Journal of Advanced Multidisciplinary Research Studies and Development

ISSN : 2583-6404
Jan - Feb 2023

NONWOVEN COTTON FABRICS TREATMENT WITH *Terminalia chebula* AND *Curcuma longa* ANTIBACTERIAL PROPERTIES

Dr. Sitalakshami Iyer
Professor, Sri Venkateshwara College of Pharmacy, University of Hyderabad.

Abstract
Due to its adaptability and widespread application in the health and hygiene business, nonwoven textiles have shown a strong growth rate in the textile industry. Unfortunately, the majority of these items are throwaway, single-use materials that have been chemically treated. A savvy customer nowadays needs hygiene products that are safe for the skin and can be disposed of in an environmentally friendly manner. Therefore, the paper's main focus is on using an environmentally acceptable aqueous extract of *Terminalia chebula* as a mordant before applying the colourant *Curcuma longa* to cellulosic nonwoven textiles of various GSMs. The textiles were pad-dyed and treated with extract solutions from both herbs in varied concentrations, and their colour qualities, colour space values, and antibacterial capabilities were also examined.
Keywords: *Curcuma Longa, Terminalia Chebula*, Nonwoven, Antimicrobial.

► *Corresponding Author: Dr. Sitalakshami Iyer*

Introduction

Nonwovens are engineered fabrics produced by bonding constituent fibers together either mechanically, chemically or thermally (Russell, 2007). Mechanically bonded nonwovens are produced by needle punching the constituent cellulosic fibers together to form a pliable and porous fabric (Lee & Cassill, 2006). The manufacturing of these fabrics requires low consumption of energy and water compared to traditional woven fabrics. Therefore, these fabrics have very quickly flourished in the textile hygiene product sector and popularly used as facemasks, face wipes, table napkins, diapers, sanitary napkins etc. Their nonlinear and nonuniform structure is ideal to create an effective barrier for protection against microbes which can be further enhanced by the application of chemical antimicrobial agents (Teli & Shukla, 2018). These finishes are bactericidal and can effectively kill the microbes present on the product or bacteriostatic and cause reduction in microorganism reproduction (Eid et al, 2021). However, several inorganic salts, organometallic compounds, iodophors, formaldehyde derivatives and amines used as antimicrobial agents are reported to be toxic to both humans and environment (Gao & Cranston, 2008).

On the other hand, several finishes made from plants are acknowledged as medicines and show strong antibacterial and antioxidant qualities. They contain terpenoids, cumarines, phenolic acids, flavonoids, tannis, terpenoids, polyacetylenes, etc (Ristic et al, 2011). *T. chebula* (Harda) and *C. Longa* are two plants that are commonly utilised in India for both natural colouring and therapeutic purposes (Turmeric). As a result, they were chosen for the study's short list.

Terminalia chebula: In India, it is frequently referred to as Harda and is known as the King of Medicine in Tibet. Due to its ability to scavenge free radicals and possess anti-carcinogenic properties, the dried fruit of the plant is utilised as an antioxidant. Additionally, its bioactive components' thermostability has been documented (Bag et al, 2009). It is often and historically used as a mordant in the process of natural dyeing since it contains 30–35% tannin (Prabhu & Teli, 2014).

Curcuma Longa: This perennial member of the ginger family is known as Curry pigment and is used as a dietary spice in amounts up to 100 mg daily. Common names for it include Haldi, Indian Saffron, Haridra, and Gurkmeja (Lin & Lin, 2008; Tiwari & Bharat, 2008). The rhizome has a variety of functions and is used to make paste, powder, lotion, or oil. It is used to treat skin cancer, scleroderma, wounds, rheumatism, arthritis, and psoriasis and dermatitis (Sun et al, 2013; Kurian, 2003). Its effectiveness as an antifungal and antibacterial agent is widely documented (Aly & Gumgumjee, 2011; Selvam et al, 2012).

Materials and Methods

1. Fabric Used: Needle punched cotton nonwoven fabric sourced from Tata Mills, Mumbai.
2. Plant Material: Dried powder of *T. chebula* (Harda) and *C. longa* (Turmeric) were procured from Sheetal Ayurvedic stores, Mumbai.
3. Microbial Strains: *Staphylococcus aureus* and *Escherichia coli* were procured from National Chemical Laboratory, Pune, India.
4. Herbal extract preparation and application:
A 1% stock solution was made via aqueous extraction. For this, 10 g of herbal powder was mixed in 100 ml of distilled water, then heated to a temperature between 80 and 85 ^{0}C for an hour by refluxing. Next, the mixture was filtered through a 60 mesh nylon fabric and centrifuged at 3000 rpm for 15 minutes. Double-dip pad dyeing was used to apply the resultant stock. The ratio of material to alcohol remained at 1:30. At 120 ^{0}C, the nonwovens underwent further drying and curing.
5. Evaluation and test Performed:
Colour strength properties of dyed cotton nonwovens: The Rayscan SpectraScan 5100+ with reflectance accessories was used to measure the colour. The values for the Color Strength were determined using the Kubelka-Munk equation (K/S).
Colour space values: The Spectra flash® SF 300 was used to evaluate the CIELAB colour space (L*, a*, b*) values. Wherein: L* corresponds to brightness, a* to red-green coordinates and b* to yellow-blue coordinates.
Microbial analysis: Using AATCC Test Method 100-2004, antibacterial activity were determined. (AATCC technical manual, 2007).

Results and Discussions

1. Colour characteristics of cotton nonwoven's pad dyed with *T. chebula* and *C. longa* .

Results of Table 1. with respect to colour coordinates (L*, a*, b*) values indicate bright shades as all L* values lie between the accepted range of 70 to 100. The *T. Chebula* dyed nonwovens displayed tones of yellow with tints of red and green. Fabrics treated with C. longa displayed plottings in the yellow-green zone with higher tendency towards bright yellow tonal values.

Table 1. Effect of *T. chebula* and *C. longa* on Colour Space Values of cotton nonwovens

Extract Conc, (20 %)	Fabric GSM	L*	a*	b*	K/S
T. chebula	200	73.29	1.97	23.64	1.72
	100	78.95	-1.46	15.19	1.00
C. longa	200	82.49	-3.87	62.52	4.24
	100	84.97	-5.93	33.18	1.07
Note: Fixation temperature 120° C for 3 minutes					

2. Antimicrobial properties of cotton nonwoven's pad dyed with *T. chebula* and *C. longa*

The percent reduction of *S. aureus* and *E. coli* CFU's on application of extracts is noted in Table 2. Application of *T. chebula* extract (40% conc) has resulted in 79% and 81% reduction in *S. aureus* and *E. coli* CFU's respectively. The presence of gallic acid and its ethyl esters, egallic acid, ethanedionic acid and other biaoactive compounds have resulted in an increase in the extracts effectiveness against *E.coli*, (Gowd et al, 2013). This is because the cell wall of the bacterium is made of lippo ploysaccarides (LPS) which protects the organism by reducing the accumulation of antibacterial agent on the cell wall (Mahosh 2012). However due to the presence of above mentioned bioactive compounds there is leakage in the cell membrane leading to reduction of CFU's (Bhattacharya et al, 2009; Datta et al, 2013). A good reduction of CFU's in *C. longa* treated samples is due to the presence of three major curcuminoids: curcumin, demethoxycurcumin and bis-demethoxycurcumin along with alkaloids, turmerol and veleric acid (Naz et al, 2010; Cikricki et al, 2008; Selvam et al, 2012). The reduced susceptibility of *E.coli* towards Turmeric could be due to the restricted permeability of the bioactive agents by the outer membrane of the bacteria. (Priyanka et al, 2012).

The highest CFU inhibition was found in 200 GSM fabrics as increase in the inherent mesh structure of the nonwoven helped retain more extract during the pad dyeing process.

Table 2. Antibacterial properties of *T. chebula* and *C. longa* extracts, on nonwovens.

Fabric GSM	**Conc, (%)**	**Bacterial Reduction, (%), *T. chebula* extracts**		**Bacterial Reduction, (%), *C. longa* extracts**	
		S. aureus	***E. coli***	***S. aureus***	***E. coli***
200	20	70.92	77.16	93.78	85.92.
	30	75.97	79.05	95.8	88.31
	40	78.91	80.81	96.64	91.01
100	20	62.41	72.88	92.02	86.43
	30	68.23	74.07	93.68	87.05
	40	72.05	75.81	94.37	89.13
Note: Fixation temperature 120° C for 3 minutes					

3. Colour characteristics of cotton nonwoven's mordanted with *T. chebula* and pad dyed with colorant *C. longa.*

As shown in Table 3, the presence of hydrolysable tannins in the extract led to a sharp rise in K/s values when *T. chebula* was used as a mordant. The colour coordinates were all in the green-yellow zone but moved further away from the greener tones of the un-mordanted samples. The pre and post-mordanted samples showed brighter yellower shades compared to the meta-mordanted fabrics who displayed the lowest L* values. This relatively low values could be due to the formation of dye-mordant complexes within the dye bath itself during its preparation, thus reducing exhaustion and absorption on the colorant on sample.

Table 3. Effect of mordanting methods on K/S values and antibacterial properties of 100 GSM cotton nonwovens: *T. chebula: C. longa* (20:20)

Colour Strength Values					**Bacterial Reduction, (%),**	
Extract Conc, (20 %)	**L***	**a***	**b***	**K/S**	***S. aureus***	***E. coli***
Pre-Mordanting	80.35	-3.52	37.85	8.10	94	89
Post-Mordanting	85.00	-5.05	34.03	6.41	90	77

Meta-Mordanting	74.40	-3.88	25.26	1.63	73	61
Note: Fixation temperature 120° C for 3 minutes						

4. Antimicrobial properties of cotton nonwoven's mordanted and pad dyed with *T. chebula* and *C. longa*

The maximum increase in antibacterial activity was observed in the pre-mordanted samples as displayed in Table 3. A plausible reason could be presence of tannins in the *T. chebula* extract which serves the dual purpose of being an antibacterial agent as well as a mordant. The herbal tannin binds to the proteins and enzymes of the cell wall, inhibiting microbial growth. Simultaneously the mordanting capability of the extract has helped exhaust maximum colourant from the dyebath and thus improve the overall amount of bioactive compounds of Turmeric on the fabric sample (Raja & Thilagavathi, 2011).

Pre-mordanted fabrics displayed highest colour strength values and antimicrobial properties.

Conclusion:

As the health and hygiene industry faces the challenging demand for skin and environment friendly textiles. This research has refocused on the ancient art of natural mordanting and dyeing of textiles to benefit from use of bioactive compounds present in herbal plant extracts. The antimicrobial capabilities of treated nonwoven textiles reveal good findings based on the hypothesis that a minimum 75% reduction in bacterial count is an acceptable level, since the untreated cotton fabrics demonstrated no antibacterial activity. *C. longa* displayed high CFU reduction for both S. aureus and E. coli. The use of *T. chebula* extract displayed considerable reduction in *E. coli* CFU's which otherwise are known to have resistance to biocides. The plants selected are indigenous to the Asian continent and further bioprospecting could be done to explore their antibacterial options in nonwoven barrier fabrics.

References:

1. Aly, M., & Gumgumjee, N. (2011, September 26). Antimicrobial efficacy of Rheum palmatum, *Curcuma longa* and *Alpinia officinarum* extracts against some pathogenic microorganisms. *African Journal of Biotechnology*, *10(56)*, 12058-12063.
2. Bag, A., Bhattacharyya, S., Bharti, P., Pal, N., & Chattopadhyay, R. (2009). Evaluation of antibacterial properties of Chebulic myrobalan (fruit of *Terminalia chebula Retz*.) extracts against methicillin resistant *Staphylococcus aureus* and trimethoprim-sulphamethoxazole resistant uropathogenic *Escherichia coli*. *African Journal of Plant Science*,3(2), 025-029.
3. Cikricki, S., Mozioglu, E. and Yýlmaz, H. (2008). Biological activity of curcuminoids isolated from *Curcuma longa*. *Records of Natural Products*. *2*, 19- 24
4. Datta, S., Uddin, M., Afreen, K., Akter, S., & Bandyopadhyay, A. (2013). 214 Assessment of antimicrobial effectiveness of natural dyed fabrics. *Bangladesh Journal of Scientific and Industrial Research*, 48(3), 179-184.
5. Eid, Y. M., Khalifa, T. F., & Ibrahim, G. E. (n.d.). *1 St International Conference of Textile Research Division*. Retrieved from http://www.mu.edu.sa/sites/default/files/content-files/40_2.pdf
6. Gao, Y., & Cranston, R. (2008). Recent Advances in Antimicrobial Treatments of Textiles. *Textile Research Journal*, 78(1), 60-72.
7. Gowd, P. M., Manoj, K. M., Sai, S. A., Sujatha, B., & Sreedevi, E. (2013). Evaluation of three medicinal plants for anti-microbial activity. *AYU Journal*,*33*(3), 423-428.

8. Kurian, J. C. (2003). Plants that heal. Pune: Oriental Watchman Publishing House.

9. Lee, H., & Cassil, N. (2006). Analysis of world nonwoven market. *Journal Of Textiles And Apparel, Technology And Management, 5*(3), 1-19.

10. Lin, C., & Lin, J. (2008). Curcumin: a potential cancer chemopreventive agent through suppressing NF-κB Signaling. *Journal of Cancer Molecules, 4 (1),* 11-16.

11. Mahosh, S. (2011). Studies on antimicrobial textile finish using certain plant natural products. *International Conference on Advances in Biotechnology and Pharmaceutical Sciences.* pp. 253-258.

12. Naz, S., Jabeeni, S., Ilyasi, S., Manzoor, F., Aslami, F. and Ali, A. (2010): Antibacterial activity of *Curcuma longa* varieties against different strains of bacteria. Pakistan Journal of Botany. *42*(1): Pp. 455-462

13. Prabhu, K., & Teli, M. (2014). Eco-dyeing using Tamarindus indica L. seed 225 coat tannin as a natural mordant for textiles with antibacterial activity. Journal of Saudi Chemical Society, *18*(6), 864-872.

14. Priyanka, R., Vasundhara, M., Radhika, B. and Shanti, K. N. (2014): Screening fresh, dry and processed Turmeric (*Curcuma longa L.*) Extract against pathogenic bacteria. *Research Journal of Pharmaceutical, Biological and Chemical Science*. *5*(6): 1041-1046

15. Raja, A., & Thilagavathi, G. (2011). Influence of Enzyme and Mordant Treatments on the Antimicrobial Efficacy of Natural Dyes on Wool Materials. Asian Journal of Textile, *1*(3), 138-144.

16. Russell, S. (2007). Handbook of nonwovens (1st ed.). Boca Raton, FL: CRC Press.

17. Selvam, M., Singh, R., & Kalirajan, K. (2012). Anti-microbial activity of Turmeric natural dye against different bacterial strains. *Journal of Applied Pharmaceutical Science, 02(06),* 210-212.

18. Sun. J., Zhao, Y., & Hu, J. (2013). Curcumin inhibits Imiquimod-induced psoriasis- like inflammation by inhibiting IL-1beta and IL-6 production in mice. *PLoS ONE, 8(6),* 1-9.

19. Teli, M. D., & Shukla, A. J. (2018). *Cellulosic Nonwovens Embedded with Camellia Sinensis Extract for Imparting Multifunctional Properties, 30*(1), 103-112.

20. Tiwari, S.C., & Bharat, A. (2008). Natural dye-yielding plants and indigenous knowledge of dye preparation in Achanakmar- Amarkantak Biosphere Reserve, Central India. *Natural Product Radiance, 7(1),* 82-87.

21. R, T., Zemljic, L. F., Novak, M., Kuncic, M. K., Sonjak, S., Cimerman, N. G., & Strnad, S. (2011). Anitmicrobial efficacy of functionalized cellulose fibers as potential medical textiles. *Science against Microbial Pathogens: Communicating Current Research and Technologies and Advances,* 36-51.