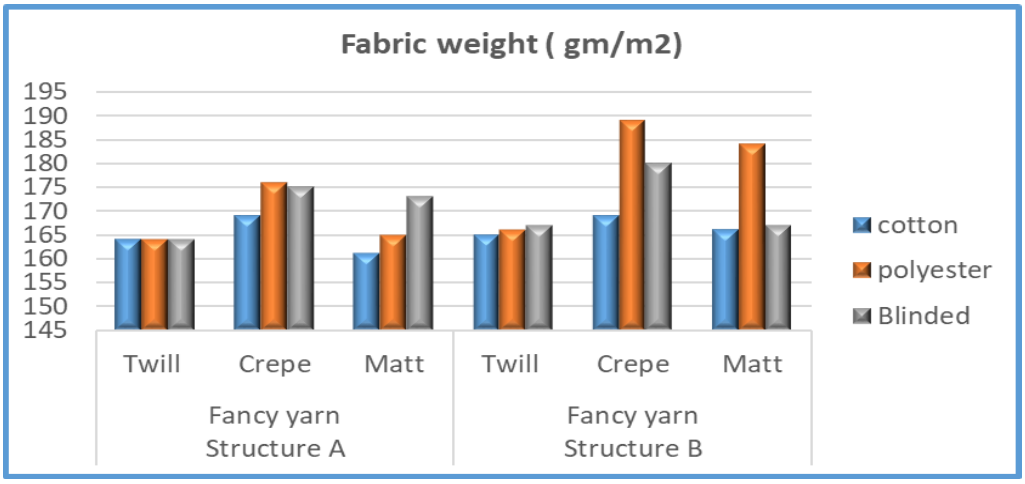


Figure 13 Effect of different Fancy yarn material, effect and weave structure on Fabric Weight

3.2Fabric Thickness (mm)

Table [7] and figure [14] shows the results of thickness test for Different weft materials of fancy yarn and different structure in samples.

Table [6] Results of fabric thickness Test (mm)

Fancy yarn weft Material	First Innovative Slub yarn			second Innovative knop yarn		
	Twill 1/3	**Crepe**	**Matt 2/2**	**Twill 1/3**	**Crepe**	**Matt2/2**
Cotton	**0.49**	**0.46**	**0.48**	**0.6**	**0.56**	**0.53**
Polyester	**0.5**	**0.48**	**0.52**	**0.69**	**0.69**	**0.66**
Blended	**0.47**	**0.49**	**0.49**	**0.59**	**0.53**	**0.56**

Results presented in Table [6]and Figure [15] show that fabric produced from the second Innovative knop yarn higher fabric thickness value than fabric from Slub yarn, the difference was due to the appearance and textures in knop fancy weft could give more bulkiness in this structure this reason increase the fabric thickness.

ANOVA results in Table [8] show that there is a significant relationship in the second innovative knop yarn, crepe weave and Twill 1/3 depending on ANOVA results.

Table 7 ANOVA statistical analysis for Fabric weight value

ANOVA						
Fabric Thickness						
Fancy yarn		Sum of Squares	df	Mean Square	F	Sig.
Slub	Between Groups	.001	2	.000	1.696	.261
	Within Groups	.002	6	.000		
	Total	.002	8			
Knop	Between Groups	.028	2	.014	16.896	.003
	Within Groups	.005	6	.001		
	Total	.033	8			

Multiple Comparisons				
Dependent Variable:		Fabric Thickness		
LSD				
Fancy yarn	(I) Structure Weave	(J) Structure Weave	Mean Difference (I-J)	Sig.
Slub	Twill 1/3	crepe	.02333	.124
		Matt 2/2	.00667	.628
	crepe	Twill 1/3	.02333	.124
		Matt 2/2	.01667	.249
	Matt 2/2	Twill 1/3	.00667	.628

		crepe	.01667	.249
Knop	Twill 1/3	crepe	.11733*	.003
		Matt 2/2	.00267	.914
	crepe	Twill 1/3	.11733*	.003
		Matt 2/2	.12000*	.002
	Matt	Twill 1/3	.00267	.914
		crepe	.12000*	.002

***. The mean difference is significant at the 0.05 level.**

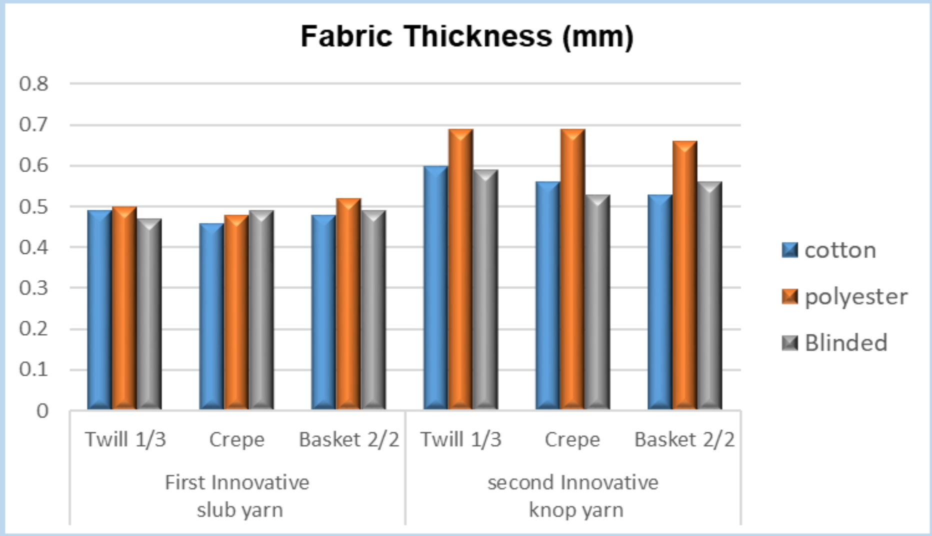


Figure [14] Effect of different Fancy yarn material, effect and weave structure on Fabric Thickness

3.3 Air permeability

Table [9] and figure [15] show the results of Air permeability for different materials and different structure in produced samples under test.

Table [8] Results of Air permeability (l/m2/sec)

Fancy yarn weft Material	First Innovative Slub yarn			second Innovative knop yarn		
	Twill 1/3	**Crepe**	**Matt 2/2**	**Twill 1/3**	**Crepe**	**Matt 2/2**
Cotton	1156	1163	882	1423	1360	1004
Polyester	1103	959	785	1382	1173	910
Blended	1080	979	788	1400	1333	970

Results presented in Table [9] and Figure [16] show that samples which produced from cotton material have scored the highest rates of air permeability followed by blended and polyester. Due to Cotton fiber's kidney-shaped cross section and convolutions allow it to make only random contact with the skin and various minute air spaces that exist. Because this type of contact is more compatible with human skin physiology, it is more comfortable to wear. The woven textile fabrics have porous structure. The porosity is defined by the ratio of space to fiber in a given volume of fabric. The porous are by voids between weft and warp yarns in the fabrics. The air passes through the pores from the surface of the fabric. (E.P.G Gohl, 1983)

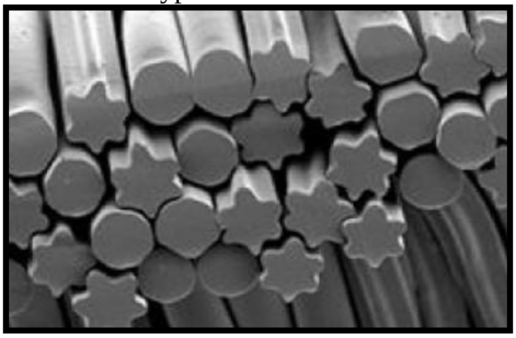


Figure7 Polyester cross section

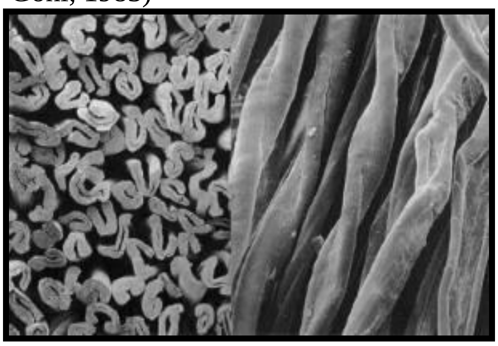


Figure 8 Cotton cross section

Correlation between air permeability value, polyester fiber specific density 1.39 g/cm3 and cotton specific density 1.52 g/cm^3. The pore size between fiber cross section Polyester fabric has the lowest air permeability because it has fewer pores with a smaller cross section area available for air passage.

According to table [8] and figure [16], the Twill 1/3 weave structure has the highest value, followed by crepe and matt weave. This is because increasing the float length leads to a wider weave (fewer intersections between warp and fancy weft), which increases porosity and thus air permeability.

ANOVA results in Table [9] show that there is non-significant relationship between air permeability and material depending on ANOVA results. And from table [10] found there is significant relationship between air permeability and weave structure

Table 9 ANOVA statistical analysis for Air permeability value

ANOVA					
Fabric Air permeability					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	181603.556	1	181603.556	3.876	.067
Within Groups	749662.222	16	46853.889		
Total	931265.778	17			

Table 10 ANOVA statistical analysis for Air permeability and weave structure factor

ANOVA					
Fabric Air permeability and structure factor					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	435852.111	2	217926.056	10.430	0.001
Within Groups	313425.000	15	20895.000		
Total	749277.111	17			

Multiple Comparisons			
Dependent Variable:			
LSD			
(I) weave structure		Mean Difference (I-J)	Sig.
Twill 1/3	Crepe	96.16667	0.267
	Matt 2/2	367.50000*	0.001
Crepe	Twill 1/3	96.16667	0.267
	Matt 2/2	271.33333*	0.005
Matt 2/2	Twill 1/3	367.50000*	0.001
	Crepe	271.33333*	0.005
***. The mean difference is significant at the 0.05 level.**			

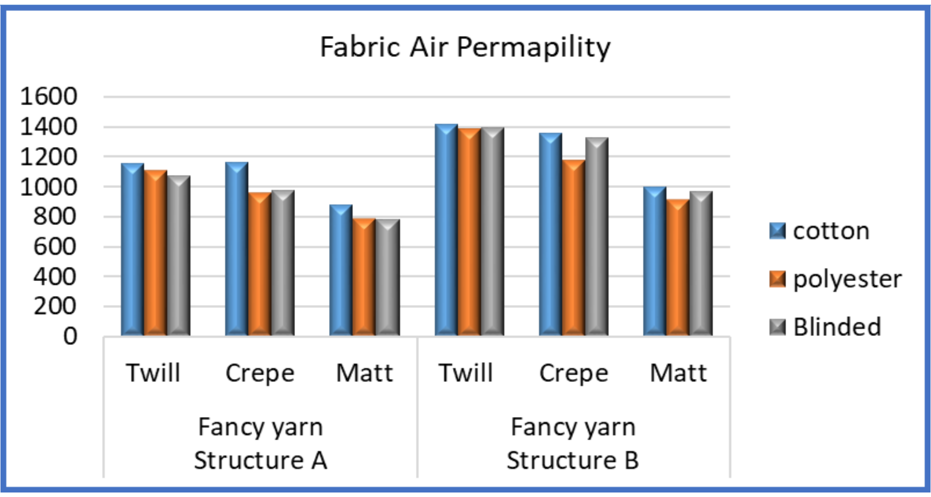


Figure [16] Effect of different Fancy yarn material, effect and weave structure on Fabric Air permeability

Conclusions

Based on the previous results and discussions, some conclusions were reached that could be used to benefit the production of different structural formations of innovative yarns and the use of this yarn as weft in produced fabrics, which could increase the functional and comfort of those fabrics. These are the conclusions:

Fabric's physical and constructional specifications have been studied in order to determine the comfort characteristic of the produced fabric. the importance of weave structure and material as the basic constituents of fabric, as well as the two main types of fibers, natural fibers (cotton) and man-made fibers (polyester). Following the effects of yarn characteristics were considered, and the effects of parameters such as yarn structural properties and texturizing were presented.

- There is direct relationship between the formation of fancy yarn effect and the weight test.
- There is direct relationship between fabric structure and the thickness test.
- There is direct relationship between the fabric material, weave structure and air permeability.

References

1. BABU, S. (2021, 4 12). *hollow spindle spinning method (wrap spinning process)*. Retrieved from Textile Adviser: https://www.textileadvisor.com
2. Co, N. C. (2020, 2 2). *IndiaMART*. Retrieved from IndiaMART: https://www.indiamart.com/proddetail/Slub-yarn-12437714091.html
3. E.P.G Gohl, L. V. (1983). second edition "Textile Science "an explanation of fiber properties.
4. Gong, R. H. (2011). *Specialist yarn and fabric structures" Developments and applications"*. Cambridge : Textile Institute Woodhead Publishing .
5. Goswami, T. C. (2018). *Textile and Clothing Design Technology*. Boca Raton: Taylor & Francis.
6. Said, H. (2011). *Effect of using metallic yarns on the properties of some upholstery fabrics.* Egypt: Applied Arts- Spinning, weaving and knitting Dept.(M.sc).
7. Shaikh Tasnim Nisarahmed, S. (June 2012). Colour Analysis of Fancy Yarns Produced on Innovative Mechanical Crimp Texturising Apparatus. *International Journal of Engineering Research and Development*, Volume 1, Issue 10 ,PP.72-79.
8. Song, G. (2011). Improving comfort. Cambridge: Textile Institute Woodhead Publishing.
9. Wright, R. H. (2002). *Fancy yarns Their manufacture and application.* Cambridge England: The Textile Institute Woodhead Publishing.
10. Yiting Duan, B. W. (2013). Knitted fabric effects using two-coloured (marl) yarns. *International Journal of Fashion Design, Technology and Education (Taylor & Francis)*, Vol. 6, No. 1, 35–42.