



Green Synthesized Moringa (*Moringa Loeifera*) Leaf Nanoparticles – As An Antimicrobial Finish On Cottons

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Abstract – Antimicrobial finish on cotton textiles can improve the inhibition power over the growth of microorganisms on the fabric. It can also control the problems like physical irritation, allergy and infections as well enhances the feeling of comfort to the wearer. In the present investigation antimicrobial properties of the woven and knitted cotton fabrics treated with 5 per cent biosynthesized Moringa leaves (*Moringa Loeifera*) nano particles (NPs) were studied. Synthesized nanoparticles were analyzed using UV- spectrophotometer which showed a wave length of 400 – 437 nm suggesting the formation of NPs. TEM analysis confirmed NPs with a range between 20.3 to 51.8 nm. Two methods were hosen to treat the fabrics are padding-drying at room temperature (T1 treatment) and pad-dry-cure method at 80°C (T2 treatment). To analyze the antibacterial activity against S.Aureus and E.Coli cultures of the treated samples, AATCC 147-1998 test method was used, where AATCC 30-1993 and Mycelial growth test methods were used for analyzing antifungal activity. From the investigation, it was found that T2 treated samples possess better antimicrobial activity against microorganisms even after five to ten launderings than T1 treated samples.

Keywords – Moringa (*Moringa Loeifera*); Bio-synthesis; Nanoparticles; Cotton textiles; Antimicrobial activity.

I. INTRODUCTION

All the textile materials can be a great response to microbial growth. However natural fibers like cotton, wool, jute, flax are reported to be most susceptible to microbial attach (Yau, 1998). The term Microbes includes variety of micro-organisms like bacteria, fungi, algae and virus, humid environment supports the growth of it, where, bacteria require more dampness/wetness in fabrics, which can cause inflict range of unwanted damage to textiles. They not only affect textiles but also a source of many problems to human beings from simple unpleasant odor to physical irritation, allergy, infections and diseases (Schatz, 2001).

The term 'Antimicrobial' finish on textiles, refers to a broad range of technologies that can provide varying degree of protection to textiles against microorganisms (Harini *et al* 2007).

The first antimicrobial textile material in modern history was developed by Lister in 1867 (Sun and Worley, 2005). The treatment should be active against microorganisms and should be safe, non-toxic and bio-degradable without altering color, pliability and strength of fabric, which have been noticed in chemical finishes. However, attention has been drawn towards green textiles, the use of plant sources for its eco-friendly nature and it has become an important subject for discussion in recent years. There has been

tremendous progress in every sphere of scientific and technological pursuit. This technological progress has been for the benefit of the environment and mankind. Only difficulty in using natural sources on cottons is that, they exhibit color change and stiff hand, which can be overcome by changing the size of particles application, i.e., through a process called 'Biosynthesis'. The current experiment is on effectiveness of antimicrobial property on cotton textiles, finished with biosynthesized Moringa oleaf Nanoparticles.

Moringa oleifera is a fast growing tree, grown throughout the tropics and sub-tropics (Doerr and Cameron, 2005). The leaves of the Moringa tree have more than three times the calcium of milk, slightly more potassium than bananas, more than twice the iron of spinach, and more than twice the vitamin C of oranges, hence called a 'Miracle Tree'. Dahot's (1998) experiment on antimicrobial activity of moringa oleifera leaves from the aqueous extraction where found there was a significant antimicrobial activity against gram positive and negative bacterial and fungal species. Kekuda *et al.* (2010) have conducted research on steam distillate *moringa oleifera lam* for antibacterial and antifungal activity. From the experiment it was found that there was a reduction in the growth of bacteria in distillate tubes compared to control tubes. The fungal activity showed reduced colony diameter in plates poisoned with distillate compared to control plates.

II. MATERIALS AND METHODS

A. Selection and Preparation of Materials

Desized woven and semi bleached knitted cotton materials, sourced from Hyderabad and Tirupur respectively. Fresh good quality Moringa leaves (*Moringa Loeifera*) leaves were selected from the surroundings of study area, which were cleaned with ethyl alcohol and distilled water solution in 1:5 ratio; dried in tray dryer at 50°C; ground into fine powder; sieved and stored aseptically.

B. Bio-synthesis of Nanoparticles

Dried leaf powder was mixed in distilled water and the mixture was decanted. To this decanted solution, 1mM solution of AgNO₃ was added in 1:9 ratios, where the color change of broth can be observed. The broth was centrifuged at 18,000 rpm for 25 min.

C. Morphological Analysis

UV – VIS Spectrophotometer

The formation of NPs was monitored by using the UV – Visible Spectrophotometer. Surface Plasmon Resonance



of nanoparticles resulted a wave length on X – axis and absorbance on Y – axis was plotted on graph.

Transmission Electron Microscopy (TEM)

Dip preparation by Flotation method was employed at Ruska lab, SVVU, Hyderabad, where the sample was observed at 30magnificance.

D. Application of Finish

The selected cotton materials (woven and knitted) were treated with 5per cent Moringa leaf nanoparticles, through padding technique at 70percent pressure with MLR of 1:10.

Shade dried samples at room temperature are coded as T1 and pad-dry-cure method at 80°C for 15min, samples as T2. All the samples were laundered for 1, 5 and 10 times and tested for antimicrobial and geometrical properties at each stage.

E. Testing of Samples for Antimicrobial Properties

Antimicrobial property was tested through antibacterial and antifungal activity test methods as given below:

a. Antibacterial Activity, AATCC-147, 1998

Qualitative, AATCC test method 147 was used to observe the growth inhibition of *Escherichia Coli* and *Staphylococcus Aureus*.

b. Antifungal Acticity

AATCC 30-1993, Agar Diffusion Test

The growth of fungi in the conical flask was observed after 3 days and the fungal growth was rated as 1, 2, 3, & 4 for No growth, Minimum growth, Moderate growth & Maximum growth respectively.

Mycelial Growth Test

Prepared PD agar sterilized at 121°C for 15min was poured in the petri dishes to test mycelial growth on the fabric, which was measured after 1, 3 and 5 days, **Raj Kumar and Krishnaveni, 2007.**

F. Geometrical Parameters of the Treated Samples

a. Preparation of Test Specimen

As per **BIS**, the test specimens were cut to the required size using standard templates by avoiding creases and 10cms from selvages, each were scattered as far as possible so that no two samples contained the same set of warp/weft yarns.

b. Atmospheric Conditions

Before testing, test specimens were conditioned for 24hours at standard atmosphere of 65 ± 2 percent relative humidity and $27 \pm 2^\circ\text{C}$ temperature in such a way to expose all portions of the material until the moisture attains equilibrium.

c. Geometrical Parameters

Yarn count

It defines fineness of yarn. Yarn count of fabrics was determined by the indirect method of counting the numbers of yarns per unit mass using Beesley's balance, **Booth, 1983.**

Fabric Count

Count for woven and knitted fabric is the number of warp & filling yarns and wale and course loops per unit distance (In.), respectively(ASTM, 2007). IS1963-1969, test method was used.

Fabric Thickness

Thickness is the distance between one surface and it's opposite (ASTM, 2007). Heal's thickness gauge was used to measure the fabric thickness, **Booth, 1983.**

Fabric Weight

Fabric weight is used with fabrics, mass per unit area (ASTM 2007). The weight of a known size of fabric specimen was measured following IS No. 1964-1970, using a sensitive balance.

III. RESULTS AND DISCUSSION

A. Morphological Analysis

a. UV – VIS Spectrophotometer

The color change from light mustard to brown was observed during reduction of Ag ions into Ag Nanoparticles, when exposed to extract. UV-VIS spectrograph of the colloidal solution of biosynthesized nanoparticles has been recorded peak nanometer at 420-30nm with an absorbance of 1.98, broadening of peak indicates polydispersed particles in the solution (Fig 1.).

b. Transmission Electron Microscopy (TEM)

Average measured nano particles size is 51.08nm at 30 magnification. The particles were well dispersed and round in its morphology (Fig 2.).

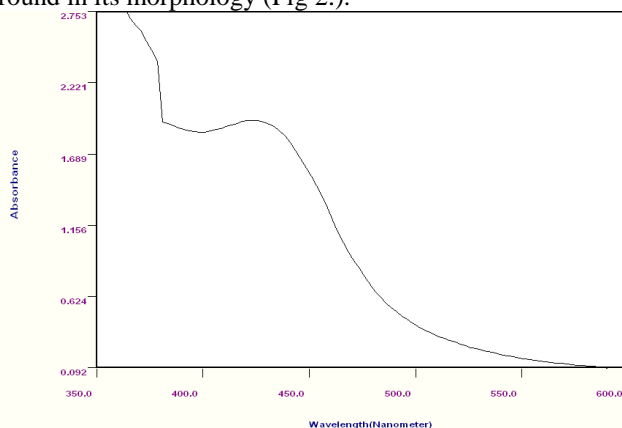


Fig. 1. Wavelength of Moringa leaf NPs

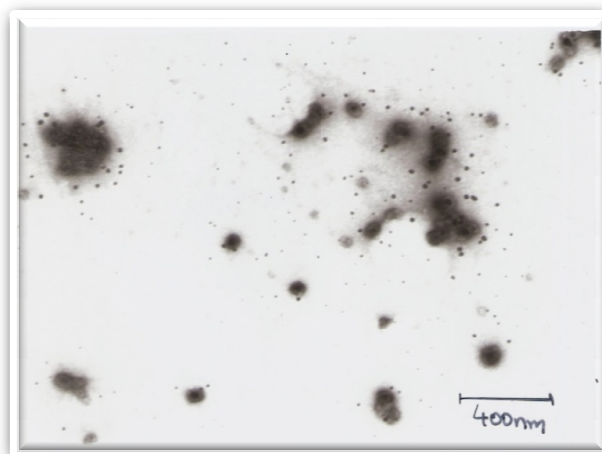


Fig. 2. TEM image of Moringa leaf NPs



B. Antimicrobial Analysis

Nanoparticles treated samples and untreated samples were analyzed through antibacterial and antifungal analysis.

a. Antibacterial Activity

Assessment of antibacterial activity against *E.coli* and *S.aureus* for untreated samples and treated samples

AATCC 147-1998 Agar diffusion test method for antibacterial property has shown no “zone of inhibition” (*zoi*) for untreated cotton and knitted samples for both gram negative (*E.coli*) and gram positive (*S.Aureus*) cultures, indicating absence of antibacterial activity. ZOI describes the efficiency of the antibacterial property in the substrate, which was calculated in mm by measuring the

area around the treated substrate into which the antimicrobial chemistry leaches or moves to kill, or inhibit microorganisms, **Kavitha et al., 2006**.

From the results, it was found that T2 treated samples has more *zoi* than T1 treated samples for both cultures, which signifies good antibacterial activity. Knitted samples have good antibacterial activity against both cultures and was stronger against gram positive bacteria than gram negative bacteria (Table 1). Anti-Bacterial activity against *S.aureus* culture showed better results than *E.coli* culture. This may be due to the difference between the peptidoglycan layer in gram positive and negative bacteria (**Silver et al. 2006**). T2 treated knitted sample have shown great activity against *S. Aureus* bacteria.

I. Antibacterial activity of Samples against *S.Aureus* and *E.Coli*

Treatments	Zone on inhibition (<i>zoi</i>) in mm.							
	Against <i>E.coli</i> .				Against <i>S.Aureus</i>			
	Woven		Knitted		Woven		Knitted	
	T1	T2	T1	T2	T1	T2	T1	T2
Untreated samples	0		0		0		0	
Treated samples	2	4	2.97	3.53	1.97	3.53	1.77	6.3
Samples after first wash	0.83	1.97	2	1.8	1.53	3.03	1.6	2.77
Samples after fifth wash	0	1	0	1.5	0	2	0	1.75
Samples after tenth wash	0	0.75	0	0.5	0	1	0	1

Assessment of Antibacterial Activity Against *E.Coli* and *S.Aureus* After One, Five and Ten Laundering

Cotton and knitted samples with both type of treatments (T1 & T2) have retained good antimicrobial activity after first laundering, where T2 treated samples have last its activity up to ten laundering against two cultures than its counterparts (Table I).

b. Antifungal Activity

Antifungal activity was evaluated through Agar diffusion test and Mycelial growth analysis.

AATCC 30-1993, Agar Diffusion Test

Assessment of Untreated and Treated Samples for Antifungal Activity

The fungal growth was rated on four point scale (1 to 4 as no growth to maximum growth respectively) analysis. Three days after initiation of test, the samples were

checked for fungal growth in the test tubes, where control cotton and knitted samples were found to be rated 4 and 3 respectively, indicates maximum fungal growth in test tube with cotton sample and moderate fungal growth in test tube with knitted sample. Experiment showed dispersed fungus for knitted sample, where in, fungus lump as layer was found in test tube with cotton samples. Both cotton and knitted samples treated with biosynthesized nanoparticles through any type of treatment possesses good activity against fungal growth.

No fungal growth was observed for T2 treated cotton sample even after tenth wash, where in test tubes with T1 treated woven and T2 treated knitted sample have shown moderate development of fungus was observed (Table II).

II. Antifungal activity of Samples

Fabrics	Treatments	Untreated samples	Treated samples	Samples after first wash	Samples after fifth wash	Samples after tenth wash
Woven	T1	4	1	1	1	2
	T2		1	1	1	1
Knitted	T1	3	1	1	1	3
	T2		1	1	1	2

Mycelial Growth

Assessment was observed by fungal growth on first, third and fifth day.

Mycelial Growth Assessment on Untreated and Treated Samples

0.6mm fungus was grown around the untreated sample after one day, which increased to 1.75mm by fifth day. For untreated knitted sample have shown mycelial growth on third and was developed to 1mm by fifth day (Table III).



III. Mycelial growth of untreated samples

Days	Mycelial growth (mm)	
	Woven	Knitted
I	0.6	-
III	1	0.5
V	1.75	1

III. a. Mycelial growth of the treated samples

Test samples	Woven samples						Knitted samples					
	T1			T2			T1			T2		
	I	III	V	I	III	V	I	III	V	I	III	V
Treated samples	-	-	0.1	-	-	-	-	-	0.7	-	-	-
Samples after first wash	-	-	0.5	-	-	0.2	-	0.5	0.7	-	0.1	0.1

Both the fabrics treated in both the methods have not shown any mycelial growth after one and third day. For woven and knitted T2 treated samples, there was a mycelial growth of 0.1mm and 0.7mm respectively. When samples were further tested after first laundering, the mycelial growth was raised to 0.5mm on fifth day for T1

treated woven sample, whereas T1 treated knitted sample has shown growth on third day and was increased to 0.7mm by fifth day. There was minimal growth was observed for T2 treated knitted samples. Compared to T1, T2 treated samples have more resistance towards mycelial growth (Table III.a.).

C. Geometrical Parameters of Fabrics

a. Yarn Count

It was tested for woven fabric. Warp direction yarns have shown increased yarn count, where there was no difference was found for yarn count of weft yarns, when compared with Untreated sample Table IV.

b. Fabric Count

When compared to untreated samples, there was an increase in the fabric count on warp direction of the woven fabric was observed, where decreased fabric count was observed for weft direction of treated samples. The samples treated with both the treatments are on par with control sample for courses and wales of knitted fabric.

IV. Geometric parameters of the test samples

Parameters	Samples	Yarn count(s)		Fabric count(No./In.)		Fabric thickness (mm)	Fabric weight (GSM)
		Warp	Weft	Warp/Course	Weft/Wales		
Woven	UT	41	37	77	56	0.282	81.62
	T1	45	39	80	54	0.29	81.60
	T2	44	38	80	54	0.282	80.92
Knitted	UT	-	-	37	36	0.709	168
	T1	-	-	38	37	0.734	178
	T2	-	-	37	36	0.686	177

Note: UT= Untreated

c. Fabric Thickness

Fabric thickness for both types of treated fabrics are on par with untreated fabric for both woven and knitted fabrics, Table 4. The thickness of knitted fabric was more than woven ones, this may be due to loosely spun yarn used in a knitted fabric for greater pliability. T2 treated knitted samples have shown decrease in thickness compared to other two counterparts, this is due to the compressed yarns during the padding and set during the curing process.

d. Fabric Weight

There was an increase in the weights of treated knitted samples were observed, Table 4. This may be due to the deeply embedded nanoparticles within the fabric. There was not much difference was observed for woven samples.

the treated samples tested through both the test methods, agar diffusion and mycelial growth tests has showed effective activity against fungal growth. Effective activity against bacterial and fungal growth lasted till 5 to 10 washes for the T2 treated samples. For geometrical properties, the treated samples are on par with the untreated samples. Increased GSM was observed for treated knitted samples than untreated ones.

IV CONCLUSION

From the present research Moringa Leaves NPs treated with T2 on woven and knitted samples has showed more *zoi* than T1 treated samples for both cultures, which signifies good antibacterial activity. Anti-Bacterial activity against *S.aureus* culture showed better results than *E.coli* culture, this may be due to the difference between the peptidoglycan layers of the bacteria. Antifungal activity of

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