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Comparative analysis of different antimicrobial agents on jute fabric

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Abstract

Researchers always give attention to find a better polymeric substance for antimicrobial properties development on jute fabric. Because of non-toxic, biodegradable nature, as well as absorption coefficient capabilities, chitosan is always used as a antimicrobial agent. But chitosan has a narrow solubility range and also give adhesive effect on jute fabric that makes fabric difficult to further use especially in medical textile. By creating derivatives such carboxylated, thiolated and acylated from chitosan, this drawback can remove. Here, derivatives metal complex (CMC-Zn) has been prepared, analyzed and studied. GSM, thickness and antimicrobial tests of both chitosan and CMC-Zn have been studied and compared. CMC-Zn has lower GSM and thickness than chitosan treated jute fabric. CMC-Zn has also shown good antimicrobial result on jute fabric. We looked into the possible advantages of these enhanced chitosan derivatives for medical textile.

Keywords: Jute fabric; Antimicrobial agent; Chitosan; CMC; CMC-Zn

1. Introduction

Jute and jute based fabrics are gaining popularity in domestic and international field due to eco-friendliness and biodegradability characteristics. Golden fibre jute has certain inherent properties e.g. flammability, high moisture absorption and susceptibility to rotting which have restricted its growth of use towards protective textiles. To find use as value added technical textiles, jute fabric has to undergo improved chemical finishing process especially antimicrobial finishing, fire retardancy, water repellency, rot resistance, crease resistance etc. depending on end use application .For the development of various types of functional finishing of jute, proper choice of chemicals along with process parameters are important[1]**.** Antimicrobial treatment or Rot-proofing treatments are usually applied on textile materials with the object of prolonging the life of material when under the actual condition of usage. It is evident that the antimicrobial treatment or rot resistance treatment so far tried on jute are limited and have been mostly confined to compounds of copper, zinc or cadmium e.g. sulphate, naphthenate, cupramoniumetc[2,3].

However, the inherent disadvantages of this cationic polymer, like chitosan has low insolubility range. This-restricts its potential for use in medicine and medical textiles [4].

The purpose of present investigation is to compare the study of potentiality of different antimicrobial agents like Chitosan, CMC-Zn metal complex and also find a alternative of chitosan.

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2. Material and methods

2.1. Materials

2.1.1. Jute woven fabric

Jute fabric was collected from weaving department of Bangladesh Jute Research Institute. Construction of jute fabric: EPI=7 ,PPI=7, Count of Warp = 12,Count of weft=12,GSM =400.

2.1.2. Chemicals

Chitosan was purchased from local market of lab grade and Its molecular weight and degree of deacetylation were 138 k Da and 80%, respectively.Peptone, yeast extract, beef extract ,sodium chloride, Agar ,IPA, Sodium Hydroxide etc. chemicals were purchased from local market .All chemicals were lab graded chemicals.

2.1.3. Machines

Electric Balance, Magnetic stirrer, Auto clave, Laminar air flow cabinet, FTIR, Incubator shaker, GSM cutter, thickness gauge etc.

2.2. Methods

2.2.1. Extraction of CMC-Zn

3 g of chitosan was dissolved in 500 ml of distilled water. The mixture was stirred using magnetic stirrer until complete dissolution of chitosan. 15 g of $ZnSO_4 \cdot 7H_2O$ was added to the solution of chitosan and stirred vigorously for15 min. 4 g of NaOH was dissolved in 500 ml of distilled water and added drop wise with constant stirring. The mixture was stirred for 2 h at 25 °C., 50 ◦ C and 90 °C. To obtain chitosan metal composite (CMC-Zn) powder, the solution was decanted and finally filtered off. The obtained powder was washed 3 times with distilled water to remove any impurities [5].

2.2.2. Fourier Transform Infrared Spectrophotometer (FTIR)

All samples and potassium bromide (KBr) were dried at 105 °C for 10 h. The samples were mixed with KBr, using mortar and pestle, to make a powder in the mass ratio 1:100 (1 mg sample and 100 mg KBr). Again, mixed samples were dried at 105 °C for 10 h [6]. Then the sample was analyzed with a FTIR spectrophotometer (Spectrum-100, Perkin Elmer, USA) using the scanning range of 400–4000 cm^{-1}.

2.2.3. Measurement of GSM

Fabric weight per unit area was measured as per Standard ASTM-D 3776-96 [7].

2.2.4. Measurement of Thickness

The principle of measurement of fabric thickness is expressed in B.S. 2544:1954 by James Heal's thickness gauge [8].

2.2.5. Quantitative Antibacterial Test

Antibacterial activity against gram negative bacteria (*E. coli*) was tested. As per the standard, a test sample of 2″×2″ was cut and put into five 50 ml conical flasks, each containing 20 ml of the nutrient broth and 20 µl of microbial culture was added. All the flasks were kept in a shaker incubator with 200 rpm at 37 °C for 24 h. The incubated test culture in the nutrient broth was diluted five times with sterilized distilled water. 20 µl of each dilution was spread in a nutrient agar petri dish. All the inoculated plates (untreated and treated samples) were incubated at 37 °C for 24 h. After 24 h, general observation of bacterial population of treated and raw samples were done from prepared petri dish.

2.2.6. Qualitative Antibacterial Test

The inhibition zones of treated and untreated samples were determined, according to AATCC-147 standard using the parallel streak method [9]. The zone of inhibition was calculated as per the following equation:

$$W = T - D/2$$

Where,
W is the width of the clear zone of inhibition in mm,
T is the total diameter of test specimen and clear zone of inhibition in mm,
D is the diameter of the test specimen in mm.

3. Results and discussion

Thickness of raw jute has found 2.20 mm. But after treatment thickness of jute fabric has increased. In case of chitosan treated jute fabric thickness has found higher than CMC-Zn treated fabric.

Table 1 Thickness measurement of raw and treated jute fabric

Sl No.	Sample Types	Thickness(mm)
1.	Raw jute fabric	2.20
2.	Chitosan treated jute fabric	2.33
3.	CMC-Zn treated jute fabric	2.21

Jute in its unprocessed form has 420 GSM. However, the GSM of jute fabric has increased following treatment of chitosan and CMC-Zn. In the case of jute fabric treated with chitosan, GSM was found to be greater than fabric treated with CMC-Zn.

Table 2 GSM measurement of raw and treated jute fabric

Sl No.	Sample Types	GSM
1.	Raw jute fabric	420
2.	Chitosan treated jute fabric	440
3.	CMC-Zn treated jute fabric	425

3.1. FTIR analysis

The composition of CMC-Zn composite was confirmed by FTIR spectroscopy. As shown in Fig. 1 , the absorption peak at about 1390 cm^{-1} and 1600 cm^{-1} are corresponding to carboxyl groups and the peak at about 2900 cm^{-1} is attributed to C–H stretching. A broad band at about 3330 cm^{-1} is attributed to OH and NH_2 of chitosan. A characteristic band observed at 863 cm^{-1} corresponds to the Zn–O stretching bond[10].

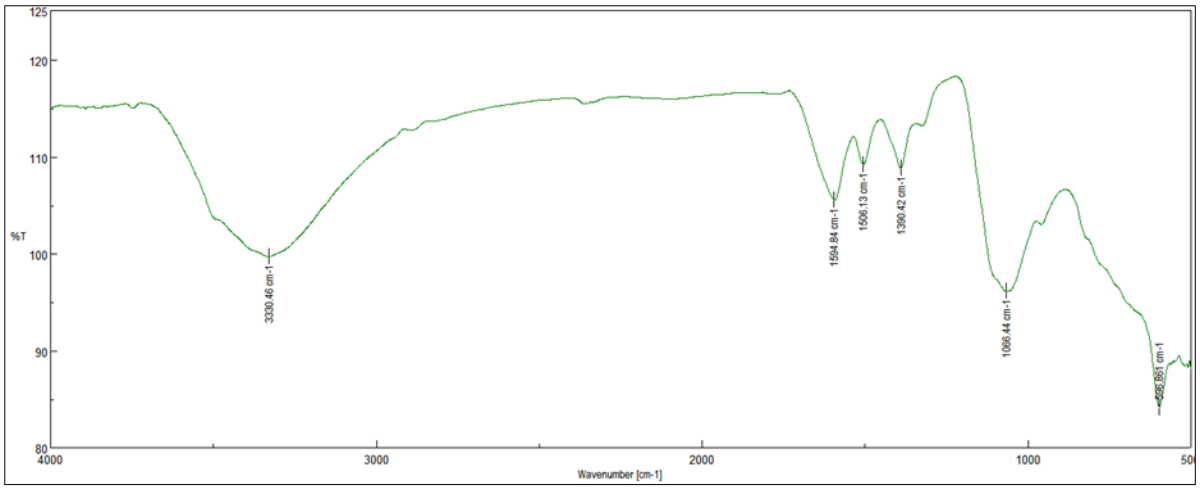

Figure 1 Carboxymethyl Chitosan –Zn complex

In quantitative approach, petri dish was prepared from culture of raw jute and treated jute .When the culture was taken from the raw jute fabric, gram negative bacteria (*E. coli*) was grown in whole petri dish (Fig.2.a). But when the cultures were taken from the treated samples (chitosan and CMC-Zn) and poured in petri dish for bacteria growing, bacteria did not grow well. The culture from chitosan treated samples shown (Fig.2.b) excellent result and bacteria did grow at all. In case of CMC-Zn, some bacterial strain were seen in the petri dish. (Fig.2.c)

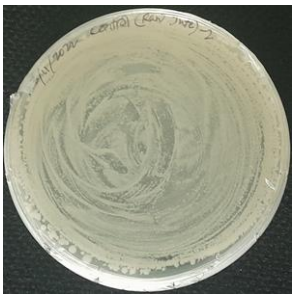

Figure 2 a Control

Figure 2 b Chitosan

Figure 2 c CMC-Zn

Figure 2 Pictorial view of inhibition of treated and untreated sample examined by Quantitative method

Antibacterial properties of jute fabric treated with CMC-Zn composite and chitosan were measured according to the inhibition zone method against gram negative bacteria (*E. coli*). Table 3 shows the results of inhibition zone of treated jute fabrics with of CMC-Zn composite and chitosan. Table 3 clearly says that all samples had inhibition zone larger than the untreated sample which was also obvious Fig. 3. Table 3 also shown that the zone of inhibition was better in CMC-Zn treated fabrics compared to chitosan treated sample.

Table 3 Antibacterial activity against *Escherichia coli* on sample treated with Chitosan, CMC- Zn

Sample	Bacterial Strain	Sample Size	Inhibition Zone (mm)
Jute fabric	*Escherichia coli*	20x20 mm	Not found
Jute fabric treated with chitosan	*Escherichia coli*	20x20mm	1.5mm
Jute fabric treated with CMC-Zn	*Escherichia coli*	20x20mm	2 mm

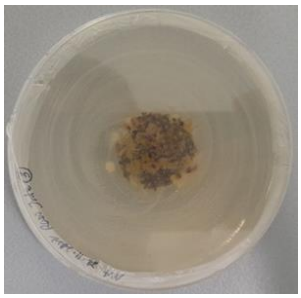

Figure 3 a Control

Figure 3 b Chitosan

Figure 3 c CMC-Zn

Figure 3 Pictorial view of inhibition of treated and untreated sample examined by Qualitative method

4. Conclusion

Chitosan and CMC-Zn successfully attached to jute woven fabric by the pad-dry-cure method. Antimicrobial effects have been proven to result from both chitosan and CMC-Zn treatment of jute fabrics. In the presence of chitosan, the GSM and thickness of treated fabric was shown to be higher than in the presence of CMC-Zn. It has also found chitosan and derivatives of chitosan both have good antimicrobial properties on jute fabric. As GSM and thickness of chitosan treated jute fabric increase, so it crates problem when to use as a antimicrobial agents. But it is derivative CMC-Zn treated fabric has less GSM, thickness and sticky than chitosan treated fabric. So it can be a suitable alternative for using as antimicrobial agents on medical textile sector.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

References

[1] Samanta, A. K., &Bagchi, A. (2017). Ecofriendly fire retardant and rot resistance finishing of jute fabric using tin and boron based compound. Journal of The Institution of Engineers (India): Series E, 98(1), 25-31.

[2] Macmillan, W. G., Basu, S. N., & Paul, P. N. (1961). Rot proofing of jute by treatment with soluble copper salt. Ind. Text. J, 71, 416-421.

[3] S. Majumdar, S. Chatterjee, B.L. Ghosh, Rot and mildew- proofing of jute fabric with quaternary ammonium compounds. Ind. J. Fib.Text. Res. 18, 48 (1993)

[4] Bernkop-Schnürch, A., Hornof, M., &Zoidl, T. (2003). Thiolated polymers—thiomers: synthesis and in vitro evaluation of chitosan–2-iminothiolane conjugates. International journal of pharmaceutics, 260(2), 229-237.

[5] Shafei, A. E., &Abou-Okeil, A. (2011). ZnO/carboxymethyl chitosan bionano-composite to impart antibacterial and UV protection for cotton fabric. Carbohydrate Polymers, 83(2), 920-925.

[6] Bagheri-Khoulenjani, S., Taghizadeh, S. M., &Mirzadeh, H. (2009). An investigation on the short-term biodegradability of chitosan with various molecular weights and degrees of deacetylation. Carbohydrate Polymers, 78(4), 773-778.

[7] ASTM D3776-96 (2002) Standard test methods for mass per unitarea (weight) of fabric. ASTM International, West Conshohocken,pp 5–5

[8] BS 2544: 1954 (1963) Determination of thickness of textile fabric.British Standard Handbook No. 11, pp 174–174

[9] Test Method AATCC: TM 147–2004 (2010) Determination of zone of inhibition by qualitative method, vol 85. AATCC Technical Manual, Research Triangle Park, pp 251–252

[10] Wang, X., Tang, R., Zhang, Y., Yu, Z., & Qi, C. (2016). Preparation of a novel chitosan based biopolymer dye and application in wood dyeing. Polymers, 8(9), 338.