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Finishing of Garments Customized for Radio and Chemotherapy Treatments of Cancer Patients

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Abstract

CANCER treatment has been known to go on for months or even years for some people, so it is important to have the suitable clothing for this period according to the side effects of the treatment. In the current research paper, the authors focused on the requirements that should be taken in patients' clothes during treatment period. Cotton/polyester blended fabrics are finished and dyed in one bath in order to impart them antibacterial, UV protection as well as self-cleaning properties besides a dye. The finishing bath contained Chitosan, magnesium oxide and disperse dye. All measurements are included and discussed in detail.

Keywords: Cancer, Anti-bacterial, UV protection, Self-cleaning.

Introduction

The most frequent cancer in women is breast cancer. [1] From the side effects of the treatment, radiation and chemotherapy increase skin's sensitivity to sunlight. [2] Anyone who is going under treatment has a higher risk of developing skin cancer in the area treated, so this makes protection essential.

While UV-B radiation is mostly absorbed by epidermal components like skin protein and DNA, part of the energy from solar radiation that reaches the skin is either transferred, dispersed, or reflected. [3] Clothing acts as a barrier by absorbing both damaging UV-B and UV-radiation, making it the most effective means to protect against sun radiation. Fabrics with UV protection are also more effective. [4-7]

Magnesium oxide is used for UV protection finishing, due to its low heat capacity and high melting point, it is a particularly attractive candidate for Insulation applications. Inorganic UV absorbers, such as magnesium oxide, are preferable to organic UV absorbers. It is more biocompatible, more durable, and has superior UV blocking characteristics over a wide range of UV wavelengths. It also has improved thermal and chemical stability.. [8-10]

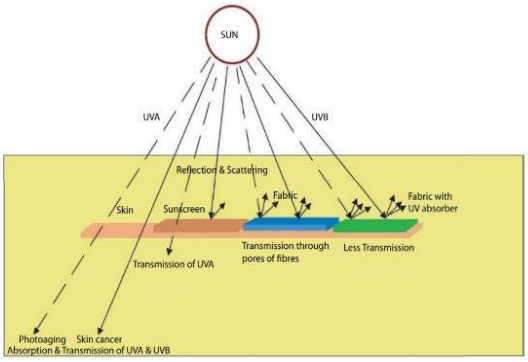

Figure 1: The protective action of sunscreen, fabric, fabric with UV protection

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Another side effect during the treatment is that, some women develop redness or sores due to radiation therapy. [1] To avoid any infection in these areas that may also happen, antibacterial finish is done on the fabric. Human sweat contains 1.4 million bacteria per gramme, and with a moisture level of 50%, that number rises to 9000 million, making it an ideal environment for bacterial development. This helps to maintain cleanliness.

Chitosan is used as it is a natural compound and it has numerous features like biodegradability, non-toxicity, non-allergic, cationic nature, and antimicrobial properties. [11-14]

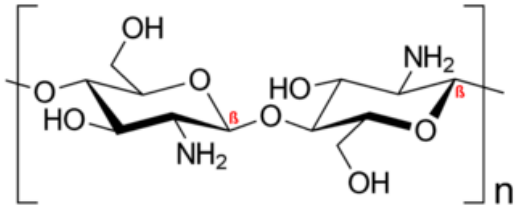

Figure 2: Commercial Chitosan

Positively charged amino acids, which interact with the bacterial cell wall to break it and encourage cellular death, are responsible for these antibacterial effects. [15]

In this paper, cotton/polyester blended fabrics are finished with Chitosan and magnesium oxide and dyed with disperse dye in one bath. High values of antibacterial, UV protection as well as self-cleaning properties are obtained. All the required measurements are investigated.

Materials and Methods

Materials

Cotton/polyester blended fabric (35/65) is kindly obtained from El-Mahala Company for Spinning and Weaving, El-Mahala (Egypt).

Disperse dye (C.I.11230) is purchased from Sigma-Aldrich (Egypt). Matexil DN-A (supplied by ICI Company, UK) as a dispersing agent. Chitosan (of low molecular weight) and Magnesium oxide (light, 95%) are purchased from Sigma-Aldrich (Egypt).

Infrared colour dyeing machine is used and manufactured by R. B. Electronic & Engineering PVT. Ltd. Mumbai, India.

Methods

Table 1 represents ingredients of the used finishing/dyeing bath, in which the cotton/polyester samples are treated with. A constant concentration of both Chitosan and disperse dye is used, while different concentrations of magnesium oxide are included in order to determine its best concentration to carry on with. Finishing/Dyeing processes are carried out into Infrared color dyeing machine. Beaker capacity of IR is prepared according to the mentioned recipe and placed inside IR at 100^{o}C for 1 hour. The beakers rotate with a speed of 30 rpm.

Table 1:Recipe of finishing/dyeing bath

Liquor ratio	1: 25
Weight of sample	2 gm
Distilled water	50 ml
Disperse dye	1.5%
Dispersing agent	2 ml
Chitosan	5%
Magnesium oxide	X Where X= (1%- 3%- 6%)
Time	60 min.
Temperature	100^{o} C

Measurements

Morphology and Elemental Composition

Using Quanta FEG250, field-emission scanning electron microscopy (FE-SEM) was used to examine the morphological characteristics of the pre- and post-treated textiles (Thermo Fisher Scientific, Brno, Czech Republic). By using various work distances and an acceleration voltage of 20 kV, this was outfitted with energy-dispersive X-ray spectroscopy (TEAM-EDX Model) to investigate the chemical composition of the pre- and post-treated textiles.

Antimicrobial Activity

To gauge the treated textiles' antibacterial activity, the disc agar diffusion technique was used. The four representative test organisms were Aspergillus niger NRRLA326 and Staphylococcus aurous ATCC 6538-P (G+ve), Escherichia coli ATCC 25933 (G-ve), and Candida albicans ATCC 10231 (yeast) (fungus). In the case of bacteria and yeast, nutrient agar plates were severely injected on a regular basis with 0.1 ml of 105-106 cells/ml. To assess the antifungal effects, 0.1 ml (106 cells/ml) of the fungal inoculum was planted into potato dextrose agar plates. The inoculation plates were covered with 15mm-diameter textile-treated discs.

To allow for maximal diffusion, plates were then maintained at a low temperature (4°C) for 2-4 hours. The plates were then incubated for the bacteria at 37°C for 24 hours and for the organisms to develop as much as possible at 30°C for 48 hours in an upright posture. The diameter of the inhibition zone, stated in millimetres, was used to measure the test

agent's antimicrobial activity (mm). The experiment was run many times, and the average reading was recorded.

Self-Cleaning Activity

The breakdown rate of methylene blue was used to gauge the photocatalytic efficacy of the treated cloth. Using a Cary Varian 300 ultraviolet-visible (UV-Vis) spectrophotometer in the wavelength range of 320-400 nm, the amount of ultraviolet transmission through textiles was measured. The performance of the photocatalytic self-cleaning was evaluated by observing the methylene blue degradation under visible light at wavelengths greater than 410 nm. Using a fluorescent lamp at a distance of 5 cm and a light intensity of 44 W cm-2, visible light irradiation was made possible.[16]

To achieve an equilibrium between photocatalysis and methylene blue under ambient circumstances, a sample of 1 g was agitated for 30 min in 50 ml of an aqueous solution of methylene blue (10 mg/L at pH 6.5). The sample was subsequently subjected to radiation while being illuminated by visible light (Coatings 2020, 10, 58 6 of 19). A sample of 5 mL of solution was obtained after each interval of irradiation and examined using a spectrophotometer. By measuring the absorption maxima at 665 nm as a function of the irradiation period, the concentration of methylene blue was determined. The following equation was used to measure the photocatalytic degradation:

Photocatalytic degradation =

$$(C_0 - C_t / C_0) = (A_0 - A_t / A_0)$$

Where A0 is the initial absorption, C0 is the starting methylene blue concentration, Ct is the concentration at various irradiation times, and At is the variable absorption at various irradiation times. [17]

Ultraviolet Protection

The UVPF (ultraviolet protection factor) was calculated using the AS/NZS 4399:1996 standard methodology. AATCC 183:2010 UVA Transmittance was used to measure the ultraviolet transmission through the cloth using a Cary Varian 300 UV-Vis spectrophotometer. [17]

Results and Discussion

Morphology and Chemical Composition

Chitosan (concentration at 5 percent owf) and magnesium oxide (concentration at 3 percent owf) were used to treat the samples, and the results of the scanning electron microscopic (SEM) examination are shown in Figure 4.

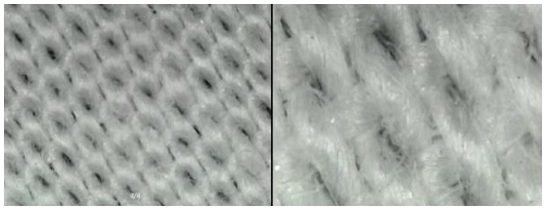

Figure 3: Scanning images of cotton/polyester fibers before dyeing and treatment with Chitosan and magnesium oxide

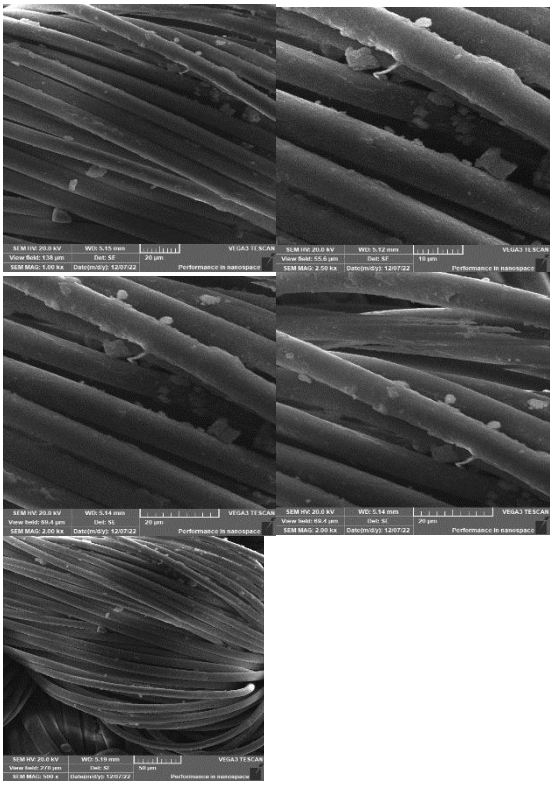

Figure 4: SEM images after dyeing and treatment with Chitosan and magnesium oxide with concentration 3%

It was proved that both Chitosan and magnesium oxide were incorporated onto cotton/polyester fabric surface filled all surface pores between fibres.

Antimicrobial Activity

Chemical or physical integration of active chemicals can give antibacterial activity to a textile product.[17] Table 2 demonstrates the antimicrobial performance of treated samples with Chitosan (concentration at 5% owf) and magnesium oxide (concentration at 3% owf).

Table 2. The effectiveness of several test antimicrobials against G+ve bacteria (S. aureus), G-ve bacteria (E. coli), yeast (C. albicans), and fungus (A. niger)**:**

The treated samples show better antimicrobial performance against G+ve bacteria (*S. aureus*) and yeast (*C. albicans*).

Self-Cleaning Activity

The conversion of the absorbed light into self-cleaning materials with the capacity to destroy its stain is one of the key aspects of treatment with metal oxide and chitosan. The following figure and table represent the resulted self-cleaning activity of treated samples with different concentrations of magnesium oxide.

After 12 hours of UV irradiation, Figure 5 depicts the effects of methylene blue on the treated materials. Metal oxide uses a unique self-cleaning process by combining an initial photocatalysis with a second hydrophobic step, which led to the production of a thin layer that might boost the hydrophobic qualities of the fabric surface when applied to cotton/polyester samples. [18] It was discovered that raising the magnesium oxide concentration causes the treated samples' self-cleaning activity to rise.

Table 3. Self-cleaning activity of treated samples with magnesium oxide with different concentrations**:**

MgO concentration % owf	**1%**	**3%**	**6%**
Self-cleaning activity	**47%**	**72%**	**95%**

Clear zone (ϕmm)			
Staphylococcus aureus	***Escheichia coli***	***Candida albicans***	***Aspergillsniger***
15	**0**	**15**	**0**
			

Figure 5: Effect of different concentrations of MgO on self-cleaning activity on cotton/polyester fabric

Ultraviolet Protection

By using absorbance spectroscopy, fabrics are investigated. Each number is the mean of three measurements taken while rotating the cloth by 90 degrees. The UV protection factor (UPF) and the percentage of the ultraviolet transmission were calculated using the transmission results. [17] The UV protection factor (UPF) of samples treated with various amounts of magnesium oxide is shown in the accompanying figure and table.

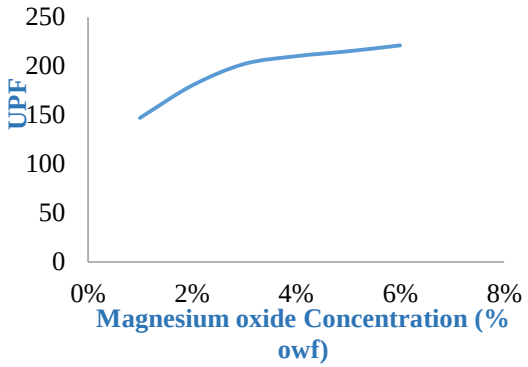

Figure 6: Effect of different concentrations of magnesium oxide on UPF on cotton/polyester

Table 4. UV protection factor (UPF) of samples treated with various amounts of magnesium oxide

MgO concentration % owf	**1%**	**3%**	**6%**
UPF	**147**	**202**	**221**

It was discovered that increasing the proportion of magnesium oxide improves the treated samples' UV protection properties. Comparing treated samples to untreated textiles, the majority of treated samples showed acceptable UV protection performance.

Conclusion

In summary, we focused on the requirements that should be found in patients' garments during their treatment period by Radiation or Chemotherapy. Cotton/polyester fabric was dyed with disperse dye and treated with Chitosan for its antimicrobial property. In order to get the highest UPF rating, different magnesium oxide nanoparticle concentrations were also put to the fabric. Due to the creation of a thin coating that may improve the hydrophobic qualities of the fabric surface and the unique self-cleaning process used by magnesium oxide, it was discovered that the treated fabric exhibited antibacterial activity, UV protection, as well as self-cleaning activity..

Conflict of Interest

There is no conflict of interest in the publication of this article.

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ملابس مجهزة ملائمة لفترة العلاج الإشعاعي و الكيميائي لمرضى السرطان

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المستخلص: يمكن أن يستمر علاج السرطان لأشهر أو حتى سنوات لبعض الأشخاص ، لذلك من المهم أن يكون لديهم الملابس المناسبة لهذه الفترة وفقًا للآثار الجانبية للعلاج. في هذه الورقة ، ركز المؤلفون على المتطلبات التي يجب توافرها فى الملابس التى يرتديها المرضى خلال فترة العلاج. تم تجهيز اقمشة مخلوطة من القطن / البوليستر وصباغتها في حمام واحد لمنحها خصائص مضادة للبكتيريا وحماية من الأشعة فوق البنفسجية بالإضافة إلى خصائص التنظيف الذاتي إلى جانب الصبغة. احتوى حمام التجهيز على الكيتوزان وأكسيد المغنيسيوم وصبغة مشتتة. يتم تضمين جميع القياسات ومناقشتها بالتفصيل..

الكلمات الدالة: السرطان، مضادة للبكتيريا ، حماية من الأشعة فوق البنفسجية ، التنظيف الذاتي .