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NATURAL COMFORT: SUSTAINABLE BABYWEAR FROM BANANA- COTTON BLENDS

Mr. S Chandrakumar [1], Chintana M S[2], Athika Tabassum S[2], Kanaga Brintha Lakshmi A[2]

[1]B. tech (Assistant. Professor (SRG)), Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India
[2]Bachelor of Fashion Technology Scholars, Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India

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ABSTRACT

The increasing demand for sustainable textiles has encouraged the use of natural fibers in infant clothing applications. This study focuses on the development of eco-friendly babywear fabric using a 60:40 blend of banana fiber and cotton fiber. Banana fiber, derived from agricultural waste, offers durability, biodegradability, and excellent moisture management, while cotton contributes softness and skin comfort. The fibers were manually blended and processed into yarn, which was then knitted to produce fabric suitable for babywear. The developed fabric was evaluated for comfort, physical, and mechanical properties. Results revealed that the banana–cotton blended knitted fabric exhibited good breathability, high moisture absorbency, and adequate strength, along with improved softness suitable for infant wear. The findings indicate that the developed fabric provides a sustainable and comfortable alternative for baby garments, supporting the use of eco-friendly materials in textile applications.

Keywords— Banana fiber, sustainable babywear, cotton blend, knitted fabric, natural fibers, eco-friendly textiles.

1. INTRODUCTION

The textile industry is increasingly shifting towards sustainable materials due to growing environmental concerns and rising awareness of eco-friendly clothing. Babywear textiles require special consideration, as infants have delicate and sensitive skin that is highly prone to irritation, allergies, and discomfort. Conventional synthetic fabrics often exhibit poor breathability and may cause skin irritation, making natural fiber-based fabrics a more suitable choice for infant garments.

Banana fiber is an emerging eco-friendly material extracted from the banana pseudo stem, which is typically discarded as agricultural waste. It is biodegradable, lightweight, and possesses desirable properties such as good moisture absorption, durability, and antibacterial characteristics. However, banana fiber alone lacks the required softness for babywear applications, limiting its direct use in infant clothing.

Cotton is widely preferred for baby garments due to its inherent softness, breathability, and excellent moisture absorbency. Blending cotton with banana fiber helps overcome the limitations of banana fiber by improving softness and overall comfort while retaining strength and sustainability. In this study, banana and cotton fibers were blended in a 60:40 ratio and processed into yarn, which was subsequently knitted to develop fabric suitable for babywear applications.

The objective of this research is to develop a sustainable banana–cotton blended knitted fabric and evaluate its suitability for infant clothing in terms of comfort and performance properties.

1.1. PROBLEM STATEMENT

The increasing use of synthetic fabrics in babywear raises concerns about skin irritation, poor breathability, and environmental impact. Infants require soft, breathable, and hypoallergenic materials. Banana fiber, obtained from agricultural waste, is eco-friendly and moisture-absorbent but lacks softness.

Blending banana fiber with cotton (60:40) improves comfort while maintaining sustainability. This study focuses on developing a knitted babywear fabric using this blend, with 40s yarn count and enzyme softening, to achieve a soft, breathable, and eco-friendly material suitable for infants.

1.2. OBJECTIVES

- To develop a 60:40 banana–cotton blended yarn using hand blending technique
- To produce knitted fabric suitable for newborn applications
- To enhance fabric softness using enzyme softening treatment
- To evaluate comfort and mechanical properties of the developed fabric
- To promote sustainable and skin-friendly babywear material

1.3. Scope and significance

This study focuses on developing sustainable babywear fabric using a banana–cotton blend at a laboratory scale and evaluating its comfort and performance properties. The research highlights the effective use of agricultural waste like banana pseudo stem to create eco-friendly, soft, and breathable fabric suitable for infant clothing, promoting sustainability in the textile industry.

2. LITERATURE REVIEW

Banana fiber has gained significant attention as a sustainable textile material due to its eco-friendly nature, biodegradability, and availability as agricultural waste. It possesses desirable properties such as good tensile strength, moisture absorption, breathability, and antibacterial characteristics. However, the inherent stiffness and coarse texture of banana fiber limit its direct application in garments, particularly in babywear where softness and comfort are essential.

To overcome this limitation, blending banana fiber with cotton has been widely recommended. Banana–cotton blended fabrics provide a balanced combination of strength and softness. Cotton contributes smoothness, flexibility, and skin-friendly properties, while banana fiber enhances durability, moisture management, and sustainability. Studies also indicate that appropriate blending improves absorbency and air permeability, which are important for babywear applications.

In addition, fabric structure plays a key role in determining comfort. Knitted fabrics are preferred for infant clothing due to their flexibility, softness, and enhanced breathability. Their looped structure allows better air circulation and ease of movement, making them suitable for delicate baby skin.

Overall, the literature suggests that banana–cotton blended knitted fabrics offer a promising solution for developing sustainable and comfortable babywear. However, research on optimized blend ratios and their specific performance in infant applications remains limited, indicating the need for further study.

3. METHODOLOGY

3.1Material Selection

Banana fiber and cotton fiber were selected for this study. Banana fiber, obtained from the pseudo stem of the banana plant, was chosen for its strength, biodegradability, and moisture absorption properties. Cotton fiber was selected for its softness, breathability, and skin compatibility. Both fibers were combined in a 60:40 ratio (banana: cotton) to achieve a balance between durability and comfort suitable for babywear applications.

3.2 Fiber Processing and Blending

The fibers were initially cleaned to remove impurities. Banana fibers were softened and opened to improve spinnability, while cotton fibers were prepared separately. The fibers were then weighed according to the required ratio and blended using a hand blending technique to ensure uniform distribution and proper mixing.

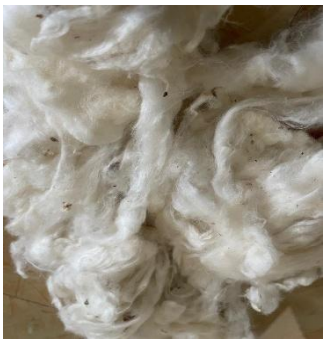

Figure 1: Cotton fiber

Figure 2: Banana fiber

3.3 Yarn Formation

The blended fibers were spun into yarn through a suitable spinning process. The process involved drafting, twisting, and winding to produce a continuous yarn. Proper twist was maintained to ensure adequate strength while retaining softness and uniformity required for fabric production.

Figure 3: Banana -Cotton yarn (60B:40C)

3.4 Fabric Formation

The yarn was converted into fabric using single jersey knitting. This structure was selected due to its flexibility, softness, and breathability. The knitted fabric provides better air circulation and stretchability, making it suitable for newborn clothing.

Figure 4: Banana & Cotton dyed fabric

3.5 Dyeing Process

The fabric was dyed at the fabric stage using synthetic dyes. The dyeing process was carried out under controlled conditions of temperature, time, and pH to ensure uniform color distribution and proper dye fixation. After dyeing, the fabric was washed and dried to remove any residual chemicals.

3.6 Garment Fabrication

The developed fabric was used to produce babywear garments through standard cutting and stitching processes. This helped in evaluating the handling properties and practical usability of the fabric.

3.7 Testing and Evaluation

The fabric was tested to assess its suitability for babywear applications. Comfort properties such as breathability and absorbency were evaluated. Mechanical properties including strength and durability were also analyzed. Additionally, safety aspects like skin-friendliness and non-toxicity were considered to ensure suitability for infant use.


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TEST REPORT

PAGE 2 OUT OF 4

APPLICANT : M/S. A.BRINTHA KUMARAGURU COLLEGE OF TECHNOLOGY COIMBATORE

REF NO : ATB-4969
DATE : 27-03-2026

SAMPLE DESCRIPTION : KNITTED FABRIC
COLOUR : DK.PINK

TESTS CONDUCTED UPON REQUEST OF THE APPLICANT

1. DIMENSIONAL STABILITY TO WASHING
SUBMITTED FABRIC WAS CONDITIONED AT 21°C ±2°/65% RH ±5%
AND WASHED IN FRONT LOADING TYPE OF WASHING MACHINE
(IFB MAKE) AT 40°C, WITH ECE REFERENCE DETERGENT (TYPE A)
SODIUM PERBORATE AND TAED, NORMAL CYCLE, FOLLOWED BY
FLAT DRY.TOTAL LOAD: 4 LB

AFTER SINGLE WASH
LENGTH WISE (%) : (-) 1.6
WIDTH WISE (%) : (-) 1.0

(-) DENOTES SHRINKAGE & (+) EXTENSION

2. COLOUR FASTNESS TO WASHING
(ISO 105 C06 A1M) AT 40°C
(TEMP-40°C, LIQ VOL:150ml, TIME:45 MIN MECHANICAL WASH,
STEEL BALLS:10,ECE DETERGENT-4 gpl)

COLOUR CHANGE	4
STAINING ON	
ACETATE	4-5
COTTON	4
NYLON	4-5
POLYESTER	4-5
ACRYLIC	4-5
WOOL	4-5

3. WEIGHT PER SQUARE METRE (GRAMS) ISO 3801 : 189.7

4. BURSTING STRENGTH
ISO 13938:99
AVERAGE BURSTING STRENGTH (psi) : 130.1

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Figure 5: Test result 1


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5. FREE & HYDROLYSED FORMALDEHYDE (ISO 14184-1:1998) : BELOW 20 ppm (AVG 1.4 ppm)

6. pH VALUE (ISO 3071:2005)
pH OF AQUEOUS EXTRACT : 6.5
pH OF THE D.M WATER USED : 6.4

7. RESISTANCE TO PILLING
(ISO 12945; PART-1:2001)
(BY ICI TYPE PILL TESTING BOX METHOD)
PILLING RATING (AFTER 18000 REVOLUTIONS) : 3-4

8. RESISTANCE TO SALIVA & PERSPIRATION (DIN 53160-1:2010) : RESISTANT TO SALIVA & PERSPIRATION TEST
STAINING ON FILTER PAPER : 4-5

9. TEST FOR HEAVY METALS CONTENT
(BS-EN-71PART3:1995) (AAS/ICPMS)

	PARAMETERS	RESULT
1	CADMIUM (Cd)	NOT DETECTED
2	CHROMIUM (Cr)	NOT DETECTED
3	LEAD(Pb)	NOT DETECTED
4	ARSENIC (As)	NOT DETECTED
5	MERCURY (Hg)	NOT DETECTED
6	SELENIUM(Se)	NOT DETECTED
7	BARIUM(Ba)	NOT DETECTED
8	ANTIMONY(Sb)	NOT DETECTED

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Figure 6: Test result 2

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10. TEST FOR AZO DYES
EN 14362-1/§ 64 LFGB B82.02-2/ (Textile/Natural)

Table I: List of Azo Dyes

No.	Name of Amines	CAS-No	
1	O-TOLUIDINE	95-53-4	<5ppm
2	2-METHOXYANILINE	90-04-0	<5ppm
3	P-CHLOROANILINE	106-47-8	<5ppm
4	P-CRESIDINE	120-71-8	<5ppm
5	2,4,5-TRIMETHYLANILINE	137-17-7	<5ppm
6	4-CHLORO-O-TOLUIDINE	95-69-2	<5ppm
7	2,4-TOLUYLENEDIAMINE	95-80-7	<5ppm
8	2,4-DIAMINOANISOLE	615-05-4	<5ppm
9	2-NAPHTHYLAMINE	91-59-8	<5ppm
10	2-AMINO-4-NITROTOLUENE	99-55-8	<5ppm
11	4-AMINODIPHENYL	92-67-1	<5ppm
12	4,4'-OXYDIANILINE	101-80-4	<5ppm
13	BENZIDINE	92-87-5	<5ppm
14	4,4'-DIAMINODIPHENYLMETHANE	101-77-9	<5ppm
15	O-AMINOAZOTOLUENE	97-56-3	<5ppm
16	3,3'-DIMETHYL-4,4'-DIAMINODIPHENYLMETHANE	838-88-0	<5ppm
17	3,3'-DIMETHYLBENZIDINE	119-93-7	<5ppm
18	4,4'-THIODIANILINE	139-65-1	<5ppm
19	3,3'-DICHLOROBENZIDINE	91-94-1	<5ppm
20	4,4'-METHYLENE-BIS-(2-CHLORANILINE)	101-14-4	<5ppm
21	3,3'-DIMETHOXYBENZIDINE	119-90-4	<5ppm
22	2,4 –XYLIDINE	95-68-1	<5ppm
23	2,6 –XYLIDINE	87-62-7	<5ppm
24	P-PHENYL AZOANILINE/ P-AMINO AZO BENZENE	60-09-3	<5ppm

Note: mg/kg = milligram per kilogram
Detection Limit = 5 mg/kg
ppm = parts per million = mg/kg
"<" = less than
">" = more than
ND = not detected

11. ABSORBENCY OF TEXTILES
(AATCC-79-2014)
AVARAGE ABSORBENCY TIME : 60+ SECONDS

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Grey Scale Rating : Excellent Good Fair Poor Very Poor

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Figure 7: Test result 3

4. RESULTS AND DISCUSSION

The results obtained from testing were analyzed and interpreted. The banana–cotton blended fabric exhibited good moisture absorbency and breathability, making it suitable for babywear applications. The presence of banana fiber contributed to improved strength and durability, while cotton ensured comfort and softness.

The fabric showed uniform dye uptake during fabric stage dyeing, indicating good compatibility with synthetic dyes. The dyeing process enhanced the aesthetic appeal without affecting the functional properties of the fabric. Overall, the developed fabric demonstrated a balanced performance in terms of comfort, strength, and usability for infant clothing.

Figure 8: Final baby garment

5. CONCLUSION

The study successfully developed a banana–cotton blended fabric suitable for newborn applications. The fabric exhibited desirable properties such as softness, breathability, moisture management, and adequate strength.

The use of banana fiber supports sustainable practices by utilizing agricultural waste and reducing environmental impact. The developed fabric shows strong potential for application in babywear.

6. FUTURE SCOPE

- Optimization of different banana–cotton blend ratios
- Exploration of eco-friendly dyeing and finishing techniques
- Improvement in fabric softness and performance properties
- Scale-up for industrial production and commercialization

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