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## Assessment of anti-microbial properties of BACO (organic cotton+banana) fabric dyed with selected natural dyes

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### Abstract

Present investigation is based on BACO fabric dyed with three selected natural dyes extracted from *Terminalia arjuna*, *Rubia cordifolia* and *Alkanna tinctoria* root. Optimal results were accomplished when dyeing at 80 °C for 90 min. The dyeing was subsequently conducted using pre-mordanting method, the mordanting produced a variety of color shades. The color fastness to washing and sunlight was found good to excellent with *Terminalia arjuna* dye. BACO fabric dyed with *Terminalia arjuna* showed very good to excellent anti-microbial properties.

**Keywords:** Natural dye, anti-microbial, pre-mordanted, BACO, blend, colour fastness

### Introduction

Natural dyes are non-toxic, non-carcinogenic and bio-degradable materials and are very safe for applications in various scopes (Mongkhlorattanasit, 2016) [8]. A growing interest in natural dyes has emerged as a result of increased awareness of the environmental and health risks associated with the manufacturing, processing, and usage of synthetic dyes (Kanchana *et al.* 2013) [5]. Natural dyes is increasing day by day as a result interest in the use of natural dyes in fabric coloration has been growing (Ashrafi *et al.* 2018) [1]. The main impediment is bacteria, which cause degradation, discoloration, smell, and skin diseases. As a result, it is critical to finish all clothes with antimicrobial treatment to prevent microbial growth on textiles while preserving desirable textile properties (Khan *et al.* 2012) [6]. Furthermore, the usage of natural dyes is vital for sustainability (Cuce 2022) [4]. Keeping these flaws in mind researcher developed a BACO fabric blend of organic cotton and banana to overcome this problem and improve the fastness properties of the fabric. Organic cotton composed of hollow fibres that are naturally soft, cool, breathable, and absorbent (Patil 2020) [9]. Banana waste is pseudostem, which produces high-quality fiber (Balda *et al.* 2021) [2] have high strength, light weight, low elongation, fire resistance, strong moisture absorption, great potential, and biodegradability (Bhatnagar *et al.* 2015) [3] and have long been known to have antibacterial or anti-UV properties, making them a green, environmentally friendly option (Sanjeeda *et al.* 2014).

### Experimental procedure

#### Procurement of raw materials

Three natural dyes *Terminalia arjuna*, *Rubia cordifolia* and *Alkanna tinctoria* and *Punica grantum* selected as mordant for experimentation in present research were procured from the Department of Textile and Apparel Designing, CCAS, MPUAT, Udaipur and the BACO fabric blend of organic cotton and banana fibre was procured from the Pahartah Fashion Llp, Himachal Pradesh.

#### Sample Preparation and Dyeing Procedure

The dye extraction was performed by mixing the plant material with distilled water in the weight ratio of 1:10 and boiling for one hour (Mongkhlorattanasit, 2016) [8]. Solid residues were filtrated out to obtain clear dye solutions. The fabrics weighing 1 gram was dyed with 20% and 30% concentrations of each dye for 1 hour at 80 °C and fabric samples was mordanted with 5% and 10% concentrations of *Punica grantum* mordants for 30 minutes at 80 °C after being left at room temperature for an hour. Based on percent dye absorption value 30% dye concentration, 10% concentration for *Punica grantum* mordant were chosen.

Dyeing was carried out for 90 minutes at 80 °C with MLR of 1:100 (Tiwari *et al.*, 2019) [12]. The samples that had been dyed were then rinsed with cold water and dried in air. The light and wash fastness properties of each dyed fabric sample were determined according to Gauge IS: 764:1979 and IS/ISO105 standard test methods and disk diffusion method against *E-coli* bacteria was used for testing the anti-microbial properties of fabric (Kanchana *et al.* 2013) [5].

## Results and Discussion

### Effect of dyeing on fastness properties

According to Table No. 1, the wash fastness property of BACO fabric samples dyed with selected three natural dyes,

pre mordanted with *Punica grantum* ranged from good to excellent ranging from 4 to 5 on the grey scale, with no staining on adjacent fabric as compared to unmordanted samples along with very good light fastness properties. Based on the evaluations, *Terminalia arjuna* was chosen for further testing of anti-microbial properties on dyed fabric based on ratings. The findings were supported by Khattak *et al.* (2015) [7] who studied alkanet (*Alkanna tinctoria*) roots to apply pad-steam dyeing to cotton fabric with Aluminum sulfate, copper sulfate, ferric chloride, potassium dichromate, and hydrated potassium aluminum sulfate. CuSO<sub>4</sub> post-mordanting resulted in improved wash, light, and crocking fastness.

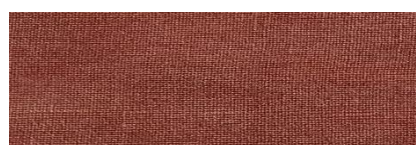
**Table 1:** Wash fastness and light fastness ratings of BACO fabric mordanted with *Punica grantum*

Natural dyes	Wash fastness				Light fastness	
	CS		CC		Control	Exp.
	Control	Exp.	Control	Exp.		
T.A.	2/3	5	2/3	5	4	8
R.C.	2/3	4/5	2/3	4/5	4	7
A.T.	2/3	4/5	2/3	5	4	8

\*Control-unmordanted fabric sample, Experimental-mordant treated fabric sample, T.C.- *Terminalia arjuna*, R.C.- *Rubia cordifolia* and A.T.-*Alkanna tinctoria*

### Colour shades obtained with selected natural dyes using *Punica grantum* as mordant

Variety of shades were obtained with *Terminalia arjuna*, *Rubia cordifolia* and *Alkanna tinctoria* on BACO fabric as shown in Plate-1.



BACO fabric dyed with *Terminalia arjuna*



BACO fabric dyed with *Rubia cordifolia*



BACO fabric dyed with *Alkanna tinctoria*

**Plate 1:** Shades of Natural dyes on BACO fabric

### Effect of dyeing on anti-microbial properties

The dyed samples show a maximum zone of inhibition against *E-coli* bacteria and highest zone of inhibition were showed by the *Terminalia dye* i.e. (8.33±0.288 mean and SD) presented in Table no.2. And findings can be supported by (Ramaiah *et al.* 2012) [10] studied natural turmeric dye to fight off various bacterial strains. The agar well diffusion method

was used to measure the antibacterial activity. Against each of the test bacterial isolates, the natural dye exhibited antibacterial activity. With zones of inhibition ranging from 7 to 15 millimeters and 10 to 15 millimeters, respectively, turmeric natural dye demonstrated good inhibitory activity against *E. coli* and *Vibrio cholera*.

**Table 2:** Anti-microbial activities against *E. coli* bacteria of dyed samples with *Punica grantum*

Natural dyes	A1			A2			A3			Mean score	SD
	D1 (mm)	d1 (mm)	H1 (mm)	D2 (mm)	d2 (mm)	H2 (mm)	D3 (mm)	d3 (mm)	H3 (mm)		
T.A.	22	6	8	23	6	8.5	23	6	8.5	8.33	0.288
R.C.	22	6	8	22	6	8	22	6	8	8	0.011
A.T.	22	6	8	23	6	8.5	22	6	8	8.16	0.288

\*A= repetition of the test, H= Zone of inhibition in mm, D= Total diameter of the test specimen and clear zone in mm and d= Diameter of the test specimen in mm, T.C.- *Terminalia arjuna*, R.C.-*Rubia cordifolia* and A.T.-*Alkanna tinctoria*



BACO fabric dyed with *Alkanna tinctoria* BACO fabric dyed with *Rubia cordifolia* BACO fabric dyed with *Terminalia arjuna*

**Plate 2:** Disk diffusion test results against *Escherichia coli* bacteria

### Conclusion

All the dyes showed very good to excellent colour fastness to wash and light and showed maximum zone of inhibition against anti-microbial properties on BACO fabric. Among all dyes *Terminalia arjuna* showed highest ratings in this study in the presence of *Punica grantum*. Hence, it can be concluded that BACO fabric may be successfully coloured using natural dyes to develop environmentally friendly colouring with good colour fastness characteristics in terms of wash and light fastness as well as enhanced anti-microbial capabilities.

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