

Antibacterial Efficiency of *Croton Bonplandianum* Plant Extract Treated Cotton Fabric



Goutam Bar¹ and Mahadev Bar^{2*}

¹Department of Textile Design, National Institute of Fashion Technology, India

²Laboratoire Génie de Production LGP, Université de Toulouse, France

Submission: July 21, 2020; Published: August 24, 2020

*Corresponding author: Mahadev Bar, Laboratoire Génie de Production, LGP, Université de Toulouse, INP-ENIT, Tarbes, France

Abstract

Croton bonplandianum (*C. bonplandianum*) is a monoecious exotic weed belonging to the euphorbiaceae family, is grown unwantedly at a large scale in the cultivation land of eastern India, along with the main crop. In this present work, sap from the *C. bonplandianum* plant is extracted through aqueous extraction method, which is further applied on a cotton fabric through pad-dry-cure method. The fabric obtained immediately after the treatment and from different stages of washing are then evaluated for their anti-bacterial activity against both the gram +ve and gram -ve pathogenic strains. It is observed that *C. bonplandianum* sap and treated cotton fabric exhibit very promising results against both the gram +ve and gram -ve bacteria and it retains its properties even after five washes.

Keywords: Antibacterial; Textile finishing; Green treatment; Sustainable processing; Bio-based treatment

Introduction

Under the shed of protective textiles, antibacterial textile has its own importance and it becomes more significant whenever a pandemic situation (like ongoing Covid 19 situation) arises. In its inherent state, a textile material is susceptible to the microbial attack but with suitable chemical treatment it can resist the same. Degeneration of fiber, foul order, change in color, unwanted stains etc. are the symbols of microbial attack, mainly a symbol of bacterial attack on textiles [1-3]. Bacteria are unicellular organisms which grow rapidly under a suitable warm and humid conditions and some of them are deadly to the human races [4]. Hence, an antibacterial finishing on textile is very essential to protect its wearer from the infectious bacteria attack. Moreover, antibacterial fabric also helps to control secondary bacterial infection or co-infection during viral pandemics [5]. Lots of synthesized antibacterial agents are available in the market. A textile fabric treated with one of these synthetic chemicals exhibits excellent antibacterial behavior. However, these synthetic antibacterial agents are toxic and harmful to the environment [6]. Evaluation of an eco-friendly, bio-based antibacterial agent can meet the aforesaid contradictory demand of antibacterial agents for textiles. There are already some studies on bio-based

antibacterial finishing on textiles has been carried out, among those sericin, chitosan, neem extract etc. shows very promising results. However, researchers are still going on with an aim of further improvement.

Croton bonplandianum (*C. bonplandianum*) a member from Euphorbiaceae family, is an exotic weed commonly known as three-leaved caper [7]. It is an annual herb having a length around 60cm long while its leaves are varying between 3cm and 5cm. A photographic image of a *Croton bonplandianum* plant is shown in Figure 1. *C. bonplandianum* is an unwanted plant grows in sandy clay soil along the roadside, irrigation canal banks, in plantations, in agricultural fields and on waste ground [8-10]. This plant is known for its medicinal value for long time. The leaves of *C. bonplandianum* is antiseptic and are used for the treatment of skin diseases, cuts and wounds. They are also used for controlling high blood pressure and to cure fever caused infection in the glands. The latex of this plant has wound healing activity and the fresh juice of the leaves is used against headache [7,11]. Looking at the high medicinal value of this plant, the present study aims to evaluate the antibacterial properties of *C. bonplandianum* plant extract when applied on cotton fabric. In this regard, fresh stem

sap and aqueous leaf extract of *C. bonplandianum* are applied on the cotton fabrics through pad-dry-cure method. The treated fabrics are washed number of times to understand the durability

of the treatment. Finally, the treated fabric and the fabric from different washing stages are evaluated for their antibacterial properties and test results are reported here.



Figure 1: Image of a *Croton bonplandianum* Plant.

Cytotoxicity of *C. bonplandianum* Plant extract

Potential toxicity of a plant extracts on living human cells determine its cytotoxicity when ingested, inhaled or being absorbed by skin. Cytotoxicity of a plant extract depends on its Phyto constituents, extracting solvent and on cell lines used to assess cytotoxicity [12,13]. Phyto constituents of any plant extract is the determining factor for its antibacterial activity. Extracting solvents ranging in polarity used to extract different plant parts and ultimately contributes to the wide variety of cytotoxicity results [13]. Researchers have prepared leaf extract of *C. bonplandianum* plant in different medium such as aqueous, methanol [14], acetone [11], hexane and ethyl acetate. It is observed that the aqueous extract of *C. bonplandianum* leaf is less cytotoxic compared to that of methanol, acetone, hexane and ethyl acetate extracts. Hence, to study the antibacterial activity of *C. bonplandianum* plant extract on cotton fabric, fresh stem sap and aqueous leaf extracts are used in this study. The aqueous extract of *C. bonplandianum* plant leaf contains carbohydrates, amino acids, proteins, tannins, saponins, flavonoids alkaloids, anthrocyanins, β -cyanins, quinones, glycosides, terpenoids, phenols, coumarins, steroids and resins [15,16].

Materials

Apparently healthy *C. bonplandianum* plants are collected personally by the researchers from the roadside of Bhubaneswar, Odisha, India. After collection, the plants are washed thoroughly for multiple times, initially using tap water followed by using deionized water in the lab. These cleaned *C. bonplandianum* plants are further used for the study purpose. A cotton fabric having a GSM of 95, 27 ends per cm and 24 picks per cm, warp and weft yarn count 32^s and 31^s Ne, respectively is used in the present study. The cotton fabric is purchase from the local fabric market

of Bhubaneswar, India. Before the antibacterial treatment, the fabric is desized, scoured and bleached in the lab respectively. Bleached fabric is then treated with 5ml per liter citric acid which acts as a crosslinking agent between cotton fabric and *C. bonplandianum* extract [17]. *Staphylococcus aureus* (*S. aureus*), a gram +ve and *Escherichia coli* (*E. coli*) a gram -ve bacteria is used to check antibacterial activity of *C. bonplandianum* stem sap and leaf extract applied on cotton. The pure culture of above-mentioned pathogenic strains is obtained from Orissa University of Agriculture & Technology Laboratory, Bhubaneswar.

Methods

Extraction of *C. bonplandianum* sap and its Application on Cotton Fabric

Fresh leaves and green soft stems are plucked manually from the cleaned *C. bonplandianum* plant, which are further used for the next process. During plucking white coloured latex or stem sap comes out from the damaged part of the plant. This sap is collected into sterile plastic containers and stored at 4°C prior to its further use. On the other hand, the plucked leaves and stems are then grinded using a grinder after adding 100ml of distilled water to 500gms of collected leaves. The grinded paste is then filtered using a clean muslin cloth and then again through a Whatman filter paper. The filtrated is then kept in an air oven and is converted to powder form. Two different solutions of *C. bonplandianum* sap is prepared. In first case, 5ml of stem sap extract is added in 20ml of distilled water to prepared 200 μ l/ml s stem sap solution while in second cases 1gm of leaf extract powder is added in 20ml distilled water to prepare 50mg/ml aqueous leaf extract solution. Both the solutions are then applied on preprocessed cotton fabric through Pad-Dry-Cure method separately. Padding was done using a laboratory padding mangle with 100% wet pickup to maintain

the add on of 200µl of stem sap and 50mgs of leaf extract per gram of fabric, respectively. Padded fabrics are then dried and cured at 140°C for 180 seconds.

Washing of the treated fabric

Effectiveness after washing is one of the major criteria for any kind of finishing applied on textiles. If the durability of the antibacterial finish does not last for a good number of washes, then the antibacterial finish applied on the garment will be of no use. Hence the washing durability of the treated samples are very important. Both the fabric sample i.e. fabric treated with stem sap solution and fabric treated with aqueous leaf extract were washed in launder-o-meter for one, three and five wash cycles using 5grams per litre non-ionic detergent with M:L ratio 1:10. Finally, the antibacterial properties of all samples are evaluated.

Evaluation for bacterial growth

100µl of each type of the pathogenic strains contained in test tubes are added to each of the two Petri plates and spread all over by the means of the cotton swabs. Then by means of sterilized forceps, the treated fabric specimens are placed in each Petri plate. On first and second petri plates base fabric (F_B), fabric treated with citric acid (F_{CA}), fabric treated with stem sap solution (F_{SS}) and fabric treated with aqueous leaf extract (F_{LE}) were kept with different pathogenic strain. Similarly, in third and fourth plates, washed fabric samples are kept with different pathogenic strain. The petri plates are kept in an incubator at 37°C for about 24hours. After stipulated time, the antibacterial activity of the treated cotton fabric is evaluated by the agar diffusion method and the developed 'zone of inhibition' is measured in mm.

Results and Discussion

Zone of inhibition during antibacterial test of base fabric, fabric treated with citric acid, samples treated with stem sap solution and aqueous leaf extract solution, on different pathogenic strains by standard agar diffusion test method are reported in Table 1. The test results obtained from the study are revealed that *C. bonplandianum* stem sap and aqueous leaf extract possesses significant antibacterial property against *S. aureus* and *E. coli* bacteria. Fabric treated with stem sap solution showed a zone of inhibition 17 ± 1.3 and 16.5 ± 1.5 mm against *S. aureus* and *E. coli* bacteria respectively, whereas aqueous leaf extract showed 15.5 ± 1.2 and 15 ± 1.3 mm respectively as shown in Figure 2. High inhibition rate against *S. aureus* and *E. coli* bacteria due to the presence of diversity of compounds including Phenols, flavonoids, alkaloids, tannins and triterpenoids in *C. bonplandianum* stem sap and leaf and extracts [18]. According to Mabhiza et al. [19], Alkaloids inhibits bacterial growth at a concentration of 1.67mg/mL, comparable effects to ampicillin, a standard antibiotic. According to Xie et al. [20], flavonoids have excellent antimicrobial activity against a wide spectrum of microorganisms and could be an alternative for tackling the so-called "antibiotic resistance crisis". According to Ketema et al. [17], phenolic compound present in the plant extract showed excellent anti-bacterial activity against the gram-positive bacteria *S. aureus* as well as the gram-negative bacteria *E. coli*. Table 2 showed the zone of inhibition of treated fabric samples after washing. Even after 5 wash cycles, antibacterial activity of the *C. bonplandianum* stem sap and aqueous leaf extract treated fabric found promising. It is mainly due to the pretreatment of cotton fabric with citric acid which enhances the washing durability of the finished fabric.

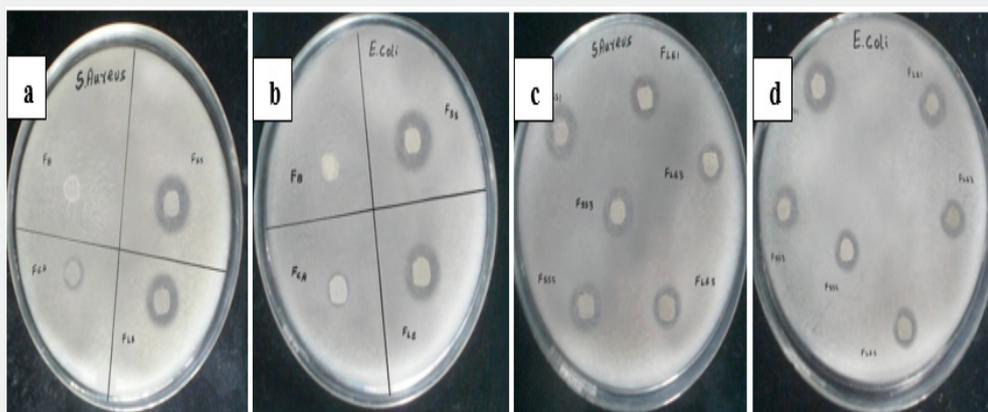


Figure 2: Antibacterial test results of cotton fabric treated with *C. bonplandianum* stem sap and aqueous leaf extracts against a) *S. aureus* bacteria; b) *E. coli* bacteria; c) *S. aureus* bacteria after one, three and five wash cycles; d) *E. coli* bacteria after one, three and five wash cycles.

Conclusion

The results of the present study indicate that the stem sap and aqueous leaf extract of *C. bonplandianum* possesses promising antibacterial activity against *S. aureus* and *E. coli* bacteria.

The effectiveness of the treatment on cotton fabric withstand even after 5 washes, which open up the avenue to apply the *C. bonplandianum* stem sap and aqueous leaf extract on textile fabrics to get antibacterial apparel products.

Table 1: Zone of Inhibition against Different Strains.

Pathogenic Strain	Zone of Inhibition (mm diameter)			
	Base Fabric	Fabric treated with Citric Acid	Fabric treated with Stem Sap	Fabric treated with Aqueous Leaf Extract
<i>S. aureus</i>	-	9±1.1	17±1.3	15.5±1.2
<i>E. coli</i>	-	8.5±1.2	16.5±1.5	15±1.3

Table 2: Zone of Inhibition of Washed Samples.

No. of wash cycle →	Fabric treated with stem sap			Fabric treated with aqueous leaf extract		
	1 wash	3 wash	5 wash	1 wash	3 wash	5 wash
Pathogenic strain ↓	Zone of inhibition (mm diameter)					
<i>S. aureus</i>	15.5±1	15±1.5	15±1.2	14.5±1.1	13.5±1.3	13.5±1.2
<i>E. coli</i>	15±1.1	14±1.1	13.5±1	13.5±1.3	13±1.4	13±1

References

- Joshi M, Ali SW, Rajendran S (2007) Antibacterial finishing of polyester/ cotton blend fabrics using neem (*Azadirachta Indica*): A natural bioactive agent. *Journal of Applied Polymer Science* 106(2): 793-800.
- Morens DM, Taubenberger JK, Fauci AS (2008) Predominant role of bacterial pneumonia as a cause of death in pandemic influenza: implications for pandemic influenza preparedness. *Journal of Infectious Diseases* 198(7): 962-970.
- Bar G, Bar M (2020) Dyeing and flame-retardant finishing of silk fabric: an ecofriendly approach. *SN Applied Sciences* 2(3): 1-9.
- Vennila V, Udayakumar R (2015) Antibacterial Activity of *C. bonplandianum* (Baill.) Against Some Bacterial Isolates from Infected Wounds. *British Microbiology Research Journal* 5(1): 83-93.
- Ramakrishnan S, Dhanavathy R, Manimozhi M, Lakshmi Thilagam, Mathavakrishnan (2012) Ethanolic extract from fresh leaf of *Croton sparsiflorus* morong exhibited antibacterial activity against four gram-negative bacteria and histochemical studies. *Journal of Pharmacy Research* 5(4): 2201-2203.
- Boryo DEA (2013) The effect of microbes on tactile material: a review on the way out so far. *International Journal of Engineering Science* 2(8): 9-13.
- Bhavana J, Kalaivani MK, Sumathy A (2016) Cytotoxic and pro-apoptotic activities of leaf extract of *Croton bonplandianus* Baill. against lung cancer cell line A549. *Indian Journal of Experimental Biology* 54(6): 379-385.
- Samanta AK, Konar A (2011) Dyeing of Textiles with Natural Dyes. *Intech Open*, p. 29-56.
- McGaw LJ, Elgorashi EE, Eloff JN (2014) 8-Cytotoxicity of African Medicinal Plants Against Normal Animal and Human Cells. *Toxicological Survey of African Medicinal Plants*, pp. 181-233.
- Jeeshna MV, Paulsamy S, Mallikadevi T (2011) Phytochemical Constituents and Antimicrobial Studies of the Exotic Plant Species, *C. bonplandianum* Baill. *Journal of Life Sciences* 3(1): 23-27.
- Giri RS, Dhanalakshmi S (2015) Antibacterial Efficacy and Phytochemical Screening of some Selected Weeds. *Asian Journal of Plant Science and Research* 5(2): 69-71.
- Gupta D, Bhaumik S (2007) Antimicrobial treatments for textiles. *Indian Journal of Fibre & Textile Research* 32: 254-263.
- Nasir E, Ali SI (1986) *Flora of Pakistan*. In: Shamim Printing Press, Pakistan, p. 1-43.
- M SP, Dsd SJ, K N, Srinivas K, Srilakshmi Bai J, et al. (2015) Phytochemical and Pharmacological Evaluation of Euphorbiaceae Family Plant Leaves- *Acalypha Indica* L., *Croton Bonplandianum* Baill. *Mintage Journal of Pharmaceutical and Medical Sciences* 4(3): 17-22.
- Deshmukh A, Deshmukh S, Zade V, Vaibhao Thakare (2013) The Microbial Degradation of Cotton and Silk dyed with Natural Dye: A Laboratory Investigation. *International Journal of Theoretical & Applied Sciences* 5(2): 50-59.
- Qaisar MN, Chaudary BA, Uzair M, Hussain SN (2013) Evaluation of Antioxidant and Cytotoxic Capacity of *Croton Bonplandianum*. *Baill. American Journal of Plant Sciences* 4: 1709-1712.
- Ketema, A, Worku A (2020) Antibacterial Finishing of Cotton Fabric Using Stinging Nettle (*Urticadioica* L.) Plant Leaf Extract. *Journal of Chemistry*, pp. 1-10.
- Mabhiza D, Chitemerere T, Mukanganyama S (2016) Antibacterial Properties of Alkaloid Extracts from *Callistemon citrinus* and *Vernonia adoensis* against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. *International Journal of Medicinal Chemistry*, pp. 1-7.

19. Xie Y, Yang W, Tang, F, Xiaoqing Chen, Licheng Ren (2014) Antibacterial Activities of Flavonoids: Structure-Activity Relationship and Mechanism. *Current Medicinal Chemistry* 22(1): 132-149.

20. Johnson M, Maridass M, Irudayaraj V (2008) Preliminary phytochemical and antibacterial studies on *Passiflora edulis*. *Ethnobot Leaflets* 12: 425-432.



This work is licensed under Creative Commons Attribution 4.0 License
DOI: [10.19080/CTFTE.2020.07.555703](https://doi.org/10.19080/CTFTE.2020.07.555703)

**Your next submission with Juniper Publishers
will reach you the below assets**

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats
(Pdf, E-pub, Full Text, Audio)
- Unceasing customer service

Track the below URL for one-step submission
<https://juniperpublishers.com/online-submission.php>