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IMPACT OF PRINTING TECHNIQUES ON THE PROPERTIES BEHAVIOUR OF SEAMED TEXTILE FABRICS

Manal A. Seif [1] & Shaimaa M. Ahmed[2]

[1]*Associate Professor, Department of Apparel Design & Technology, Faculty of Applied Arts, Helwan University, Cairo, Egypt*

[2]*Lecturer, Department of Apparel Design & Technology, Faculty of Applied Arts, Helwan University, Cairo, Egypt*

ABSTRACT

Surface design is the coloring, patterning, structuring, and transformation of fabric, fiber, and other materials. Printing is a common technique used to create colored patterns on fabric.

Many designs or finishes are applied to fabric surface by methods such as dyeing or printing. These methods generally hold the use of chemical finish, mechanical finish, or both. Most of these finishes create a change in the texture of the surface and hand of the fabric and in sequence the behaviour of fabric properties.

The scope in this research is to determine the impact of different printing techniques on changing the textile properties behavior by seamed and non-seamed fabrics. Three printing methods were applied, the traditional methods batik printing and tie-dying printing and the third method is the digital printing. Chosen fabrics were sewn with two different stitch types in three levels of stitch lengths. The properties investigated were tensile strength and elongation, seam pucker, bending stiffness, dimensional stability and colour fastness. Results were statically analyzed and discussed. They confirmed the tight effect of the different printing methods on changing the properties under the study.

KEYWORDS: *Bending Stiffness, Colour Fastness to Rubbing, Dimensional Stability, Printing Techniques, Seam Elongation, Seam Pucker, Seam Strength, Sewing Factors*

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INTRODUCTION

It is known that early man decorated his skin with various stains, dyes and incisions and eventually began to use animal hides and thin layers of bark for clothing. In time, he discovered that he could make cloth from natural fibers and decorate it by applying designs to the surface using various techniques [13].

Printed textile fabrics are an integral part of our lives, which are being universally used to decorate both clothing and other things. The Printing is a broken method of dyeing. Textile printing is linked to dyeing, but in dyeing, the whole fabric is equally covered with one colour, in printing one or more colours are applied to it in definite parts only, and in sharply defined motives. There are two types of printing process available in textile printing in the industry: all over print and piece print. In all over print, the fabric is printed before cutting and printing paste is applied at the same time in the required place. For all over print, every so often it is difficult to recognize mistakes as the process runs continuously. So extra effort needs to provide during the process. In case of piece print, printing attach is applied after cutting, printing is done piece to piece of an individual part of garments. In piece printing it is easy to find mistakes and take needed actions to solve the problem [12].

The printing technique has an unlimited prospective role for decorating clothes, furnishing fabrics and wallpapers. In order to decorate textile fabric surface, several of printing techniques are applied. For textile fabric, colour is applied in definite motives and designs using various methods such as stencil printing, batik printing, tie- dye printing and digital printing [20].

PRINTING CLASSES

The printing class refers to the type of printing rather than the design or the chemical process. VIDYASAGAR [25] describes three main classes of printing consisting of direct, resist, and discharge, while STOREY [20] describes an additional class, dyed. VIDYASAGAR (1998) incorporates the dyed class into the direct class by defining dyed as a variation of the direct printing class [15].

RESIST

To print with a resist process, a material (paste, wax) is applied to the fabric to prevent dye from penetrating the fabric surface. The area in which the resist is applied remains its original color through further color applications. Resist and dyed printing are the oldest forms of textile printing.

DISCHARGE

Discharge printing involves the removal of color from a dyed fabric. In discharge, printing a chemical is applied to the fabric in the form of a pattern. The chemical then removes the color leaving white areas of fabric. The removal of color is difficult to control in discharge printing. Therefore, when discharge printing is done without scientific calculation and precise chemical formulation, the removal of color will differ. This process is aesthetically similar to the prints in the resist class. Modern day discharge involves the addition of illuminating dyes, which allow treated areas to be discharged and colored at the same time while maintaining dark backgrounds.

DIRECT

Direct printing, as the name implies, is applying color directly to the fabric using pigment or print paste. Direct printing is not to be confused with direct dyeing in which liquid dyes are applied to the fabric. In direct printing, designs are applied to selected areas of the fabric with a thickened colour.

DYED

Dyed printing is often categorized under the direct method, but STOREY separates direct printing and dyed printing because dyed printing uses liquid dyes and the direct class uses pigment or print paste. In addition, the dyed class is often described as a variation of the direct because a mordant must be applied to the fabric for the dye to adhere to the surface. Mordants are required to attach the dyed to the fabric surface. Areas of the fabric in which the mordant was not applied will not take the dyestuff [23].

These four printing classes provide a broad overview of how printing methods are characterized. Within each class there are many specific surface design techniques used to design fabric.

PRINTING TECHNIQUES

Textile Fabrics can be printed in a different ways. Printing involves transferring colour to the surface of fabric. Some printing methods are very old techniques, which are still used by crafts people today. However, the textile industry uses high-speed digital machines for textile printing [9].

Some of the printing techniques, which commonly used in the textile industry, are presented below:

BATIK PRINTING

Batik is an Indonesian word describing a form of resist printing, which known and practiced as a local craft in southeast India, Europe and parts of Africa. It is obtained by applying wax to both sides of the fabric. Dyeing is then carried out in the cold to avoid melting the wax, thus confining the coloration to the not waxed area. Selective further waxing and redyeing, allows a range of colourings of increasing depth to be built up additively. Where complete colour changes are required the wax is completely removed in boiling water and the washed and dried cloth re waxed to cover those areas that it is preferred to protect from further dyeing. Batik fabric can have complicated designs by applying different layers of wax and dye [3], [5], [9].

The technique of making batik is from the preparation process to the making process of batik. The preparation process includes (1) washing fabric to be ready made as batik, (2) starching and ironing, the making process of batik covers (1) adhering batik wax on fabric to create a motif, (2) dyeing batik painting and (3) removing the wax from the cloth. The making techniques of batik motifs are various, among others by using canting called written batik, using the copper block called batik stamp, using a brush called batik painting, using a printing machine called batik printing, and using an embroidery machine called batik embroidery [14].

TIE-DYE PRINTING

Tie and Dye, like Batik. It is a resist-dyeing process for creating attractive coloured designs on fabrics. However, while in Batik, resistance to dye penetration is provided by a coated layer of wax, in the case of tie and dye, this is achieved by knotting, binding, folding or sewing certain parts of the cloth in such a way that the dye cannot penetrate into these areas when the cloth is dyed. It is a hand process by which complicated and attractive patterns can be produced

Tie-dyeing is a very old method. The fabric is tightly tied in certain places, then dished into the dye. The dye will not enter in the spots where the fabric is tied. The fabric can be retied and dipped in a different colour of dye [26].

There are many ways to create designs using tie and dye technique (figure 1). These are:

Marbling: The fabric is taken and crumbled to form a ball. The tie will be with a thread at different areas, randomly. Then the fabric will be dyed. Then it should be opened and dried. The dyed fabric will have a marble effect.

Binding: The fabric is picked up from one point and tied with a thread at intervals and then should be dyed [16].

Knotting: Putting knots on the fabrics, wherever desired and dye it.

Folding: The fabric is put flat on a table. It should be pleated and folded uniformly in lengthwise direction. Then it would be tied with a yarn at regular intervals, to get widthwise lines after dyeing. For horizontal lines, pleat and fold the fabric widthwise. Then roll the fabric from one corner to the diagonally opposite corner and tie at regular intervals to get diagonal lines.

Peg Tying: Cloth pegs can be used or clamped as resist materials. By fold the fabric and putting pegs at regular interval.

Tritik: Making a design of choosing the fabric with running stitch, pulling the thread tightly and tie it.

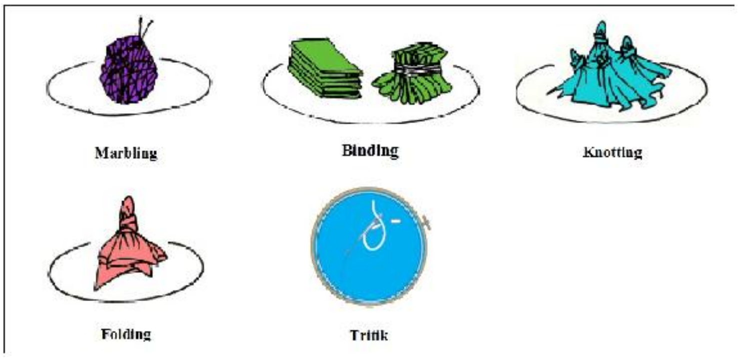


Figure 1: Tie-Dying Ways

DIGITAL PRINTING

A very important transformation is taking place in the textile industry: the digital revolution. That sounds very twenty-first century, but it started 30 years ago, and although it is essential to understand the developments and progress made in that time regarding hardware and software, It is believe that we must now consider the most important part of the equation - the human element [11].

Digital technology is becoming more available, and plays a progressively more important role in the textile and apparel industries. It is defined as any printing device that inputs a digital data stream and outputs printed pages. The textile and apparel industries, primarily use inkjet digital printers. Inkjet fabric printing is a process in which inks, made up of dyes, are placed onto the fabric surface creating an image. Each printer has a specified number of colours to print, so all other colours must be created through hesitant. The hesitant process places tiny ink drops, from the available colours, onto the cloth at different values to give the appearance of additional colours, simulating the appearance of the original image [11].

The use of digital fabric printing in textile and apparel companies is increasing. Continuing research on increasing colour quality, speeding up production rates, development of new inks, and increasing the number of print heads will facilitate adoption of this technology [15].

The best way to explain the difference that digital will make is to show how a textile collection is produced using firstly traditional methods, then digital technology. Any textile manufacturer producing a twice-yearly collection of designs works in the same way as a freelance designer. In order to sell designs for eventual production, they must show samples of their work at the major world trade fairs, where mainly clothing manufacturers choose the styles they want the manufacturer to produce for them. The success rate for samples being turned into mass production is about 15± 20%.

This means, of course, that for the manufacturer's factory to have a full order book for their production schedule, they must present hundreds of samples twice yearly [7], [11].

STATEMENT OF THE RESEARCH PROBLEM

Many researches were done in the field of textile printing methods and techniques. None of the previous studies investigated the change of the textile fabric properties according to adding the print motifs or print stuff or print technique. In addition to that, in the apparel industry, fabrics are sewn together to produce a garment piece. It is known that, garment appearance has changed with the change of fabric properties behavior. None of these studies investigated the different appearance and behavior of the properties, when the fabric was manufactured and sawn with different sewing factors.

Many related literatures and articles concentrated in the technique of batik printing [3], [5]. Another study concerned with the traditional discharge printing method on the 100% cotton fabric [4]. In the field of digital printing, there are a lot of researches and books [11], [18], [19]. Some researchers made a comparison between the old techniques and the digital printing [15]. Some studies examined the changes in dimension and grain alignment of digitally printed and post-treated prepared for print textiles [26].

OBJECTIVES OF THE STUDY

After making a focus of the research problem and the related studies, the objectives of this research are:

- Investigation of the influence of some printing techniques on changing the properties behavior of non-seamed textile fabrics, such as dimensional stability and colour fastness to rubbing.
- Determining the effect of printing methods on changing the surface appearance and properties of seamed fabrics, such as seam stiffness, seam strength and elongation, seam pucker.

MATERIALS AND METHODS

Two white textile cotton fabrics with plain weave structure with different weights per unit area and thickness were used for this investigation. The two fabrics are seamed with different stitches and stitch lengths. The geometrical properties of the white cottons fabrics are given in Table 1.

Table 1: Geometric Parameters Investigated Raw Materials

Material	Fabric Contents	Weave Structure	Weight Per Unit Area [g/m2]	Thickness [mm	Ends/ cm	Picks/ cm
M 1	100% Cotton	Pain 1/1	128.8	0.26	31	33
M 2	100% Cotton	Plain 1/1	157.33	0.30	26	17

The selected two materials are printed with three different printing techniques (Batik, Tie-Dye, and digital) and sewn using traditional sewing machines with different sewing parameters Sewing was done on industrial sewing machines under particular sewing conditions that are commercially approved in apparel manufacturing. Sewing thread spun polyester 40/2 was used for sewing all specimens. Table 2 showed the investigated printed fabrics for the experiments. The two stitch types with three different levels of stitch lengths, which chosen for the experiments, were shown in table 3.

Table 2: Investigated Printing Materials

Fabric Code	Printing Methds		
	Digital Printing	**Batik Printing**	**Tie-Dye Printing**
M 1			
M 2			

Table 3: Variations of the Sewing Parameters for Experiments

Sewing Parameter	Variation	Description
Stitch type	2 types	Lock stitch 301, Multi-chain overlock stitch 504 (Over 3 Thread)
Stitch length	3 levels	Stitch 301 (1.5 mm, 3 mm, 4.5 mm) Stitch 504 (2 mm, 3 mm, 4 mm)

After sewing the materials, laboratory tests were been carried out to study the effect of the printing methods on changing the material properties. Seam stiffness, seam strength, seam elongation, seam pucker, colour fastness and dimensional stability are measured by seamed and non-seamed materials as mentioned in table 4.

Table 4: Investigated Laboratory Tests

Fabric Properties	Raw Materials	Printed Materials	Sewn Materials Raw & Printed	Devices & Standards
1- Tensile strength	√	√	√	Instron tensile strength ASTM (D5035-95) [6]
2- Elongation	√	√	√	Instron tensile strength ASTM (D5035-95) [6]
3- Bending stiffness	√	√	√	Shirley stiffness device DIN (53362) [10]
4- Seam pucker	×	×	√	AATCC standard photos AATCC 88B [1]
5- Colour fastness	×	√	×	AATCC crock meter AATCC test method 8-2005 [2]
6- Dimensional stability	√	√	×	BS EN ISO 3759:1995, BS EN ISO 6330:2001 [8]

RESULTS AND DISCUSSIONS

In order to determine the impact of applied printing techniques on the changing the surface appearance and fabric behaviour, laboratory tests were been carried out for all printed and raw fabrics without seam and without seam. Results of individual parameters were been separately shown and discussed. Some of properties were been carried out for seamed and non-seam fabric, printed and not printed fabrics, such as the tensile strength, the elongation and the bending stiffness. Other properties were tested only by seamed fabrics (with and without printing), such as the seam pucker. The dimensional stability was been measured by samples without seam (printed and not printed). The colour fastness to rubbing was carried out for printed fabric without seam only.

Studying the Tensile Strength Behaviour

To analyze the results statically, the correlations are calculated using the statically program SPSS. The correlation between the material without printing and every printing method separately is calculated and presented.

Table 5: Paired Samples Correlations for Tensile Strength (Material 1)

		N	Correlation	Sig.
Pair 1	MATERIAL1 & DIGITAL	7	.999	.000
Pair 2	MATERIAL1 & BATIK	7	.974	.000
Pair 3	MATERIAL1 & TIEDYING	7	.955	.001

To perform statistical hypotheses:

Null hypothesis: The coefficient of linear correlation between variables is not significant.

$$(H_0): \mu_1 = \mu_2$$

Alternative hypothesis: Linear correlation coefficient between variables is significant.

$$(H_1): \mu_1 \neq \mu_2$$

Where:

μ_1 = Material without printing

μ_2 = Printed material

From the table above (table 5), it is clear that all degrees of correlation were positive and more than 0.5, which confirm the existence of correlation from medium to strong correlation between tensile strength of material before printing and after printing.

Table 6: Paired Samples T-Test for Tensile Strength Behaviour

Paired Samples		Paired Differences					"T" Value	df	Sig. (2-tailed)
		Mean "M"	Std. Deviation "S"	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MATERIAL1 - DIGITAL	-1.81429	.61218	.23138	-2.38046	-1.24812	-7.841	6	.000
Pair 2	MATERIAL1- BATIK	1.47143	1.60905	.60816	-.01670	2.95955	2.419	6	.042
Pair 3	MATERIAL1- TIE-DYING	3.18571	2.13887	.80842	1.20759	5.16384	3.941	6	.008

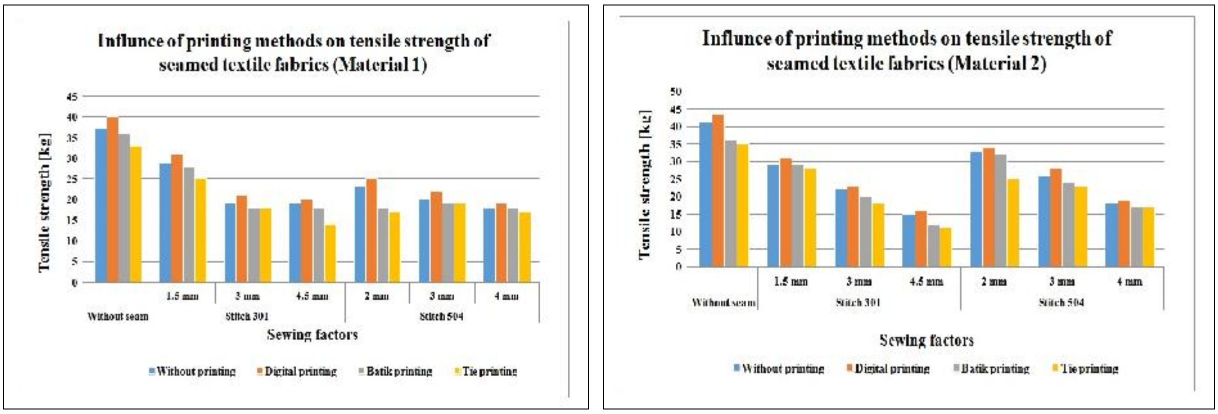
To verify the effect of the printing methods on the tensile strength, the "t" test had been applied, and the table 6 shows that:

The value of "t" equals "-7.841" in the case of material1 and digital printing, and "2.419 " in case of batik printing and "3.941" in case of tie-dying printing. It is a statistically significant value at the level (0.05), which indicates the existence of real differences between material without printing and with printing, and this indicates the influence of the printing techniques on the tensile strength of the fabrics.

Since the P-value of the first pair (Material and digital) equal 0.000, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the second pair (Material and batik) equal .042, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the third pair (Material and tie-dying) equal .008, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.



(a): M 1 **(b): M 2**

Figure 2: Influence of Printing Methods on Tensile Strength

Results in figure 2 confirmed in general that, the seam causes decrease in the seam strength. That maybe, because of the weak points resulted from the sewing penetration during sewing process.

The results also indicated that the digital printing technique had the highest effect on increasing the tensile strength of fabrics with and without seam, then came the batik printing and tie-dying printing.

For evaluating the effect of stitch types, appeared the Over lock stitch (504) stronger than the Lockstitch (301). Results indicated also that with the stitch length 1.5 mm by stitch 301 and stitch length 2 mm by stitch 504 (Stitch density is high) became the fabrics stronger than by other investigated stitch length levels, due to increasing the stitch density and sewing thread consumptions.

Studying the Elongation Behavior

Referring to table 7, we find that all degrees of correlation were positive and more than 0.5, which confirm the existence of correlation from medium to strong correlation between the elongation of material before printing and after printing.

Table 7: Paired Samples Correlations for Elongation Behaviour (Material 1)

		N	Correlation	Sig.
Pair 1	MATERIAL1 & DIGITAL	7	.975	.000
Pair 2	MATERIAL1 & BATIK	7	.924	.003
Pair 3	MATERIAL1 & TIEDYING	7	.916	.004

To confirm the impact of the printing methods on the elongation behaviour, the "t" test had been applied, and the table 8 shows that:

The value of "t" equals "-2.646" in the case of material1 and digital printing, and “2.664“ in case of batik printing and “4.143” in case of tie-dying printing. It is a statistically significant values at the level (0.05), which definite the differences between material without printing and with printing, and these pointes to the influence of the printing techniques on the elongation of the fabrics.

Table 8: Paired Samples T-test for Extensibility Behaviour

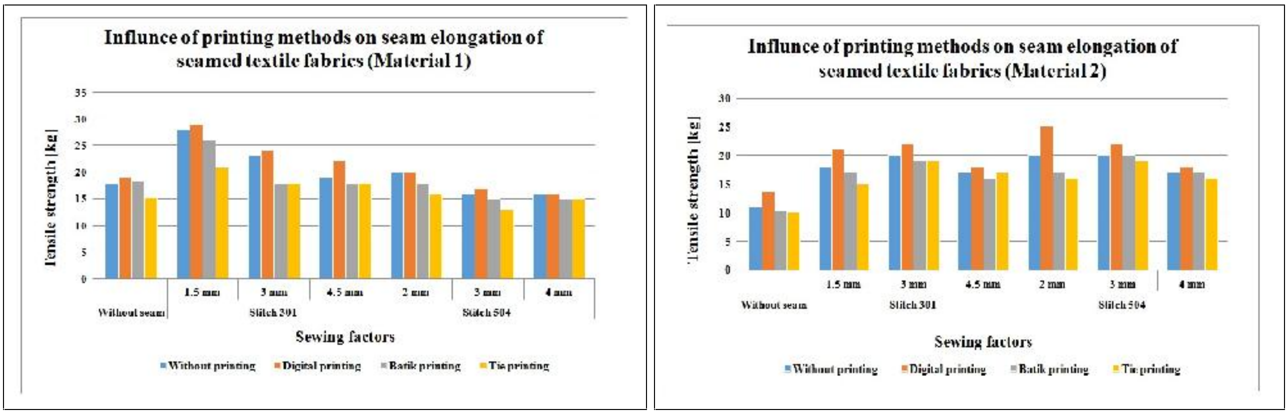
Paired Samples		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MATERIAL1 - DIGITAL	-1.00000	1.00000	.37796	-1.92485	-.07515	-2.646	6	.038
Pair 2	MATERIAL1-BATIK	1.67143	1.66003	.62743	.13615	3.20670	2.664	6	.037
Pair 3	MATERIAL1-TIE-DYING	.037	2.16212	.81720	1.38609	5.38534	4.143	6	.006

To analyze the significance of the T-test in table 8, we found that the P-values by the three investigated printing techniques were less than 5%. Therefore, we reject the null hypothesis of this correlation and we can say that it is significant.

Since the P-value of the first pair (Material and digital) equal 0.038, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the second pair (Material and batik) equal .037, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the third pair (Material and tie-dying) equal .006, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant



(a): M 1 **(b): M 2**

Figure 3: Influence of Printing Methods on the Elongation

Results shown in figure 3 pointed to, that the extensibility or elongation of the fabrics behaved opposite to the strength, seams made the fabrics more elastic, due to the stitches, which allow the fabric to elongate more before defecting.

In other side, the printing techniques increased in general the extensibility of investigated materials. To compare the effect of the different printing methods, it could be said, that the digital printing recorded the highest value of fabric elongation, then came the batik printing and at the end came the tie-dying printing method.

Analyzing the sewing parameters showed that, the over-lock stitch 504 is more extensibility than the lock stitch 301. To determine the effect of stitch length, behaved the elongation by different stitch lengths similar to the seam strength. By more stitch density, stitch length 1.5 mm by stitch 301 and 2 mm by stitch 504, showed the materials more elongation.

Studying the Bending Stiffness Behaviour

Investigation the influence of printing techniques on changing the bending stiffness bahviour indicates that, the printing caused increasing the bending stiffness in general. In addition the seam leads to more stiffness in the materials also. Results of bending stiffness of material 1 were presented in figure 4.

It could been concluded that, Batik technique showed the highest bending stiffness, Then came the tie -dying technique and at the end came the digital printing.

Studying the effect of sewing parameters confirmed that, the over-lock 504 showed more stiffness than the lockstitch 301. Analyzing the influence of stitch length pointed to, that with long stitch length showed the materials more stiffness, because of increasing in the sewing threads consumption. The longer the stitch length is, the higher the bending stiffness.

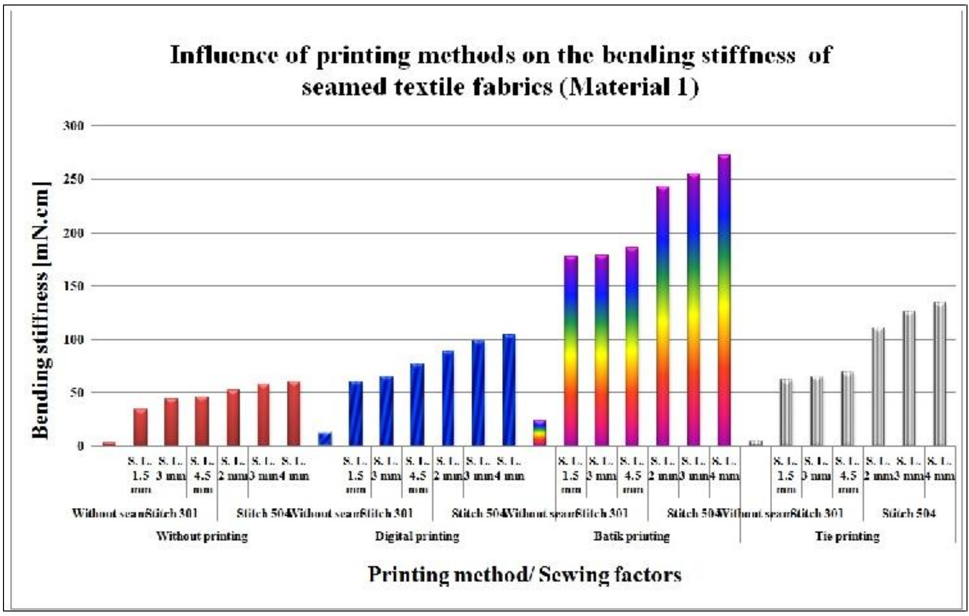


Figure 4: Influence of Printing Methods on the Bending Stiffness (M 1)

To analyze the results statically, the correlations are calculated using the statically program SPSS. In table 9, we get that all of correlation degrees were positive and more than 0.5, which prove the survival of correlation from medium to strong correlation between the bending stiffness of material with and without printing.

Table 9: Paired Samples Correlations of Material 1

		N	Correlation	Sig.
Pair 1	MATERIAL1 & DIGITAL	7	.988	.000
Pair 2	MATERIAL1 & BATIK	7	.983	.000
Pair 3	MATERIAL1 & TIEDYING	7	.947	.001

To achieve the goal to find the influence of the printing methods on the bending stiffness behaviour, the "t" test had been chosen to application, and table 10 shows that:

The value of "t" equals "-6.459" in the case of material1 and digital printing, and “-6.084 “ in case of batik printing and “-3.756” in case of tie-dying printing. It is a statistically significant values at the level (0.05), which specific the differences between material without printing and with printing, and these pointes to the influence of the printing techniques on the bending stiffness of the fabrics.

To analyze the significance of the T-test in table 10, we establish that the P-values by the three printing techniques were less than 5%. Therefore, we refuse the null hypothesis of this correlation and we can say that it is significant.

Table 10: Paired Samples T-Test for Bendin Stiffness Bahaviour

Paired Samples		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MATERIAL1 - DIGITAL	-30.18386	12.36461	4.67338	-41.61922	-18.74850	-6.459	6	.001
Pair 2	MATERIAL1-BATIK	-148.55671	64.59892	24.41610	-208.30075	-88.81268	-6.084	6	.001
Pair 3	MATERIAL1-TIE & DYING	-39.39243	27.75100	10.48889	-65.05782	-13.72704	-3.756	6	.009

Since the P-value of the first pair (Material and digital) equal 0.001, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the second pair (Material and batik) equal 0.001, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant.

Since the P-value of the third pair (Material and tie-dying) equal 0.009, this is Less than 5% and therefore we reject the null hypothesis of this laboratory and we can say that it is significant

Studying the Seam Pucker

Evaluation of seam puckers is one of the most important aspects for quality control in garments manufacturing industry. Seam puckers lead to garments aesthetically unacceptable and may cause inconvenience in wear [17]. One of the aims of this study was to determine if the printing techniques an effect on the seam pucker have. The evaluation of the seam pucker was carried out by using the standard seam pucker photos. There are 5 grades of the pucker, from 1 to 5, where 1 is the worth and 5 is the best. The acceptable grades are from 3 to 5 grade.

Results in figure 5 confirmed that, the two investigated printing techniques (digital and batik printing) affected the fabrics similarly. The results of seam pucker grade in all cases were about 4 and 5 grade, which means the seam pucker is acceptable and the printing technique did not have a negative effect. Only the tie- dying technique had an effect on reducing the pucker grade, The seam pucker were between 3 and 4 grade, defiantly still acceptable grade. Analyzing the influence of sewing parameters pointed to, that the different stitch types had the same effect also. Only by the stitch length showed the small stitch length, 1.5 mm by stitch 301 and 2 mm by stitch 504, appeared the seam pucker grade lower than by the other stitch lengths, it could be happed because of the more stitch density.

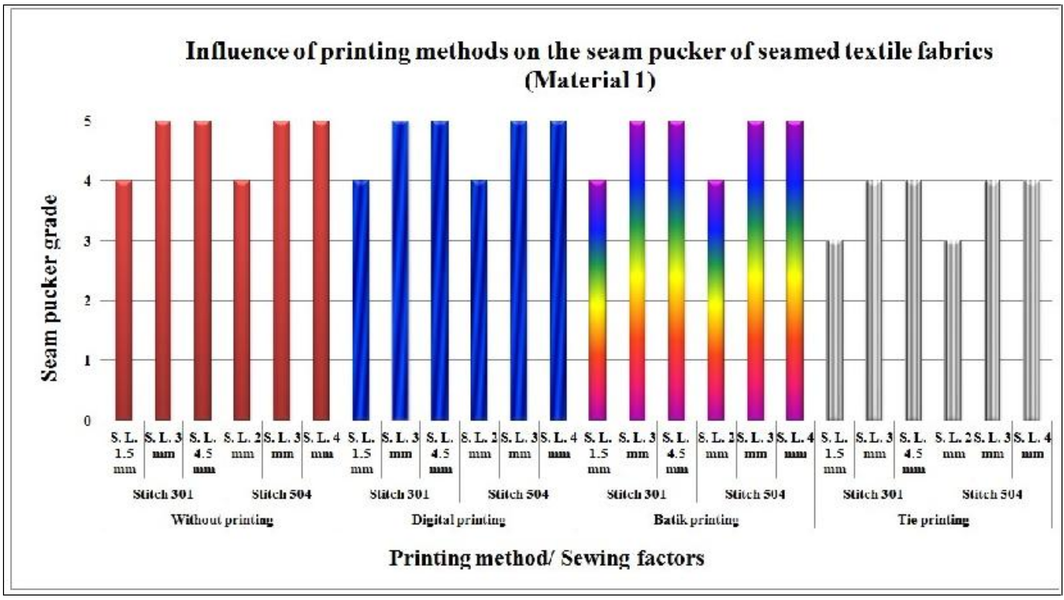


Figure 5: Influence of Printing Methods on the Seam Pucker

Studying the Dimensional Stability

The dimensional stability of a fabric is a measure of the extent to which it keeps its original dimensions subsequent to its manufacture. Fabric shrinkage can cause problems in two main areas, either during garment manufacture or during subsequent laundering by the ultimate customer.

The following types of dimensional change are generally recognized and investigated in this research:

Hygral Expansion (HE): Is a reversible change in dimensions, which takes place when the moisture regain of a fabric is altered.

Relaxation Shrinkage (RS): Is the irreversible dimensional change accompanying the release of fibre strains imparted during manufacture, which have been set by the combined effects of time, finishing treatments, and physical restraints within the structure.

In this study, we investigated the change in the dimensional stability (RS and HE) in warp and weft direction according to the following equations [21]:

$$RS = \frac{L1 - L3}{L1} \times 100$$

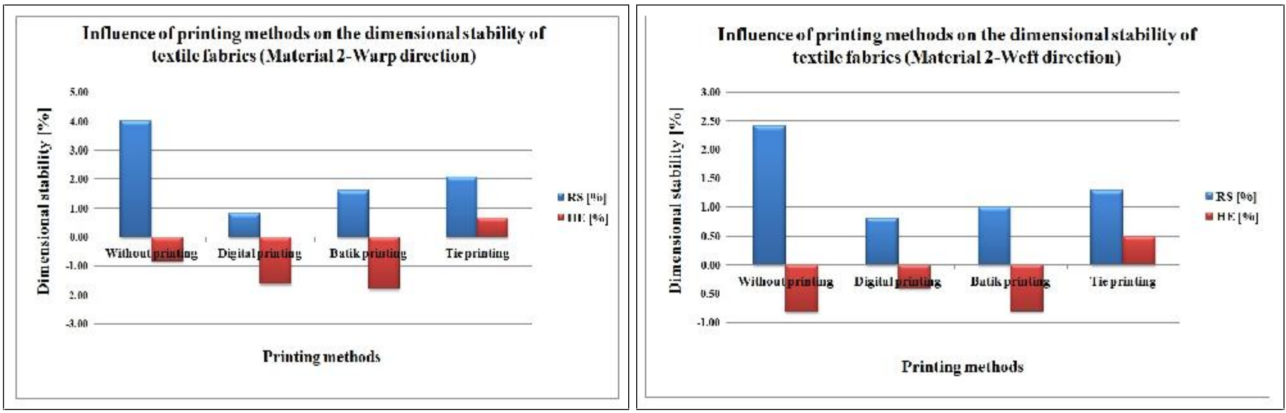
$$HE = \frac{L2 - L3}{L3} \times 100$$

Where:

L1= original measurement of fabric

L2= measurement of wet fabric

L3= final measurement of fabric after drying



(a) Warp Direction **(b) Warp Direction**

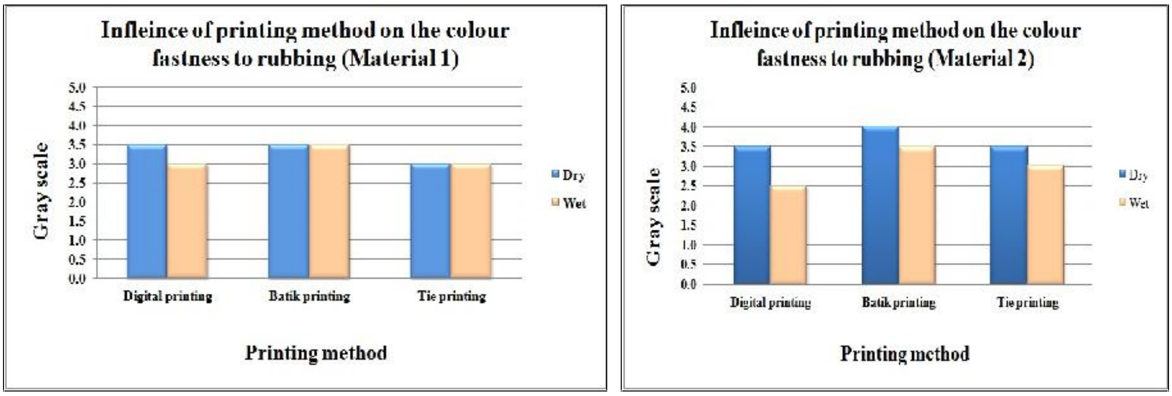
Figure 6: Influence of Printing Methods on the Dimensional Stability (M 2)

Results in figure 6 of the dimensional stability of material 2 in warp and weft directions indicated that, printing techniques affected positively in decreasing the shrinkage ratio. Both of RS and HE were lower by printed fabrics than by materials without printing. That means it is in general lead the fabrics to be more stable. Results showed also that, when comparing the effect of different printing technique, showed the tie-dying printing the highest effect followed by the batik printing and came the digital printing at the end. It can be due to the method of the tie –dying making the printing stuffs not covering the whole fabric surface.

Studying the Colour Fastness to Rubbing

Colour fastness to rubbing was carried out in two cases; Wet and Dry, for printed materials without seam only. The visual assessment (Grey scales) was used in this study. Grey scales have a rating of 1 to 5. With 1 being the worst colour performance and 5 being the best. Each rating can be divided to two values, so that there are nine available ratings within the grey scale system.

Figure 7 indicated that, the three applied printing methods recorded values between 2.5 and 4 degree in both dry and wet cases, which considered acceptable degree of colour fastness. In general, the valued by crocking in dry case is higher than by in wet case.



(a) M 1 **(b) M 2**

Figure 7: Influence of Printing Methods on the Colour Fastness to Rubbing

To determine the influence of the printing method, it is clear that the batik printing showed the highest value of colour fastness in the two cases; wet and dry. The digital dying and tie-dying showed closed results in the two cases.

CONCLUSIONS

Textile printing is the most important and flexible technique, which used to add design, color, and specialty to textile fabrics. The goal of this study was to investigate the changes in the textile fabric properties behavior, according to adding the print motifs or the print stuff or print technique. Three printing techniques (digital, batik and tie-dying) were used for printing the fabrics. Two kinds of stitch type (lockstitch and overlock stitch) with three levels of stitch lengths were applied to the samples. 6 laboratory tests were carried out; Factors considered are tensile strength, elongation, bending stiffness, seam pucker, dimensional stability and colour fastness to rubbing. Results were statically by the SPSS program analyzed and introduced. The p-values are Less than 5% and therefore we can say that it is significant. Results indicated that the digital printing technique had the highest effect on increasing the tensile strength and the elongation of fabrics with and without seam. Results confirmed that, batik technique showed the highest bending stiffness between the three investigated methods. Analyzing the results of seam pucker showed that, investigated printing techniques (digital and batik printing) affected the fabrics similarly. The results of seam pucker grade in all cases were about 4 and 5 grade, which means the seam pucker is acceptable. Only the tie- dying technique had an effect on reducing the pucker grade. From the results of the dimensional stability, we can conclude that, printing techniques affected positively in decreasing the shrinkage ratio. That means, it is in general lead the fabrics to be more stable. By crock meter, the three applied printing methods recorded values between 2.5 and 4 degree in both dry and wet cases, which considered acceptable degree of colour fastness. In general, the valued by crocking in dry case is higher than by in wet case.

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