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Investigation on the Antimicrobial Effect of Rodalon on Some Pathogenic Microbes Observed on Silken Fibers

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In Iranian culture, carpet is the most common first choice for covering the floor. It is a very suitable substrate for growing pathogenic microbes. In present research, the main aim is to investigate the antibacterial effectiveness of Rodalon solutions on silken fibers by spraying method used in silken carpet. Silken pile carpet laid in a public place (in VIP of The Homa hotel) for 30 days and the existence of some microbes were investigated on it. The antimicrobial effect of different Rodalon solutions for identified microbes was studied *in vitro*. The silken fibers were treated with the same different solutions of Rodalon as before and the antimicrobial effectiveness was assessed by the zone of inhibition method in different times. Two pieces of carpet untreated and treated with Rodalon solution sewed together and laid for two weeks in the public same place and the amounts of bacterial growth determined by colony count method and the results compared. Finally some mechanical properties of treated silken fibers measured after 30 days and compared with untreated one. The results showed the presence of some pathogenic microbes on the laid carpet such as *Escherichia coli* and *Staphylococcus aureus*. The inhalation time for treated silken fibers improved. The amount of colony growth on treated carpet reduced considerably and besides the mechanical tests results showed no significant deterioration effect of studied properties in comparing with untreated yarn.

Key Words: Rodalon, Silken carpet, Inhalation time, Colony count, *Escherichia coli*, *Staphylococcus aurous*.

INTRODUCTION

Micro organism is part of our life. Activity of microorganisms on the textile products cause three major problems *i.e.*, to risk human health, prepare bad odours and destruction of good[1,2]. Carpet is famous an historical textile. It is more suitable substrate for growing microorganism such as pathogenic microbes, due to the direct touch with human body, long washing periods and laying on the floor[3-5].

The silken carpet in comparison with other carpets has a special position. For this reason it needs some special methods for keeping or using one of the factors

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that endanger the quality of these goods, is the activity of microorganism. In recent years, in order to prevention of the activity and transition of harmful microbes many researches be a complied on antimicrobial material with short and long term effects in production, construction and completion of fibers[6,7]. It is very important to pay attention to the healthy and cleanliness of it. It is mentioned that two different aspects of antimicrobial protection provided by chemical finishes can be distinguished. The first is the protection of the textile user against pathogenic or odour causing microorganisms (hygiene finishes). The second aspect is the protection of the textile itself form damage caused by mould, mildew or rot producing microorganisms that it can be called antibacterial protection finish. According to Schindler and Hauser[8] and Vigo[9] many chemical reagents including inorganic salts, organometallics, iodophors (substances that slowly release iodine), phenols and thiophenols, onium salts, antibiotics, heterocyclics with anionic groups, nitro compounds, urea and related compounds, formaldehyde derivatives, biopolymers and amines have been used as antibacterial agent for hygiene finish or antibacterial protection finish. There are many studies in this field using these compounds[3,6,7,10-12].

Many antimicrobial agents have been used as antimicrobial agent for hygiene finish or antibacterial protection finish[8,9]. Between these antimicrobial agents quaternary ammonium salts exhibit marked antibacterial activity agent a wide rang of bacteria. These compounds have a central nitrogen atom which is joined to four organic radicals and one acid radical. Quaternary ammonium halide cationic surfactants are widely used in antibacterial surface-active and detergent properties[13-17].

Rodalon (Fig. 1) is one of the conventional quaternary ammonium salts. Its solution rapidly acting antiinfective agents with a moderately long duration of action. They are active against bacteria and some viruses, fungi and protozoa. Solutions are bacteriostatic or bactericidal according to their concentration[3,4].

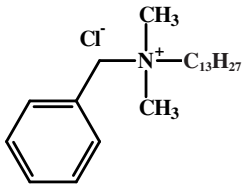

Fig. 1. Molecular structure of Rodalon

The exact mechanism of bacterial action is unknown, but it is thought to be due to enzyme inactivation. Activity generally increases with increasing temperature and pH. It has been used in textile industry, such as an insecticidal or antimicrobial[14,18,19].

In the present study, a conventional antiseptic agent, rodalon (*e.g.* roda) was applied through spraying method for improving silken carpet inhibition against some pathogenic microbes and the antibacterial effectiveness of it was evaluated by standard tests.

EXPERIMENTAL

Rodalon was purchased from Asalib Co. (Table-1). The carpets were purchased from Saran Co. (Table-2). Silken yarns were prepared from Saran Co. (8/2 Nm). The pure bacteria were supplied from the Bouali Hospital, Tehran, Iran and all tests were done in the Laboratories of Tarbiat Modarres University, Islamic Azad University Science and Research Campus Branch and Islamic Azad University of Shahre-Rey in 2008.

TABLE-1
TECHNICAL DATA OF THE APPLIED RODALON

Trade name	Rodalon 50
Product	A 50 % v/v solution of alkyl benzyl dimethyl ammonium chloride, complying with BP 2003 and USP 26-NK 21 monograph.
Appearance at 20 ºC	Clear liquid
Colour	Colourless to pale yellow
Density at 20 ºC	0.99 g cm^{-3}
Viscosity at 20 ºC	120 CS
Assay (mmw = 349.8)	50 ± 1
Non-quatermished amine (mmw = 223.3)	0.5 % max
Sulphated ash	0.2 % max
pH (5 % in water)	6.5-8.5

TABLE-2
SPECIFICATION OF THE APPLIED CARPETS

Colour	Ivory (mostly)
Pile yarn	100 % Silk
Pile length	11 ± 1 mm
Warp yarn	100 % Silk
Weft yarn	Cotton/polyester (35/65) %

Methods: For investigating the kind of present bacteria on carpet, (especially pathogenic ones) carpets were laid in a public place (in VIP of the Homa Hotel) for 30 days (everyday approximately 300 people were stepped on it), thereafter some fibers were cut of the carpets randomly and immersed in thioglycolate and nutrient broth mediums. After incubating for 24 h at 37 ºC, the solutions of each media sub-cultured in nutrient and blood agar mediums and after incubating in nutrient and blood agar mediums and after incubating for 48 h at 37 ºC the colonies of microbes were cultured by streak test method. For identifying the kind of cultured microbes the gram stain, catalase, oxidase, citrate agar, Christensen's urea broth and TSI agar tests were done. The cultured microbes kept in skimmed milk for next step. Ditch plates method was used for evaluating the antibacterial effectiveness of rodalon against bacteria present on carpet. Ditch plates were prepared by allowing the Mueller Hinton Agar to solidify in a petri dish and ditches (with diameter of approximately 4 mm) produced on it by removing the agar. Ditches were inoculated by different rodalon solutions (1/100, 1/500, 1/1000 and 1/2000 v/v solutions of rodalon). The

dishes incubated for 18 h 37 ºC to let the rodalon solutions penetrate to the agar medium. Microbes (stored in skim milk) were mixed with a semi liquid Mueller Hinton Agar (Agar conc. < 1 %) added to the inoculated plates. The plates were incubated at 37 ºC and the zone of inhibition in different time intervals (12, 24, 48, 72, 96, 120, 148, 172, 196, 220, 244 and 268 h) determined. The positive results repeated three times and the mean of zone of inhibition reported for 120 h. Silken fibers were spraying within different solutions of rodalon (1/100, 1/500, 1/1000, 1/2000 v/v solutions of rodalon) and after drying they entered in plates containing the pure microbes and the zone of inhibition were observed until the zone of inhibition disappeared. Every 24 h the plates were replaced with new plates of pure microbes. For comparing the antibacterial effectiveness of rodalon in practice one carpet splitter into two parts, one remained untreated and the other treated with rodalon solution (1/500 v/v solution of rodalon by spraying method). Two pieces sewed together and laid in the public place) in VIP of the Homa Hotel). Some fibers cut of two samples and the previously described methods use for culturing and separating of microbes and the antimicrobial effectiveness of rodalon on carpet was measured by colony count method. Some mechanical properties of untreated and treated (1/500 % v/v solution of rodalon) silken yarns were measured by Tensorapid (SDL Co.) after 30 days. The length for every sample was 300 mm and the speed of test was 999.9 mm/min.

RESULTS AND DISCUSSION

The presence of some microbes were proved in the studied carpet laid for 30 days, including *Escherichia coli*, *Enterobacter*, *Staphylococcus aureus*, *Pseudomonas*, *Bacillus*, *Penicillum*, *Aspergillus*, *Fusarium*, *Mucor.* Colonies of microbes are shown in Figs. 2 and 3.

The antimicrobial effectiveness of rodalon solutions on the found microbes after 120 h is shown in Table-3. According to the results the 1/2000 v/v solution of rodalon shows significant antimicrobial effect.

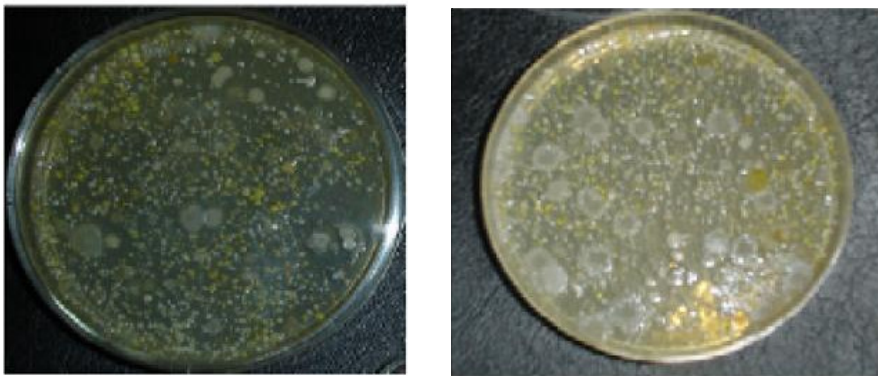

Fig. 2. Colonies of microbes on nutrient agar plate

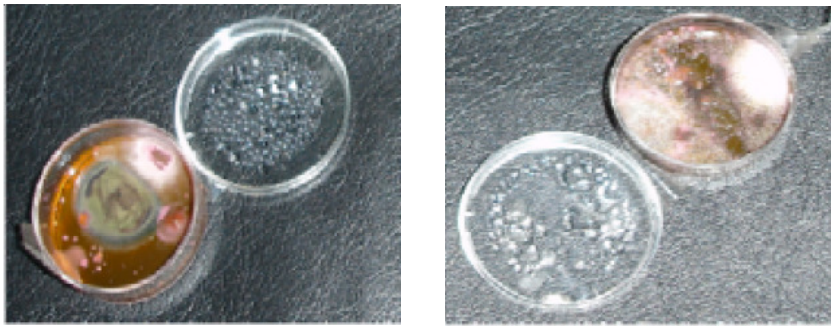

Fig. 3. Colonies of microbes on blood agar plate

TABLE-3
ANTIMICROBIAL EFFECT OF RODALON SOLUTIONS
ON THE FOUND MICROBES ON THE CARPET

	Zone of inhibition (mm) of rodalon solution			
Microbe	1/100 (v/v)	1/500 (v/v)	1/1000 (v/v)	1/2000 (v/v)
Escherichia coli	18	14	12	*
Enterobacter	17	14	12	*
Staphylococcus	16	14	*	*
Pseudomonas	13	13	*	*
Bacillus	12	Less than 12	*	*
Penicillum	14	12	*	*
Aspergillus	14	12	*	*
Fusarium	14	12	*	*
Mucor	14	12	*	*

*: Showed no zone of inhibition.

Antibacterial effects of treated silken fibers with different solutions of rodalon assessed by the remaining time of the zone of inhibition are shown in Table-4. Comparing results of the treated and untreated two pieces of carpet after laying for two week in a public place is shown in Table-5. It can be seen that the number of colonies growth were decreased about 56, 93, 97 and 90 % for *Stapylococcus*, *Bacillus*, *Pseudomonas* and *Escherichia coli* orderly.

The effect of 1/100 v/v solution of rodalon on some mechanical properties of treated carpet in compare with untreated one is shown in Table-6. There is no significant deterioration effect on the studied mechanical properties mechanic (*e.g.* the significant level of $\alpha = 0.05$, about Table-6).

Conclusion

Rodalon was chosen for this study because it is a common antiseptic and belongs to the group of cationic surface active agents. Considering its charge it can act link a cationic dye and tend to take up and hold on the surface of natural substrate such as silk. According to the results the presence of some pathogenic microbes on the laid carpet confirmed including *Escherichia coli* and *Staphylococcus* which can be

TABLE-4
ANTIMICROBIAL EFFECT OF TREATED SILKEN FIBERS WITH RODALON

Maximum time of inhibition of treated fibers with Rodalon solution (h)				
Microbe	1/100 (v/v)	1/500 (v/v)	1/1000 (v/v)	1/2000 (v/v)
Escherichia coli	263	161	67	29
Enterobacter	264	161	66	29
Staphylococcus	237	93	67	31
Pseudomonas	162	47	23	*
Bacillus	42	24	*	*
Penicillum	243	75	*	*
Aspergillus	244	99	*	*
Fusarium	244	98	*	*
Mucor	219	75	*	*

*: Showed no zone of inhibition.

TABLE-5
NUMBER OF COLONIES GROWTH ON UNTREATED AND TREATED CARPET WITH 1/100 RODALON (v/v) AFTER 14 DAYS

	No. of colonies	
Bacteria	Untreated carpet	Treated carpet
Staphylococcus	9.40	6.2
Bacillus	101.98	9.4
Pseudomonas	19.00	2.5
Escherichia coli	21.00	1.5

TABLE-6
EFFECT OF TREATING SILKEN YAM WITH RODALON ON SOME MECHANICAL PROPERTIES AFTER 30 DAYS

Mechanical property	Elongation at break (%)	Work of rupture (Nm)	Initial modulus (CN/Tex)	Tenacity (CN/Tex)
Untreated	6.232	5.9562	556.98	39.560
CV	8.984	12.3200	6.68	5.020
Treated	6.185	6.0120	561.50	39.732
CV	8.120	9.4900	2.92	2.456

causing many infections. So it is worthy to enhance the antimicrobial activity of the carpet with a proper antimicrobial finishing. Although the kind of microbes on the carpet depends considerably to the environment of course, but it was shown that treating silken fabric with rodalon inhibits considerably the growth amount of studied bacteria and in some cases up to 99 %.

The wash fastness or durability of the effect against washing of the treated carpet in the study was not under attention because the interval of washing periods for textile floor covering is not short and during these intervals usually the activity of the antbacterial agent vanishes, as it was seen in the case of rodalon which its maximum inhibition time with a high concentration (1/100 v/v) was just 263 h.

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