Effect of different industrial washes on seam shrinkage of knit (single jersey and rib) garments

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Abstract

The readymade garment sector of Bangladesh has been primarily dependent on the export of different knitwear. Knitted garments are made by the interloping of one set of yarns. Due to this reason, knitted garments have inherent extensibility and flexibility. Due to the laundering and several washing processes applied on the knitted garments for functional and beautification purposes, the garments come in contact with vigorous mechanical force, which significantly affects the dimensional stability commonly known as the shrinkage property of the garments. This has a significant impact on the final measurements of the garments. This research focuses on the impact of different garment washing techniques such as normal, detergent, bleach, and acid wash on the dimensional stability of single jersey and rib knitted t-shirts. The dimensions of the t-shirts were measured before washing and they were subjected to garments washing. After different washing, the garments showed a different level of changes in the dimensional stability that has been expressed as shrinkage percentage. Amongst the different washes, the acid wash has shown the highest amount of shrinkage due to the interaction with some strong washing conditions whereas normal wash with water showed the lowest amount of shrinkage as no chemicals have been used in this process. This research will be beneficial for garment manufacturers when patterns are being developed for fabric cutting, the expected shrinkage, known as residual shrinkage, needs to be considered to avoid unexpected changes in garment dimensions.

Keywords: Garment Washing; Knitwear; Edge Neatening Seam; Dimensional Stability

1. Introduction

Garments crafted from knitted fabrics have gained immense popularity worldwide owing to their distinctive attributes such as a soft texture, graceful draping, and inherent elasticity. Knitted apparel, such as briefs and vests, is widely embraced as undergarments due to its exceptional comfort and superior tactile qualities. Consequently, the expansion of knit garment factories in Bangladesh has been on the rise, as it presents numerous advantages to manufacturers, including reduced production costs, enhanced productivity, higher profit margins, and the ability to cater to a wide range of product types, spanning from basic to high-fashion garments [1, 2].
To ensure optimal customer satisfaction, the product quality must meet and exceed customer expectations. The quality of a garment is determined by factors such as reliability, durability, and visual appeal. By maintaining good quality standards, a garment can enhance its reputation, bolster customer satisfaction, and secure a competitive edge in the market [3].

Knitwear factories often encounter a range of challenges, particularly regarding the quality of their products. These issues encompass various sewing defects, fabrication flaws, color mismatches, and sizing discrepancies. Furthermore, fabric shrinkage poses a significant quality problem in the clothing industry, leading to sizing issues after laundering, as well as seam puckering, torque, and skewness in garments. While shrinkage occurs in both woven and knit fabrics, it is more pronounced in knitted fabrics due to their loose structure. In woven fabrics, the propensity for shrinkage is

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influenced by the weave design, with patterns featuring high interlacing points and low yarn crimps exhibiting superior dimensional stability [4].

Shrinkage in knitted fabrics can be attributed to two main factors: the construction of the fabric during knitting and the subsequent fabric processing. The stretching forces applied during knitting and other processes exceed the contraction or compression forces within the fabric, resulting in residual shrinkage [5]. Extensive research has been conducted to identify the causes behind dimensional problems in knit fabrics, taking into account parameters such as fiber, yarn, knitting techniques, and finishing processes. These factors play a crucial role in understanding and mitigating dimensional issues in knit fabrics.

Extensive research has been conducted to explore the dimensional stability of fabrics, with a particular focus on the parameters associated with fiber content. Studies have consistently demonstrated that water-absorbent fibers such as cotton and wool exhibit a greater tendency to shrink when compared to water-repellent fibers like nylon and polyester [6]. Among the water-absorbent fibers, wool has been extensively investigated due to its poor dimensional stability [7], whereas cotton's dimensional stability continues to be a subject of study owing to its widespread usage in the global clothing market [8, 9].

To address this issue, researchers have examined various blend ratios of water-absorbent fibers with water-repellent fibers. Their findings indicate that fabrics made from blends of cotton and polyester or cotton and spandex exhibit improved stability compared to fabrics composed solely of cotton [10, 11]. Furthermore, the utilization of microfiber and its blends has shown promise in achieving good dimensional stability. While initial research primarily focused on woven fabrics, subsequent studies have indicated that microfiber has equal potential for the knitwear industry as well [12].

The dimensional stability of fabrics is influenced by various yarn parameters, including yarn type, twist level, and linear density. Distinctions in dimensional stability have been observed between ring-spun yarn and open-ended yarn due to differences in fiber orientation [13]. The linear density of yarn plays a significant role in determining shrinkage percentage. When all other fabric parameters are held constant, an increase in yarn count leads to a higher density of courses and a lower density of wales in a relaxed state. Similarly, fabrics made from high-twisted and low linear-density yarn exhibit a more stable structure compared to those made from low-twisted and high linear-density yarn [14].

In knitted fabrics, parameters such as knit structure and fabric weight have been extensively studied to assess their impact on fabric shrinkage. Various knit structures, including single jersey, rib, interlock, fleece, pique, and others, have been examined in this context. All knit structures exhibit instability when in contact with water. However, looser structures, such as single jersey, demonstrate higher shrinking ability compared to more stable structures like interlock and fleece [15]. Additionally, the tightness of the fabric and stitch density significantly affect the stability of knitted fabrics. When compared to factors like yarn linear density and twist factor, stitch length directly influences the shrinkage of knitted fabric [16].

Following the manufacturing process, knitted fabrics can undergo washing through either the dry method or the wet method. The wet method is considered more cost-effective and time-efficient compared to the dry method. In the wet method, textiles may undergo various processes such as mercerization, laundering, and different types of finishing processes [18, 19]. While significant research has been conducted in this area, factors specifically related to garment manufacturing have not received sufficient attention. Stitching parameters have been analyzed to assess their impact on the shrinkage of knitwear made from single jersey fabric [20].

Different types of knitted structures are utilized for clothing purposes, each having varying abilities to shrink. It is crucial to investigate the effect of stitching and washing parameters on the dimensional stability of knit structures beyond single jerseys. Hence, the current study aims to examine the impact of different garment washing techniques on the dimensional stability of knitwear made from single jersey and rib fabric.

2. Materials and Method

2.1. Materials

In this study, 100 % cotton combed finished single jersey (160 GSM) and 1*1 rib fabric (190 GSM) were used which was collected from NZ Textile Ltd. 100% Polyester core spun sewing thread of 40 Tex was used for the research purpose. The five-thread overlock sewing machine of Jack Sewing Machine Co. Ltd. was used for edge neatening seam preparation. A lock-stitch plain sewing machine was used from the same brand for sample preparation. The washing machine of Tonello Garment Finishing Technologies, Italy was used for washing purposes. A locally manufactured hydro-extractor machine was used to extract the excess water after washing. The tumble dryer of Ramsons Garment Finishing Equipment's Private Ltd. was used for drying the garments after washing.
Subsequently, the samples underwent washing using various washing processes, including normal wash, detergent wash, bleach wash, and acid wash. The specific chemicals utilized in each washing process are outlined in Table 1.

Table 1: Chemicals used for garment washing

Types of Chemicals	**Name of Chemicals**
Basic Chemicals	Potassium Permanganate, bleaching agent, Lavacon Pupe, Thermocol ball,
Detergent & Scouring agent	Detergent, Biodin, NTN, ECE
Washing agent	Anti-back staining agent, KCI, Meta
Salt	Glauber salt
Softener	Silicon, super soft NS

2.2. Sample Preparation

The samples were meticulously prepared with precise measurements, featuring a length of 35.5 cm and a width of 26 cm. To ensure secure seams, overlock stitches were applied to the T-shirt samples using an overlock sewing machine, while lock stitches were skillfully applied using a lock stitch sewing machine. The samples were prepared in such a way that the edge neatening seam could be prepared in the shoulder and side seam of each garment sample. It is sewn on the overlock machine on both shoulder and side seam and sleeve join (Armhole) also. The bottom hem was prepared using a lock stitch sewing machine. 12 SPI was fixed for both overlock and lockstitch operation.

2.3. Test Procedure

After successfully executing the procedures of washing and drying, the measurements of every individual sample were obtained utilizing a measurement tape and recorded as post-wash measurements. To ascertain the percentage shrinkage of each sample, the following formula (1) was employed:

$$\Delta \mathrm{L} = \frac{\mathrm{L1} - \mathrm{L2}}{\mathrm{L1}} x \; 100 \qquad (1)$$

In equation (1), ΔL represents the percentage alteration in dimensions, while L1 denotes the measurement before washing, and L2 represents the measurement after washing.

Fig. 1. Samples after different washes (Single Jersey)

Bleach washed sample Bleach washed sample

Acid washed sample Acid washed sample

Fig.2 Samples after different washes (1x1Rib)

3. Results and Discussions

The difference in shrinkage percentage is calculated using Equation 1. The observed result is expressed in figures in detail. The results were analyzed using a column chart. The shrinkage effect has been calculated at the seam on both the left-side seam and right-side seam. Finally, the overall shrinkage percentage on garments also has been calculated in this research paper. Details result with discussion as follows.

3.1. Shrinkage percentage of both side seam

Figure 3 and Figure 4 respectively demonstrate the amount of shrinkage in the left-side seam and right-side seam of both single jersey and rib garments. Among the four types of garment washes, the normal-washed samples show the least amount of shrinkage. The reason behind this is normal washing is the simplest form of garment wash where no chemicals are used.

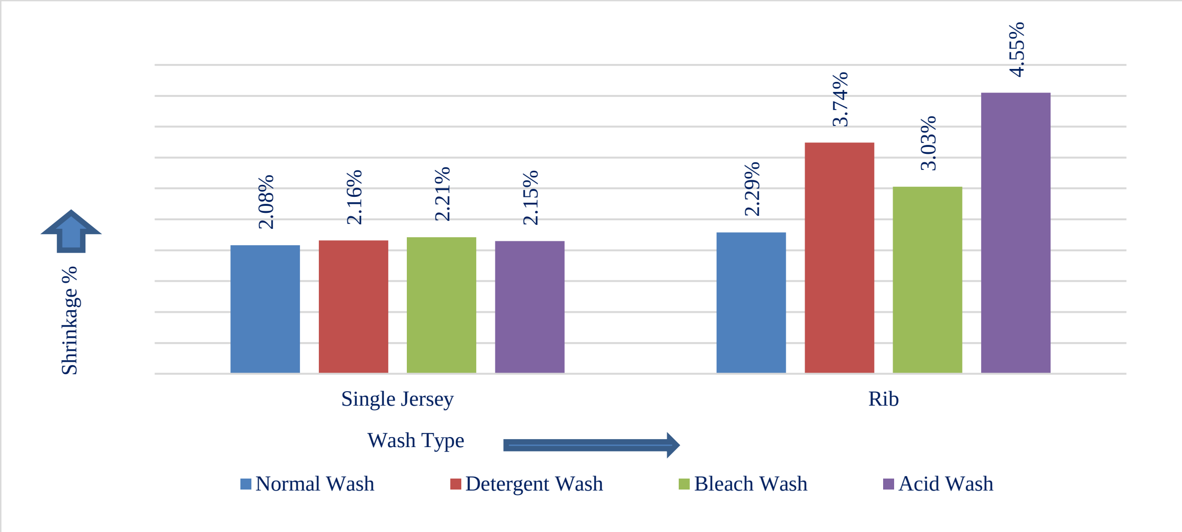

Fig. 3. Shrinkage percentage on left side seam

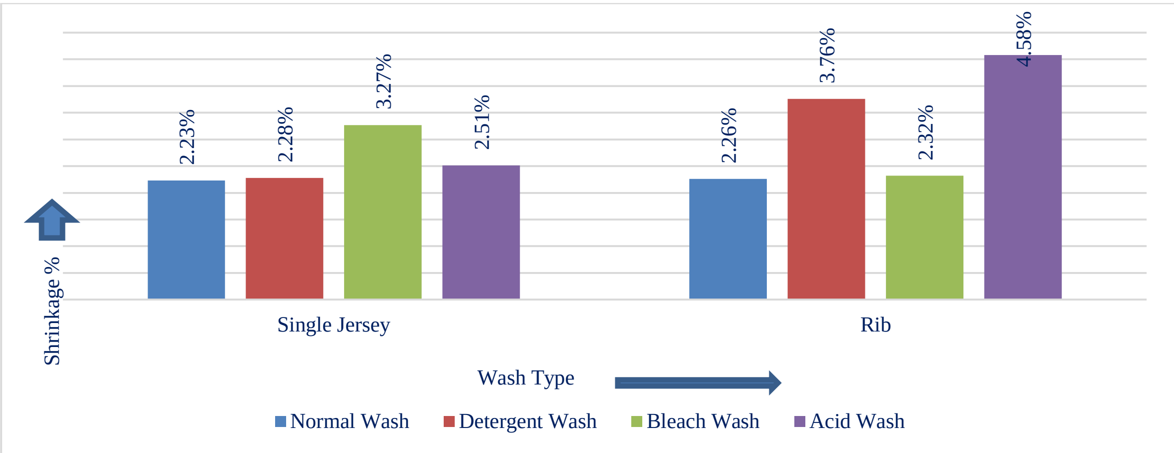

Fig. 4. Shrinkage percentage on right side seam

It is done for the removal of adhering materials like dirt dust and unfixed dyes and chemicals. On the other hand, acid-washed samples have shown the highest value of shrinkage. Acid wash is used for producing an uneven and irregular fading effect on garments popularly known as the ice effect. In this washing, vigorous tumbling of garments has occurred with different strong chemicals like acid and potassium permanganate. The detergent and bleach wash have shown a shrinkage percentage in the range between acid and normal wash, due to the fewer chemicals used than acid wash.

3.2. Overall Shrinkage Percentage of Garments

Figure 5 illustrates the average edge neatening seam shrinkage percentage of both single jersey and rib-knitted garments. As mentioned earlier, in this study four types of garment wash were done to obtain the shrinkage percentage namely: normal wash, detergent wash, bleach wash, and acid wash.

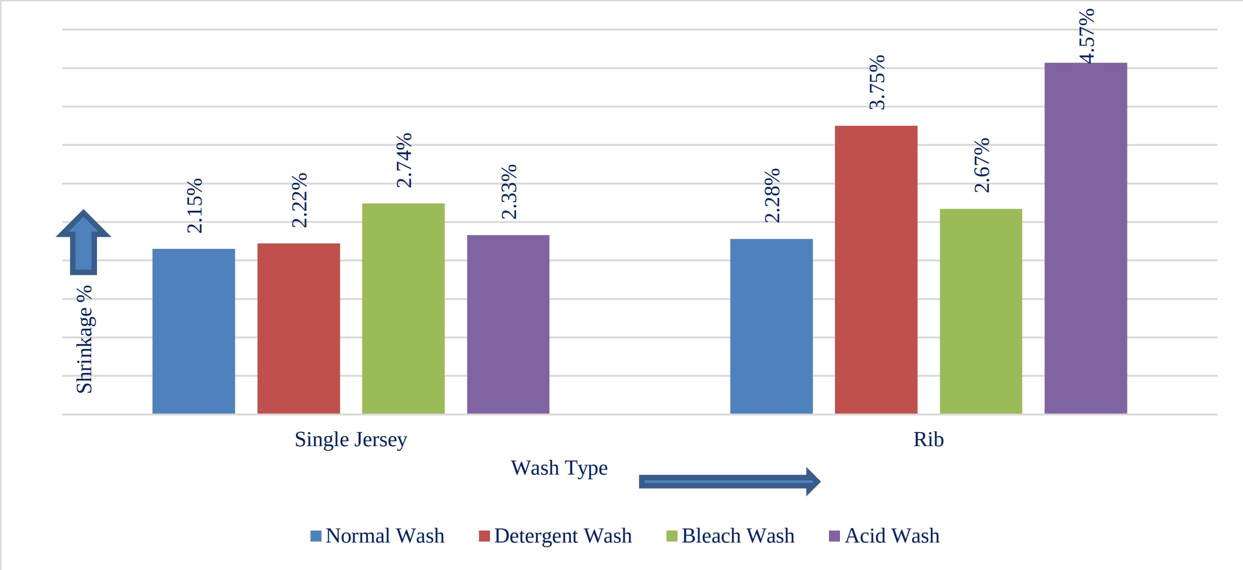

Fig. 5. Overall Shrinkage percentage on Garments

As can be seen from the above figure, the garment shrinkage that was obtained after washing treatments was highest (4.57%) in the case of rib garments during acid wash. Similarly, the lowest shrinkage percentage obtained was in the case of normal wash of single jersey garments (2.15%).

4. Conclusions

Dimensional stability is an important parameter for analyzing the quality of a garment. As garments are exposed to different mechanical forces during washing & laundering in both households and industry, their dimension can be changed significantly. Understanding the shrinkage behavior of a garment can lead to the production of garments with accurate measurement. Hence, the reworking for rectification of the measurement defects can be eliminated. This research showed the edge neatening seam shrinkage behavior of two of the most commonly used knitted fabrics (single jersey and 1*1 rib) when subjected to normal, detergent, bleach, and acid wash. The measurements of the side seams of each sample were taken before and after washing. The shrinkage was measured and the obtained data were compared. Acid wash caused the highest shrinkage because of its interaction with some harsh washing chemicals, whereas normal or regular wash caused the least shrinkage because no chemicals were utilized in the process. This research will help get an idea about the shrinkage behavior of edge neatening seams produced in single jersey and rib garments. This will help garment manufacturers predict the amount of shrinkage of single jersey and rib garments after performing different washes on them.

Acknowledgments

The authors are very grateful to the Department of Textile Engineering, Uttara University for providing the support for conducting the study in their laboratory.

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