

A Comparative Investigation of Knitted Fabrics Produced from Excess Yarn Cones and Mixed Yarn Counts


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Abstract

This study investigates the utilization of excess yarn cones in knitted fabric production as a cost-effective and sustainable alternative to conventional yarn usage. Two types of fabrics were produced using a circular knitting machine: conventional fabric made with 20s cotton yarn and experimental fabric produced using mixed yarn counts (20s and 30s) collected from excess yarn cones. Both fabrics were knitted under similar machine conditions such as same gauge, diameter, and loop length. The produced fabrics were tested for various structural and physical properties including GSM, CPI, WPI, loop length, tightness factor, bursting strength, air permeability, shrinkage, thickness, and color fastness after dyeing. The results show that the experimental fabric produced using mixed yarn counts exhibited properties comparable to the conventional fabric with only minor variations. In addition, the cost analysis revealed that the use of excess yarn cones significantly reduces production cost by eliminating rewinding processes and utilizing low-cost yarn materials. The study demonstrates that excess yarn cones can be effectively utilized in knitted fabric production to reduce yarn waste and promote sustainable textile manufacturing.

Keywords

Excess yarn cones, knitted fabric, mixed yarn count, sustainability, cost analysis, air permeability, bursting strength

Introduction

The textile industry is one of the largest manufacturing sectors in the world and generates a considerable amount of material waste during yarn and fabric production. One common type of waste generated in knitting industries is excess yarn cones, which are often left unused after completing production orders. These leftover yarn cones are typically sent for recycling or sold as waste, which results in economic loss and additional processing requirements.

With the increasing focus on sustainability and cost reduction in textile manufacturing, it has become important to explore alternative methods to utilize these excess yarn materials efficiently. One possible approach is to directly use these leftover yarn cones in knitting processes by combining yarn counts that are available in similar quantities. By mixing different yarn counts, such as 20s and 30s cotton yarn, it may be possible to produce fabrics that still maintain acceptable structural and physical properties.

Knitted fabrics are widely used in the textile industry due to their flexibility, comfort, and breathability. Among various knitted structures, rib fabrics are commonly used in garments such as T-shirts, innerwear, and casual wear. Rib

structures are produced using circular knitting machines that utilize both cylinder and dial needles, creating interlocking loops that provide elasticity and durability.

In this study, an attempt has been made to utilize excess yarn cones in knitting by mixing available yarn counts and comparing the resulting fabric properties with conventional cotton fabric produced using 20s yarn. The fabrics were produced using the same knitting machine parameters including gauge, diameter, and loop length to ensure consistent knitting conditions.

Various structural and physical properties of the fabrics were tested including GSM, CPI, WPI, loop length, tightness factor, bursting strength, air permeability, thickness, and shrinkage. Additionally, the dyed fabrics were evaluated for color fastness to washing and rubbing. A cost comparison was also carried out to analyze the economic benefits of using excess yarn cones.

The objective of this study is to determine whether excess yarn cones can be effectively utilized in knitted fabric production without significantly affecting fabric quality while reducing production cost and promoting sustainable textile manufacturing.

Methodology

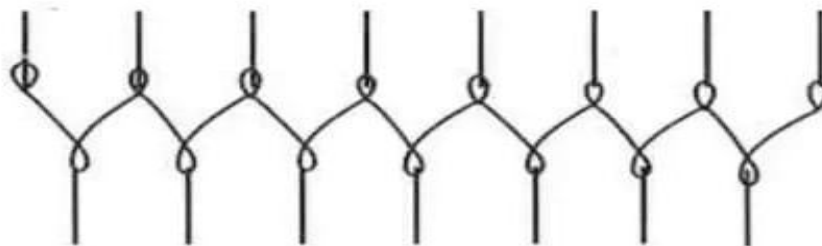
In this study, two types of knitted fabrics were produced using a circular knitting machine. The first fabric was a conventional cotton fabric produced using 20s cotton yarn, while the second fabric was an experimental fabric produced using mixed yarn counts of 20s and 30s collected from excess yarn cones available in the knitting unit.



The fabrics were knitted using a circular rib knitting machine with a machine diameter of 26 inches and a gauge of 24. Both fabrics were produced under similar knitting conditions, maintaining the same loop length and machine settings to ensure a fair comparison. The experimental fabric was produced by grouping excess yarn cones and arranging them in the feeders to obtain an average yarn count suitable for the machine gauge.



After knitting, the greige fabric samples were tested for structural and physical properties such as GSM, CPI, WPI, loop length, tightness factor, bursting strength, air permeability, thickness, and shrinkage. The fabrics were then subjected to dyeing and finishing processes, after which additional tests such as color fastness to washing and rubbing were conducted.



FULL NEEDLE RIB

The obtained test results were recorded and compared between the conventional fabric and the experimental fabric to evaluate their performance and quality characteristics.

Results and Discussion

The results obtained from the testing of greige and dyed fabrics show that the experimental fabric produced using mixed yarn counts exhibits properties comparable to the conventional 20s cotton fabric.

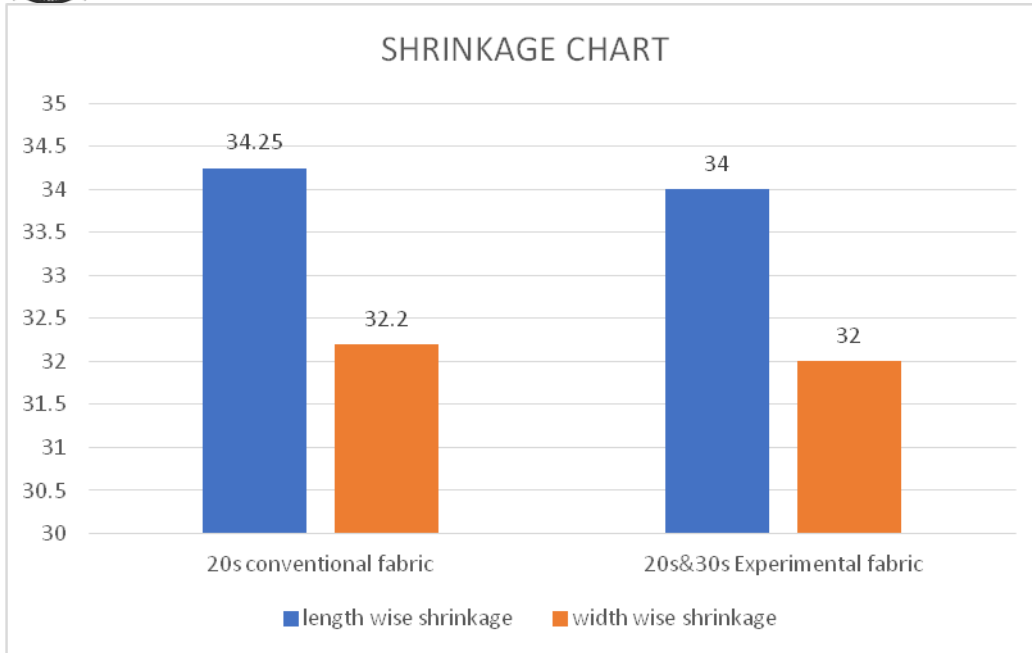


Figure 4.1 : comparison of Greige fabric Shrinkage

Shrinkage Analysis

The shrinkage behavior of both conventional and experimental knitted fabrics was evaluated in terms of length-wise and width-wise dimensional changes after washing. The results indicate that the conventional fabric (20s yarn) exhibited a length-wise shrinkage of **34.25%** and width-wise shrinkage of **32.2%**. In comparison, the experimental fabric produced using mixed yarn counts (20s and 30s) showed slightly lower shrinkage values, with **34%** in the length direction and **32%** in the width direction.

The marginal reduction in shrinkage observed in the experimental fabric can be attributed to the presence of finer 30s yarn in the structure. The finer yarn contributes to a slightly more flexible and less compact loop formation, which reduces the overall तनाव (stress) relaxation during washing. Additionally, the mixed yarn composition may help in distributing internal stresses more evenly within the fabric, thereby minimizing dimensional changes.

Both fabrics exhibited higher shrinkage in the length direction compared to the width direction, which is a typical characteristic of weft-knitted fabrics due to loop geometry and relaxation behavior. The differences between the two fabric types are minimal, indicating that the use of excess yarn cones with mixed counts does not significantly affect the shrinkage performance.

Overall, the experimental fabric demonstrates comparable dimensional stability to the conventional fabric, supporting its suitability for practical textile applications while promoting sustainable yarn utilization.

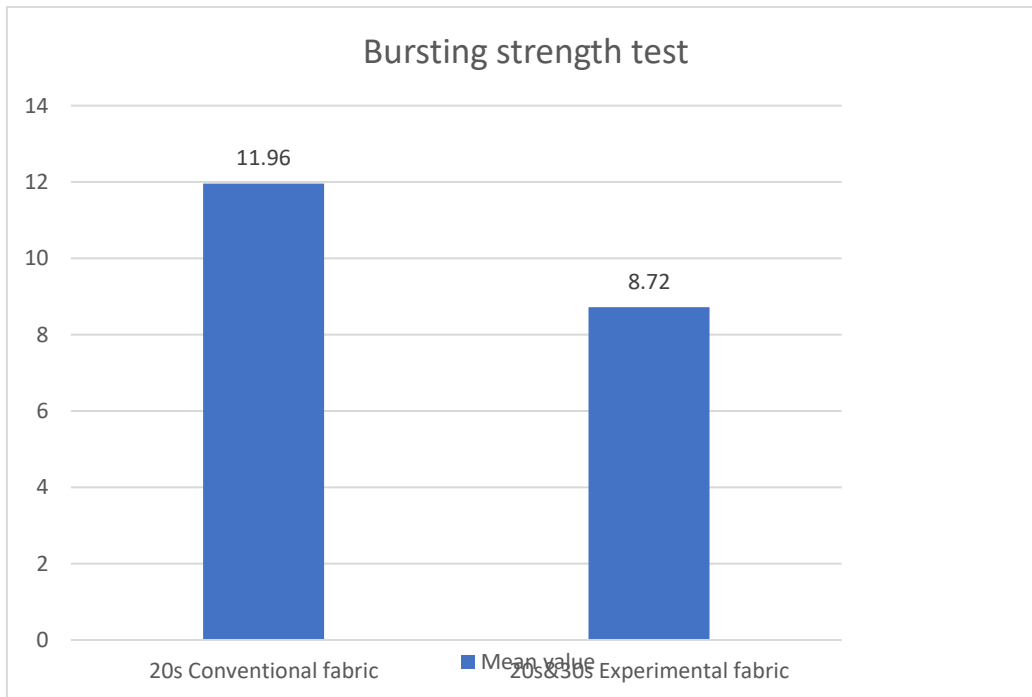


Figure 4.2: comparison of bursting strength test

The bursting strength test results indicate a noticeable difference between the conventional and experimental knitted fabrics. The conventional fabric produced from 20s cotton yarn exhibited a higher mean bursting strength of **11.96**, whereas the experimental fabric made from mixed yarn counts (20s and 30s) showed a lower value of **8.72**.

This reduction in bursting strength in the experimental fabric can be attributed to the use of mixed yarn counts. The inclusion of finer 30s yarn reduces the overall yarn thickness and structural compactness of the fabric. As a result, the fabric becomes less resistant to multidirectional stress, leading to a decrease in bursting strength. In contrast, the conventional fabric, composed entirely of 20s yarn, has a more uniform and coarser structure, which contributes to better load distribution and higher resistance to rupture under pressure.

Additionally, variations in yarn linear density in the mixed count fabric may lead to uneven loop formation and reduced inter-loop cohesion, further affecting strength performance. Despite this reduction, the bursting strength of the experimental fabric remains within an acceptable range for many general apparel applications.

Overall, while the use of excess yarn cones with mixed counts slightly compromises bursting strength, the difference is not drastic, supporting the feasibility of using such yarns for sustainable and cost-effective knitted fabric production.

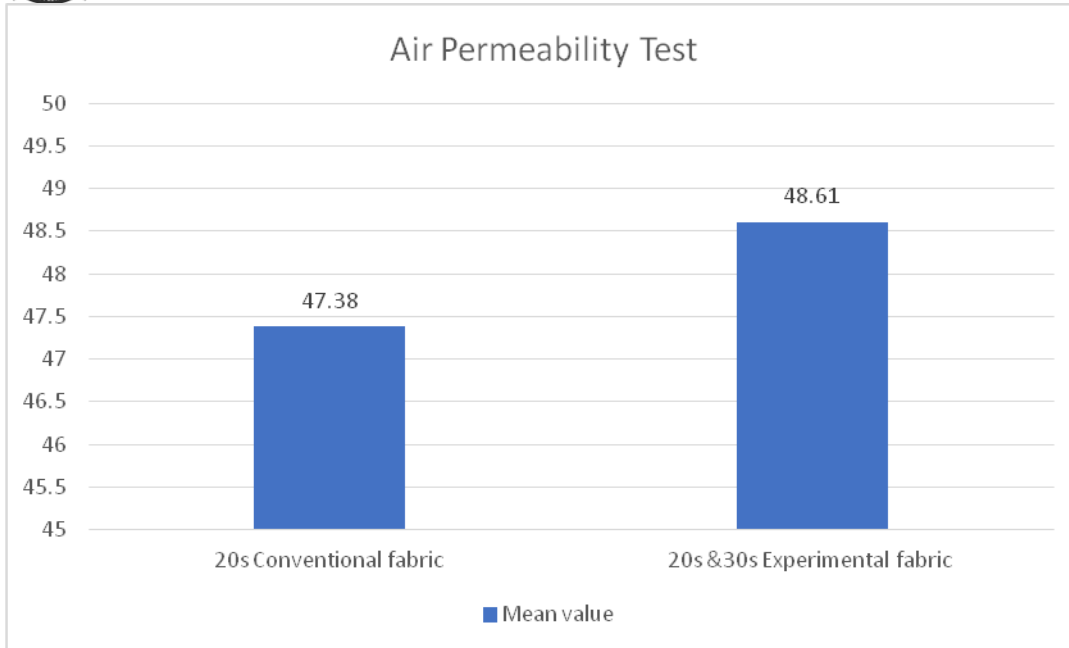


Figure 4.3: comparison of Air permeability

Air Permeability Analysis

The air permeability test results reveal a slight variation between the conventional and experimental knitted fabrics. The conventional fabric produced from 20s cotton yarn exhibited an air permeability value of 47.38, whereas the experimental fabric made from mixed yarn counts (20s and 30s) showed a higher value of 48.61.

The increased air permeability in the experimental fabric can be attributed to the incorporation of finer 30s yarn in the knitted structure. The presence of finer yarns tends to create a comparatively less compact fabric with larger loop spaces, allowing more air to pass through the fabric. This results in improved breathability and ventilation characteristics.

In contrast, the conventional fabric made entirely from 20s yarn has a relatively coarser and more compact structure, which slightly restricts airflow. The uniformity and higher thickness of the yarn contribute to reduced pore size within the fabric, thereby lowering air permeability.

Although the difference between the two fabric types is not substantial, the experimental fabric demonstrates enhanced breathability without significant compromise in other properties. This indicates that fabrics produced from excess yarn cones with mixed counts can offer improved comfort properties, making them suitable for applications where air permeability is desirable, such as casual wear and summer garments.

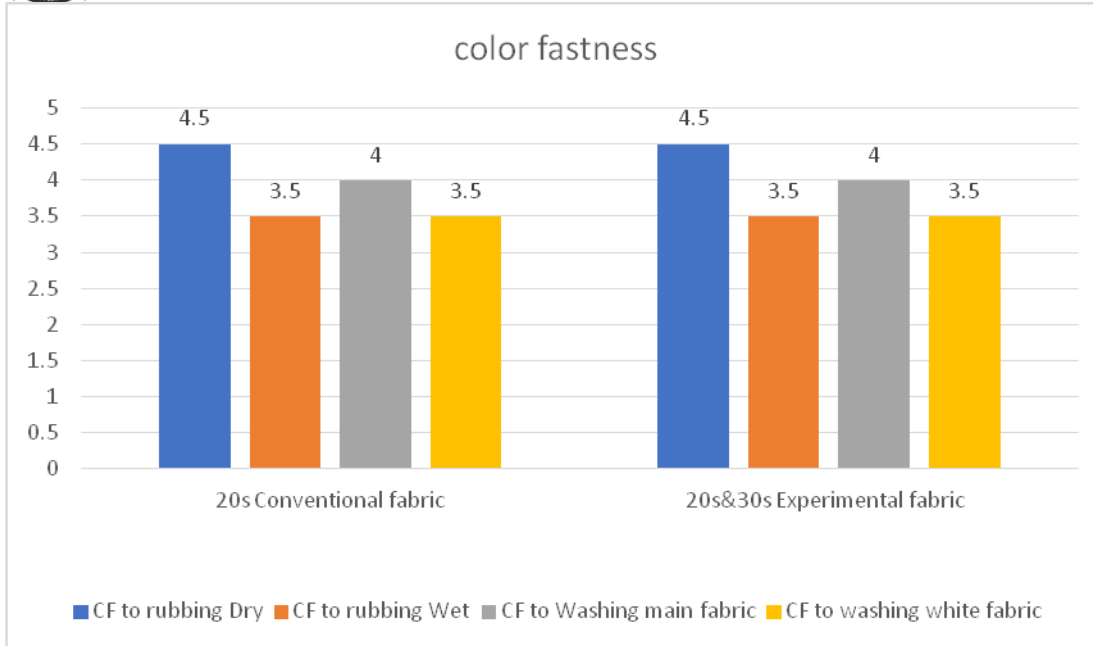


Figure 4.4: comparison of colour fastness to rubbing and washing

The color fastness properties of the developed experimental fabric (20s & 30s count) were evaluated and compared with conventional 20s fabric using standard textile testing methods. The assessment focused on resistance to rubbing (dry and wet) and washing (color change and staining), which are critical parameters for determining the durability and end-use performance of dyed textiles.

The results indicate that both conventional and experimental fabrics exhibited a color fastness rating of 4.5 to dry rubbing, which falls under the “very good” category. This suggests excellent resistance to color transfer under dry frictional conditions, indicating strong dye fixation within the fiber structure. In contrast, the color fastness to wet rubbing was rated at 3.5 for both fabrics, reflecting a moderate reduction in performance when moisture is present. This decrease is typically attributed to the swelling of fibers in wet conditions, which facilitates the migration of unfixed dye molecules to the fabric surface.

With respect to washing fastness, both fabric types demonstrated a rating of 4 for color change in the main fabric, indicating good resistance to fading during laundering. This implies that the dyeing process ensured adequate penetration and bonding of dye molecules within the fiber matrix. However, the staining on adjacent white fabric was rated at 3.5, suggesting a moderate degree of dye transfer during washing. This may be due to the presence of loosely bound surface dyes or insufficient after-treatment processes such as soaping.

Importantly, the experimental fabric (20s & 30s) showed no significant variation in performance compared to the conventional fabric, across all evaluated parameters. This indicates that the introduction of varied yarn counts does not adversely affect the dye uptake or fixation characteristics of the fabric.

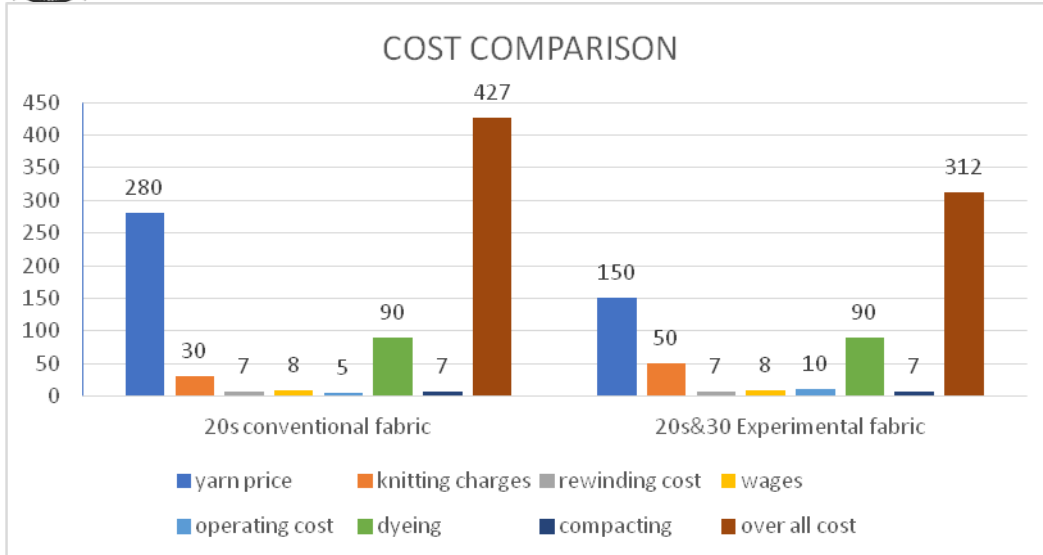


Figure 4.5: cost wise comparison

The cost of conventional 20s fabric was compared with the experimental 20s & 30s fabric by considering different production components.

The yarn cost is much lower in the experimental fabric (150) compared to conventional fabric (280). This is the main reason for the overall cost reduction. However, the knitting charges increased slightly from 30 to 50, and the operating cost increased from 5 to 10, due to handling of different yarn counts.

Other costs such as rewinding (7), wages (8), dyeing (90), and compacting (7) remain the same for both fabrics. Even though a few costs increased, the overall cost reduced significantly from 427 to 312 in the experimental fabric.

Conclusion

This study confirms that excess yarn cones can be effectively utilized in knitted fabric production through the combination of different yarn counts, such as 20s and 30s. The experimental fabric developed using mixed yarn counts demonstrated structural and physical properties comparable to those of conventional cotton fabric, with only minor variations.

Although a slight reduction in bursting strength was observed, the fabric remained suitable for general textile applications. Additionally, the dyed fabrics exhibited satisfactory color fastness and dimensional stability.

The findings further highlight that the use of excess yarn cones leads to a significant reduction in production cost while minimizing material waste. Therefore, this approach offers a practical, sustainable, and economically viable solution for modern textile manufacturing.

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