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Laundry Bluing Effect on Performance Attributes of African Prints

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ABSTRACT

During the process of care of garments, various agents or additives are employed such as fabric softeners, spray starch and bluing. The purpose of this study was to determine the effect of laundry blue on selected performance properties of white Ghanaian cotton printed fabrics. With the aid of experimental procedures the study was carried out using three different types of black and white Ghanaian cotton printed fabrics. The total number of specimens used for the study was 264. The parameters investigated included weight, tensile strength and elongation, colourfastness to washing and dimensional stability (shrinkage) to washing. The data was analysed using Predictive Analytical Software (SPSS) for windows Version 22. Means of parameters such as yarn count, weight, strength and elongation were calculated. Inferential statistics (Analysis of Variance and Independent samples *t*-test at 0.05 alpha levels) were employed in testing the hypotheses. Differences were observed with specimens rinsed with and without laundry blue in terms of strength, elongation, shrinkage and colourfastness. Further research is recommended for analysis of laundry blue on other fabrics.

KEYWORDS: Bluing, whitening effects, colour fastness, dimensional change, tensile strength, African prints.

INTRODUCTION

Printed fabrics are widely used by humans in our daily lives for products such as apparel and home fashions. The print designs are made on base fabrics originating from both natural and man-made fibre sources such as cotton, rayon and flax with cotton being the most often used natural fibre worldwide. Cotton printed fabrics are produced worldwide and are extensively used in Ghana. They are used almost on all occasions for instance for weddings, outdooring and funerals. In some Ghanaian cultures, traditional African Wax print forms part of the bride price. As far back as 2006, [1] noted that among the major factories that produce African prints in Ghana are Printex, Akosombo Textiles Limited (ATL) and Tex Styles Ghana Limited, formerly Ghana Textile Printing Company (GTP). These industries still exist in Ghana producing various print designs. The variations of textile prints produced include Java, Real Wax and Fancy in their various colours. Usually the white and black and white and blue printed fabrics are mostly used for celebratory occasions such as funerals where the individual was 70 years and above to celebrate the person for having lived a full life as well as outdooring and naming ceremonies in the Ghanaian culture [2]. Individuals in some instances have to pay high price for the clothes made for them for such occasions. For an individual to spend money on such garments made, they would expect that the garments stay for a longer period in the condition in which they were purchased.

In an attempt to keep clothes looking new always and fit for purpose, various care procedures are followed. Such procedures include laundering (washing), dry-cleaning and ironing [3]. During the process of care, various agents or additives are employed such as fabric softeners, spray starch and bluing. These additives may contain ingredients that may react with the fabrics chemical composition to either enhance or destroy some performance attributes of the fabrics they are used on and need to be investigated. For the purpose of this work, bluing is the main concern. Bluing which is also termed as laundry blue or washing blue is noted to be an age old household laundry product that white fabrics are rinsed with to improve their appearance [4]. The household managers in the Ghanaian community that make use of this bluing agent do so with the intention of maintaining or improving the appearance of the white and black and white and blue African print fabrics as well as all white fabrics.

Bluing adds trace of blue dye which is often synthetic ultramarine, sometimes Prussian blue to the fabric when used in laundering [5]. They may come in the liquid or powdered form. Liquid bluing is a colloidal suspension of a very fine blue powder and water [5]. Bluing, [5] indicated may contain other ingredients such as pH balancer and a biocide to prevent the build-up of algae and bacteria and is a more environmental alternative to bleach [4]. However, [6] indicated that liquid bluing is slightly toxic and can be more toxic as Prussian blue can emit hydrogen cyanide when

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exposed to high temperatures, strong ultraviolet light or acid. Colour experts are able to differentiate about 300 shades of white where some whites are pink-white others gray-white, but the brightest white seen by the human eye as "whitest white" has a slight blue hue [7]. It was indicated that as colour experts prove with the use of colour spectrographic by comparing two whites, the one with blue added reflects more light causing it to appear whitest. This explains why individuals that wish to maintain or return their clothes to the original sparkling white colour employ the use of bluing in the washing process. During the manufacturing stages of fabrics, such as cotton fabrics, bluing is used to enhance the appearance of the fabrics even after bleaching as the bleaching process is not enough to make the yellowish grey good whiter. The bluing applied at the manufacturing stages wears off during the care and storage process causing the fabric to yellow over time since they were never white to start with. Dirt and oils may also cause discoloration and therefore the blue hue has to be renewed or restored by the use of the blueing additive during washing [4].

Consumers use various additives to maintain the appearance of their products as indicated, but the question is, do they even think of the effects these additives may have on the products they wish to maintain?. As indicated by [7], there are various washing additives on the market today, however, it is advisable to establish through experimental investigations if the products truly does what the manufacturer says without causing any harm to the clothes that are washed with such additives. Sometimes even the precautions to take in order to avoid damage may not be indicated. For instance quantities to be used, when to use it and how may vary depending on the type of fabric the consumer is working with. In the case of bluing, for example, [7] indicated that the quantity to be used depends on the size of the wash load and whether it is being used in the wash or rinse water. Bluing must always be diluted and not poured from its container into the wash or rinse water when clothes are present to prevent some fibres from absorbing excess undiluted bluing to cause blue spotting [4, 7]. Bluing does not remove stains, all it does is to brighten the appearance of the fabric [7]. An individual wanting to achieve a very good effect may increase the quantity that has been indicated which may mere the appearance or affect some attributes of the fabric. Whiles bluing agents have been used for years on fabrics its effect on performance attributes of fabrics have not received much attention especially with regard to the much adored African print fabrics. Even though detergents manufacturers are adding optical brightening agents to replace the work of bluing, there exist the use of bluing in some homes today. This study therefore sought to establish whether bluing causes any effect to fabric performance attributes when used.

Objectives of the study

The study's objectives were to;

1. determine the basic performance attributes (weight, thread count and weave type) of three selected white and black African printed fabrics.
2. evaluate the effects of bluing on the strength, colour change, dimensional change and elongation of three white and black cotton African prints after three washing cycles.

Hypotheses

Ho_1: there is no statiscally significant difference between the numbers of times of washing with bluing and the strength, elongation, and shrinkage of three selected white and black printed fabrics.

Ho_2: there is no statiscally significant difference between fabrics specimens rinsed with bluing and those rinsed without bluing in terms of strength, elongation and shrinkage.

The outcome of the study is expected to assist in establishing whether bluing has any effect on the selected performance attributes of fabrics and advice consumers accordingly. It would also serve as literature for further research.

MATERIALS AND METHODS

Materials

Three different Ghanaian produced white and black African print fabrics from three popular fabric producing companies were purchased from the market and labelled A, W and P**.** The quantity bought was 2.7 meters for each fabric type. Eighty-eight (88) specimens were prepared from each fabric type making the total number of specimens used for testing the various fabric attributes in the study 264.

The detergent type used for washing the specimens was a standard soap which does not have optical brightener. This soap is used by the Ghana Standards Authority (GSA) for carrying out tests. The soap was selected so that soap could be kept constant whiles observing the effect of bluing on the selected fabrics.

A container of one brand of powdered bluing was also purchased from the market and used for rinsing the specimens.

Methods

Test methods developed by the International Organisation for Standardization (ISO) adopted by Ghana Standards Authority (GSA) were employed by the researchers. The specimens were conditioned for 24 hours in a relaxed state at a relative humidity of 65 ± 2% and a temperature of 21°± 1°C [8] before the investigation. A number of the specimens were subjected to three cycles of washing (some rinsed with bluing and others rinsed without bluing) whiles others were unwashed. The performance characteristics evaluated on the fabrics were as follows:

Woven Fabric Yarn Count

Five specimens each measuring 2.5cm in the warp direction and 2.5cm in the weft direction were cut from each type of printed fabric and labelled for easy identification. A magnifying glass was used to test for yarn count where the numbers of yarns in the warp and weft directions of the specimens were counted from each cut specimen and recorded separately. After that an average warp and weft count was calculated for each fabric type.

Weight of Fabrics

Five specimens with the area of $0.015m^2$ were cut with the help of a sample cutter from each fabric type and labelled. Each specimen was weighed using Adams equipment weighing balance, Model No. B215846278. The average weight of the five specimens were calculated and indicated in grams per square meter.

Colourfastness

Four specimens (2 were washed and rinsed with bluing and 2 washed and rinsed without bluing) 10cm×4cm were cut from each type of fabric and labelled. A multi-fibre fabric of same measurement was attached to each specimen. The specimens were then taking through washing procedures and colourfastness assessment was carried out with the aid of the ISO Grey Scale for colour change. Five readings were recorded in the visual inspection of the specimens for colour change for each fabric in a well-lighted colour assessment chamber. The grey scale ratings ranged from excellent to poor with grade 5 being excellent, 4 very good, 3 good, 2 moderate and 1 poor colourfastness.

Dimensional Stability (Shrinkage) to Washing

Four specimens (2 were washed and rinsed with bluing and 2 washed and rinsed without bluing) measuring 15cm×15cm were cut from each fabric such that the yarns in both directions (warp and weft) were parallel to the edges and labelled for easy identification. Two lines of 10cm apart and 2.5cm from the specimen edges were marked on each specimen. After the washing procedures, the distance between the marked lines (10cm×10cm) were re-measured from each direction (warp and weft) of the specimen with the aid of tape measure and recorded to determine if any change in the original length (10cm×10cm) occurred. Percentage dimensional change (shrinkage) was calculated with the formula provided by GS, ISO 5077 [9], which was:

$$\text{Dimensional Change} = \frac{\text{Change in Length}}{\text{Original Length}} \times 100$$

Fabric Strength and Elongation

The strip test method following ISO 13934-1 [10] was used for testing fabric strength and elongation with the help of a tensile testing machine (Tinius Olsen CRE H50KT). Seventy specimens (35 each from the warp and weft directions) each measuring 30cm×7cm was cut from each fabric and labelled (30 were washed and rinsed with bluing, 30 washed and rinsed without bluing and 10 were unwashed). The lengthwise direction of each specimen was frayed to obtain 30cm×5cm for testing. The gauge length of the tensile testing machine was 200mm and the rate of extension or the speed of extension was set at 100mm/minute. Force (strength) at break and the elongation (extension) at break were recorded for each unwashed and washed specimen in both the warp and weft directions. Maximum forces at rupture were recorded in Newtons (N). Elongation was recorded in millimetres and calculated using the formula:

$$\text{Breaking elongation} = \frac{\text{Elongation}}{\text{Original length}} \times 100$$

Laundering Procedures

The fabric specimens that needed to be laundered were laundered and dried according to the Ghana Standards Authority's guidelines for laundry test conditions using a Launder-Ometer (Gyrowash 315) at a temperature of 60^0C for 30 minutes. The specimens were washed with a solution of standard soap, rinsed with and without a solution of bluing and dried under the sun for 10 minutes repeatedly for three cycles of washing. The quantity of soap solution

used for washing in the three cycles was 240 litres. For the bluing, 2 grams was mixed with 1 litre of water and 100mls of that solution was used to rinse each washed specimen for 5 minutes before drying in each cycle of washing.

Data Analysis and Presentation

The data for the study was analysed with the Predictive Analytical Software for windows, version 22. Means of parameters such as yarn count, weight, strength and elongation were calculated. Inferential statistics (Analysis of Variance and Independent samples *t*-test at 0.05 alpha levels) were employed in testing the hypotheses. The results were presented in Tables.

RESULTS AND DISCUSSION

The three Fabric types used for the study were 100% cotton with plain weave of 1×1 repeat. The fabric labelled P had the highest weight (M= 147.6) and W had the least weight (Table 1). In terms of yarn count, A had the highest count in the warp (M= 86), but lowest count in the weft direction (M= 60) (Table 1).

Table 1: Basic Structural performance attributes of investigated fabrics

Attribute	Weight (g/m^2)	Yarn Count		Strength (Newton)	
Sample		Warp	Weft	Warp	Weft
A	126.8	86	60	462	342
W	114.2	81	71	416	248
P	147.6	76	64	481	276

With regard to strength, P had the highest strength (M= 481) in the warp direction, and W had the lowest strength in the weft direction. Surprisingly, the fabric with the highest count (W) had the least strength in both the warp and weft directions. This could be due to differences in the linear density of the yarns in the fabrics, which was not determined in this research. The results shows that weight of fabrics do not only depend on their yarn count. The finding is in agreement with what [11] found. She observed that fabrics with high counts recorded lowest weight values, which she attributed to the linear density and fibre content of the sampled fabrics. She concluded that the weight of a fabric does not only depend on the fabric's yarn count but also by its linear density and confirms the assertion of [12, 13] that fabrics weights vary due to differences in fibre content, number of yarns per 2.5cm (1 inch) as well as in yarn size. All the fabric samples, however, met the minimum standard specification for yarn count (warp= 68-80 and weft= 64-70 directions), strength (warp=235N and weft = 216N directions) and weight ($107g/m^2$) set by the Ghana Standards Authority for African print fabrics [14].

Comparing specimens washed and rinsed with blue and the ones washed and rinsed without blue, it can be noted that for sample A, in terms of strength, in the warp, there was an increase after all the three wash cycles, but in the weft, increase, decrease and increase pattern was observed. The specimens rinsed with blue rather increased in strength throughout the wash cycles in the warp direction (Table 2). For sample P, in the warp, there was an increase, decrease and increase in strength and for the weft, increase strength was observed after each wash cycle with the specimens washed with blue compared to those washed without blue (Table 2). Sample W, the specimens rinsed with blue experienced increase, increase and increase strength in the warp and decrease, decrease, increase pattern after each wash cycle in the weft compared to the specimens rinsed without blue (Table 2). Generally, it can be observed that specimens rinsed with blue obtained greater strength after washing compared to the ones rinsed without blue. However, comparing the specimens rinsed with blue and those rinsed without blue to the unwashed specimens for all three fabric samples (A, P and W), it can be noted that there was a decrease in strength after the three wash cycles, but largely the specimens rinsed without blue lost more strength (Table 2). This shows that the addition of the blue impacted the specimens positively in terms of strength, since without blueing the fabrics lost more strength. It must be noted that even though there were reductions in strength in all the fabric samples after washing with or without blue, they all maintained their strength above the set standard minimum limit by the Ghana Standards Authority for African print fabrics.

Table 2: Mean Strength and Elongation results before and after washing with and without bluing

	A				P				W			
	Strength (N)		Elongation (%)		Strength (N)		Elongation(%)		Strength (N)		Elongation (%)	
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
Unwashed	462	342	9	28	416	248	8	26	481	276	8	23
Washed and rinsed with bluing												
1st Wash	399	272	9	31	356	285	9	26	471	206	9	26
2nd Wash	382	256	10	30	366	235	9	29	479	274	10	21
3rd Wash	308	265	11	35	363	261	11	28	457	274	11	28
Washed and rinsed without bluing												
1st Wash	335	270	8	25	300	276	9	23	446	336	9	25
2nd Wash	304	294	9	29	368	219	8	20	439	314	9	27
3rd Wash	240	221	8	25	293	253	8	26	267	228	10	23

With regard to elongation, for sample A, the specimens rinsed with blue experienced increase in both the warp and weft directions after each wash cycle compared to the ones rinsed without blue (Table 2). In relation to the other two fabric samples (P and W), generally, the specimens rinsed with blue experienced increase in elongation compared to those rinsed without blue (Table 2). However, the fabric A specimens rinsed with blue experienced increases in elongation after each wash cycle in both the warp and weft directions, whiles the specimens rinsed without blue decreased in elongation in both directions after each wash cycle compared to the unwashed specimens (Table 2). For sample P, specimens rinsed with blue had increase elongation in both warp and weft directions, but those rinsed without blue maintained their elongation in the warp and decreased in the weft compared to the unwashed specimens. For sample W, there was increase in elongation in both specimens rinsed with and without blue, but those rinsed with blue had greater elongation compared to unwashed specimens. As observed with strength, specimens rinsed with blue performed better with elongation than those rinsed without blue.

The results for colour change (Table 3) shows that for all the fabric samples, there was a slight change in colour after rinsing the specimens with blue compared to the specimens rinsed without blue, where the latter performed better than the former. The specimens in each of the rinsing groups obtained an intermediate rating between very good and excellent. The grey-scale ratings obtained by both specimens rinsed with blue and without, however, met the standard specification for colourfastness set by Ghana Standards Authority for African print Fabrics which is 4. This indicates that in terms of colourfastness, whether the samples are rinsed with or without blue their performance would be satisfactory.

Table 3: Results for change in colour after washing with and without bluing

	A	P	W
Washed and rinsed with bluing			
1st wash	4/5	4/5	4/5
2nd wash	4/5	4/5	4/5
3rd wash	4/5	4/5	4/5
Washed and rinsed without bluing			
1st wash	5	4/5	4/5
2nd wash	4/5	4/5	5
3rd wash	5	5	5

With regard to dimensional stability (shrinkage), minimal difference was found between the samples washed with blueing and the ones washed without bluing (Table 4). The fabric samples whether washed with or without blueing met the standard specification set by Ghana Standards Authority for shrinkage for African print fabrics which is a minimum of 5%.

Table 4: Results for dimensional change to washing after washing with and without bluing

Sample	A		P		W	
	Warp (%)	Weft (%)	Warp (%)	Weft (%)	Warp (%)	Weft (%)
Washed and rinsed with bluing						
1st Wash	2	2	3	3	2	2
2nd Wash	2	3	3	2	3	2
3rd Wash	3	3	2	2	3	3
Washed and rinsed without bluing						
1st Wash	2	3	3	2	3	2
2nd Wash	2	3	2	3	3	3
3rd Wash	3	3	3	3	3	3

Hypothesis 1

The analysis of variance results presented in Table 5 shows significant differences existed between the wash cycles in terms of elongation in the warp, but not in the weft. Post hoc analysis for the warp direction revealed that differences were significant between unwashed ×2nd wash, unwashed ×3rd wash, 1st wash × 3rd wash and 2nd wash × 3rd wash specimens. However, in terms of strength and shrinkage no significant differences were found (Table 5). It must however be noted that from the mean scores in Tables 2 and 5, visible differences are observed with wash cycles in terms of strength and elongation. In Table 5, for instance, in terms of strength, specimens washed three times experience the greatest loss in strength.

Table 5: ANOVA results for fabrics (washed with blue) strengths, elongation and shrinkage by wash cycles

Wash cycle	Unwashed		1st Wash		2nd Wash		3rd Wash		MS	df	*F*	*p-value*
Parameter	M	SD	M	SD	M	SD	M	SD				
Strength (Newton)												
Warp	453	33.42	409	58.12	409	61.15	376	43.50	2996.667	3	0.86	0.499
Weft	289	48.26	254	42.36	255	19.52	267	6.66	771.222	3	0.68	0.590
Elongation (%)												
Warp	8	0.58	9	0.00	10	0.58	11	0.00	3.889	3	23.33	0.001*
Weft	25.67	2.52	28	2.89	27	4.93	30	4.04	12.083	3	0.87	0.494
Shrinkage (%)												
Warp	-	-	2	0.58	3	0.58	3	0.58	0.111	3	0.33	0.729
Weft	-	-	3	0.58	2	0.57	2	0.57	0.111	3	0.33	0.729

**Significant p<0.05, M= Mean, SD= Standard Deviation, MS= Mean Square*

Hypothesis 2

No significant differences were found between specimens rinsed with and without blueing with regard to strength, elongation and shrinkage (Table 6). The null hypothesis was therefore retained. However, from the mean values in Tables 2 and 6, visible differences are observed with specimens rinsed with and without blue in terms of strength and elongation where the ones rinsed with blue generally performed better.

Table 6: Means, Standard Deviations, T-values and P-values for strength, elongation and shrinkage by wash treatment (washed with and without blue)

	Wash Treatment	Rinsed with blueing		Rinsed without blueing		df	*t-value*	*p-value*
Parameter		**M**	**SD**	**M**	**SD**			
Strength (Newton)								
Warp		412	57.85	363	83.50	22	1.674	0.075
Weft		273	42.16	266	32.21	22	-.452	0.220
Elongation (%) Warp		10	1.09	9	0.67	22	2.488	0.061
Weft		28	3.65	25	2.49	22	2.025	0.332
Shrinkage (%) Warp		2	0.53	3	0.50	16	-.459	0.414
Weft		2	0.53	3	0.44	16	-1.455	0.097

**Significant p<0.05, M=Mean, SD=Standard Deviation*

CONCLUSION

The fabric samples behaved differently when rinsed with and without the laundry blue. Generally the specimens rinsed with blue performed better compared to the ones rinsed without blue. This raises a matter of concern which needs to be investigated further to determine the specific ingredients in the laundry blue causing the observed differences. The effect of laundering blue on the performance parameters strength, elongation, shrinkage and colour seems to be positive from the outcome of this study, however further research is required to test other combinations such as washing with soap bought from the market and rinsing with the laundry blue as well as the use of laundry blue on coloured fabrics to establish a clear performance direction of the laundry agent. That would help to present a better picture for industry practitioners to make informed decisions about the use of laundry blue in the care of fabrics.

REFERENCES

[1]. Quartey, P. (2006). The textile and clothing industry in Ghana. Available at: http://library.fes.de/pdf-files/iez/03796/10ghana.pdf, accessed October 2020.

[2]. Wright, J. (2019). *A tale of two fabrics: the fabric of life in a wax print setting.* Available at: https://gtpfashion.com/2019/11/01/a-tale-of-two-fabrics-the-fabric-of-life-in-a-wax-print-setting/, accessed February 2021.

[3]. Marshall, S. G., Jackson, H. O., & Stanley, M. S. (2012). *Individuality in clothing selection and personal appearance* (7thed.). New York: Prentice Hall.

[4]. Hand, J. (2017). How to whiten your sheets with laundry bluing. Available at: www.remodelista.com, accessed February 2021.

[5]. Leverette, M. M. (2020). *Laundry bluing and how to use bluing.* Available at: www.thespruce.com accessed February 2021.

[6]. Reinbold, J. (2021). What is bluing liquid? Available at: www.sciencing.com, accessed February 2021.

[7]. Educational Innovations Inc. (2011). Mrs. Stewart's Liquid Blueing. Available at: www.TeacherSource.com, accessed January 2021.

[8]. Ghana Standards Authority 2005. GS ISO 139: 2005- Textiles- standard atmospheres for conditioning and testing. Accra, Ghana: Ghana Standards Authority.

[9]. Ghana Standards Authority 2008. GS ISO 5077: 2008- Textiles- determination of dimensional change in domestic washing and drying. Accra, Ghana: Ghana Standards Authority.

[10]. International Organization for Standardization 13934-1 2013. Textiles- Tensile properties of fabrics-Part 1:Determination of maximum force and elongation at maximum force using the strip test method. Switzerland: International Organization for Standardization.

[11]. Danquah, P. (2018). A comparative analysis of fabrics used for the Ghanaian basic school uniforms. International Journal of Textile and Fashion Technology (IJTFT), 8(5), 19 – 28.

[12]. Pizzuto, J. J. (2012). *Fabric science* (10thed.). New York: Fiarchild.

[13]. Glock, R. E., & Kunz, G. I. (2005). *Apparel manufacturing: sewn product analysis* (4thed.). New Jersey: Pearson Prentice Hall.

[14]. Ghana Standards Authority. (2012). GS 124: 2012 - Textiles specifications for traditional African prints (3rd ed). Accra, Ghana: Ghana Standards Authority.