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TEXTILE FABRICS CONTAINING NEOMYCIN

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This invention relates to a durable textile finish containing neomycin, to processes of using said finish and to articles made of textile fibers having been treated by the finish whereby neomycin is uniformly adhered to the fibers thereof and are capable of a continuing antibacterial action over extended periods of time and possess re-usable utility and antibacterial activity after irioning, washing, and other cleaning operations. This application is a continuation-in-part of out application Serial No. 482,392, filed January 17, 1955, now abandoned.

In recent years, increased attention has been given to the development of textile finishes which have become known as purifying finishes. These are intended to reduce the number of microorganisms residing on the material whereby such materials may be used with less danger from harmful bacteria. These purifying finishes when applied to articles of clothing worn close to the body are also helpful in preventing the development of body odors.

A satisfactory purifying finish should be durable and active at low concentrations against a broad spectrum of microorganisms. It should be non-toxic and non-allergenic. It should not have the tendency to sensitize the wearer of the textile fabric to the material of the finish. It should not have the property of allowing strains of bacteria to develop which are resistant to the antibacterial agent of the finish. It should impart little or no color to the fabric and should be stable with respect to color and activity for many months under storage and shipping conditions. It should be resistant to home laundry conditions and to commercial laundry and dry cleaning operations. It should impart little or no modification of the hand of the textile. It should be substantitive to the fibers and be compatible with dyes and resin-containing textile finishes. The textile finish of the present invention rates very high in each of the qualifications just mentioned.

Various textile purifying finishes containing antibacterial substances such as hexachlorophene, tetrachlorophene, quaternary ammonium compounds such as dimethyl benzyl ammonium chloride, metal complexes of mercury, copper and silver, organic compounds and others have been used but are for the most part non-durable and unsatisfactory in other respects.

Antibiotics have previously been employed to coat or impregnate various materials in order to induce therein desirable bacteriostatic or bactericidal properties. For example, surgical dressings, gauze bandages and the like have been treated with tetracycline, chlortetracycline, oxytetracycline, tyrothricin, bacitracin, chloroamphenicol, etc.; but such materials have been limited to single-use purposes and have necessarily been discarded or thrown away following such single use. This, of course, was due to the fact that the antibiotics were not sufficiently stable or substantive to the base materials and consequently could not remain in active antibacterial form therein following cleaning operations prior to reuse.

As a result, the use of antibacterial agents has been limited to some extent and their commercial and industrial applications have not been as completely and universally widespread as their desirable properties and characteristics would suggest.

It is therefore a principal purpose of the present invention to provide a base material possessing antibiotic properties over an extended period of time and possessing re-usable utility and antibacterial activity after ironing, washing or other cleansing operations. More specifically, it is a principal purpose of the present invention to provide a fibrous base material to which is substantively adhered on the fibers thereof a sufficient concentration of neomycin whereby such material possesses antibiotic activity for an extended time with such activity surviving cleansing operations.

It has been found that neomycin may be readily applied to textile fibers, is substantive thereto and will impart to such articles made therefrom antibiotic properties which will remain after cleansing operations or manufacturing and finishing processes, even at elevated temperatures.

Neomycin is an antibiotic discovered by Waksman and Lechevalier and is produced by a strain of Streptomyces closely related to *Stretpomyces fradiae* (ATCC No. 3535). Science, March 25, 1949, volume 109, pp. 305–307. It is a basic compound, freely soluble in water, possesses a wide antibacterial spectrum, is generally non-irritating and non-sensitizing and bacterial resistance to it develops very slowly. The term "neomycin" is used herein in its ordinary sense to denote the commercially available product which is called neomycin, it actually being a mixture of two very closely related antibiotics known more specifically as neomycin B and neomycin C. The term is also intended to cover neomycin as just defined, the individual components of the complex or its salts of which the sulfate is most generally available. Other salts of neomycin have been used by us in finishing textiles with good results. Among these may be mentioned neomycin para-hydroxybenzoate, neomycin sulfanilate, neomycin N-tartrate, neomycin propionate, neomycin aconitate, neomycin phthalate, neomycin undecylinate, neomycin palmitate, neomycin stearate and others.

The exact nature of the chemical reaction or physical attraction of the neomycin and the fibers and the precise mechanism whereby the antibiotic becomes substantive to the base material is not completely understood; but the phenomenon of substantivity has been clearly indicated with a broad range of materials. The invention is particularly useful with fibers of cellulosic origin. Included in this group as illustrative but not limitative are cotton, regenerated cellulose, cellulose acetate, wood fibers, linen, jute, ramie, hemp, and other fibers used in the making of textiles, cordage, paper, paper board, and the like. The purifying finish of the present invention may also be applied to good advantage to proteinaceous fibers such as wool, silk, and the synthetic polyamide fibers which are sold under tradenames such as Nylon 66 and Perlon, and also the caprolactams such as Nylon 6. The present invention is also concerned with the treatment of the acrylic fibers such as Orlon (polyacrylonitrile), Creslan and Acrilan (acrylic tripolymers), and Dynel (a copolymer of vinyl chloride and acrylonitrile). Also synthetic fibers of the polyester type may be treated with the neomycin finish of the present invention to provide a durable antibacterial finish. Among these may be mentioned Dacron and Terylene (polyesters of terephthalic acid and ethylene glycol). Other miscellaneous synthetic fibers which may be used with the purifying finish of the present invention include Saran, a polyvinylidene chloride. In addition to these synthetic fibers, natural and synthetic mineral fibers

such as asbestos and glass wool may be treated by the purifying finish of the present invention to yield products having a durable antibacterial activity. These fibers may be treated as such or as yarn or after they have been made into a fabric.

The particular articles to which the neomycin is substantively adsorbed may take any shape, size or form but are preferably of woven, non-woven, knitted, felted or otherwise fabricated cloth or similar fibrous materials and are articles which are intended to be re-usable. Specific illustrations of such articles would include: handkerchiefs, diapers, hand, dish and bath towels, books and book covers, washable cloth toys, dolls and similar playthings; hospital and hotel sheets, and pillow cases, hospital and examination room bathrobes and slippers, barber's and beautician's cloths, paper tissue, diaper liners and catamenial bandages, and similar fibrous articles used in commerce and coming in contact with the general public.

The concentration of the neomycin in the materials may be varied within wide limits depending on the use to which the particular material is intended. Useful results are obtainable when the fabric contains as little as 0.0001 percent by weight of neomycin. The preferred range varies from about 0.01 percent to 1 percent by weight of neomycin based on the weight of the fabric. For prophylactic purposes, deposition of from about 0.05 microgram up to 10 micrograms per square centimeter has been found satisfactory with preferred commercial ranges lying between about 0.1 and about 6 micrograms per square centimeter.

The neomycin may be readily adsorbed and substantively adhered to the fibrous base materials by padding, exhausting, spraying or by other techniques which are practiced in the art whereby the solution containing neomycin is brought into contact with the fibers for a sufficient period of time to become substantively adhered to the base. When applying by exhaustion of the neomycin from a solution, it has been found that a period of time from about 5 minutes to about 60 minutes or more is sufficient to enable substantially all of the neomycin to become substantively adhered to the base. The base is then rinsed, preferably two or three times, in order to remove any excess treating solution and it is then dried at room temperatures or more rapidly at elevated temperatures as high as 350° F. The materials are then found to have all of the neomycin present substantively adhered to the base.

When making fibers produced by a felting process as in the manufacture of paper, the neomycin may be added to the beater or associated with the fibers at a step prior to the felting operation. The fact that neomycin is substantive to cellulose fibers to a high degree makes it possible to apply the antibiotic without additional equipment in the paper-making process without loss of the expensive antibiotic in the white water. In addition, this leads to an important advantage of the invention which is the fact that the neomycin is uniformly distributed throughout the entire fabric and is not located merely on the surface or a particular area thereof.

If desired, the neomycin may be dissolved in other solvents such as methanol, butanol, or other organic solvents; but such normally introduces increased production costs and is not commercially desirable.

The concentration of the neomycin in the treating solution may be varied within wide limits depending on the use to which the treated material is intended. When applied by padding, the solution should contain from approximately 0.0001 percent to 4 percent and more by weight of neomycin as is desired in the dried fabric since in the padding operation the fabric is usually impregnated with from about 150 to 25 percent of the weight of the liquid and then dried. When applied by exhausting, the solution may contain as little as 0.001 microgram per milliliter of solution when highly adsorptive cellulosic fibers are treated. From 5 to 500 micrograms of neomycin per milliliter is considered a preferred range for application by exhaustion. For normal prophylactic purposes, sufficient concentrations of neomycin may be substantively adhered to base materials from aqueous treating solutions containing from about 1 microgram to about 400 micrograms per milliliter with preferred commercial limits lying between about 2 and about 200 micrograms per milliliter.

The finishing composition that will be most satisfactory for distribution to the textile trade will contain about 0.1 percent to 5 percent by weight or more of commercial grade neomycin and, preferably, a small amount of a color stabilizer for the neomycin, about 0.2 percent by weight of sodium metabisulfite or 3 percent of sodium citrate, for instance. It may also contain other substances such as antifungal agents, colors, brighteners, wetting agents, softeners, odors, and the like.

The invention will be further illustrated in more specific detail by the following tests and related examples. It should be understood, however, that although these tests and examples may describe in more particular detail some of the very specific features of the invention, they are given primarily for purposes of illustration and the invention in its broader aspects is not to be construed as limited thereto.

EXAMPLES 1, 2, AND 3

The following methods were employed for testing the substantivity of various antibiotics on cotton cloth at 52° C. and 95° C.

White cotton cloth (80 x 80 count) was rinsed twice in distilled water at room temperature and then air-dried before use in the various tests. Swatches of the cloth measuring approximately 17.5 cm. x 13.5 cm. and weighing approximately 2.5 grams each were used.

The various antibiotics were tested on a weight basis at concentrations of 2 micrograms and 20 micrograms per milliliter in distilled water, unless otherwise specified. Approximately 50 milliliters of solution of the antibiotic was employed for treating each 2.5 gram test sample of cotton cloth.

The cloth swatches were labeled, folded and placed in screw-cap jars containing the antibiotic treating solutions employed. The jars were then placed in a heated water-bath maintained at the temperature indicated in the particular table and held for approximately 30 minutes with mixing and agitation every 10 minutes. The jars were then removed from the water-bath and the antibiotic solutions were decanted and held for assay. The cloths were immediately rinsed three times in tap water at room temperature by dipping three times in each water rinse in the jar and then squeezed and wrung out by hand. Sample discs approximately 10 to 11 millimeters in diameter were removed using an ordinary cork borer and not less than eight discs were tested for each cloth. Each 10 to 11 millimeter cloth disc appeared to absorb approximately 0.033 milliliter of solution and measured approximately 0.94 square cm. The cloth discs were dried for approximately one hour at 37° C. and then placed on suitable test plates, with the results shown in Tables I, II, and III.

The assay procedures were carried out as follows:

In all determinations approximately 5 milliliters of cooled (50° C.), inoculated agar was distributed into each Pyrex No. 3162 flat-bottomed dish provided with an unglazed ceramic lid. The plates were permitted to solidify at least 20 minutes before applying the test discs.

Assay Procedures (18 hours—37° C.)

Antibiotics	Test organism	Medium
Neomycin	*B. subtilis* No. 6633	Difco nutrient agar + 0.5% NaCl adj. to pH 8.0.
Chlortetracycline, Oxytetracycline, Tetracycline	*B. subtilis* No. 6633	Difco nutrient agar adj. to pH 6.0.
Polymyxin B sulfate	*Br. bronchiseptica* No. 4617	B. B. L. trypticase soy broth + 1.5% agar + 1.0% Tween "80."
Patulin	*E. coli* 9637	Difco nutrient agar pH 6.0.
Bacitracin	*M. flavus* PCI No. 16	Difco pen. seed agar pH 6.8.
Tyrothricin	do	Difco pen. seed agar + 5% propyl. glycol.
Chloramphenicol	*S. lutea* No. 9341	Difco pen. seed agar pH 6.8.
Penicillin	*B. subtilis* No. 6633	Difco nutrient agar + 0.5% NaCl adj. to pH 6.8.
Erythromycin	*S. lutea* No. 9341	Difco pen. seed agar pH 8.0.

TABLE I

[Substantivity of various antibiotics at 52° C.; 2 mcg./ml. treatment.]

Antibiotic	Mcg./disc (0.94 cm.²)
Neomycin sulfate	0.128
Oxytetracycline hydrochloride	0.064
Tetracycline hydrochloride	0.050
Erythromycin	0.046
Tyrothricin	0.021
Polymyxin B Sulfate	0.017
Potassium Penicillin G	0.000
Patulin (crystalline)	0.000
Chloramphenicol	0.000

Consideration of Table I indicates the marked superiority of the substantivity of neomycin sulfate over the other antibiotics tested. It is to be observed that the substantivity of neomycin sulfate was approximately twice that of the second best antibiotic at a temperature of 52° C.

TABLE II

[Substantivity of various antibiotics at 95° C.; 2 mcg./ml. treatment.]

Antibiotic	Mcg./disc (0.94 cm.²)
Neomycin sulfate	0.043
Erythromycin	0.008
Tetracycline hydrochloride	0.006
Chlortetracycline hydrochloride	0.002
Oxytetracycline hydrochloride	0.000
Patulin (crystalline)	0.000
Bacitracin	0.000
Chloramphenicol	0.000

Consideration of Table II even further indicates the marked superiority of the substantivity of neomycin sulfate over the other antibiotics tested. It is to be observed that the substantivity of neomycin sulfate was approximately five times that of the second best antibiotic at a temperature of 95° C. This temperature is deemed to be more indicative of the true superiority of neomycin sulfate inasmuch as such higher temperature is closer to cleaning and sterilizing temperatures than that of the preceding tests at 52° C.

TABLE III

[Substantivity of various antibiotics at 95° C.; 20 mcg./ml. treatment.]

Antibiotic	Mcg./disc (0.94 cm.²)
Neomycin sulfate	1.390
Erythromycin	0.104
Tetracycline hydrochloride	0.096
Chlortetracycline hydrochloride	0.054
Oxytetracycline hydrochloride	0.014
Patulin (crystalline)	0.000
Bacitracin	0.000
Chloramphenicol	0.000

Consideration of Table III drastically indicates the marked superiority of the substantivity of neomycin sulfate over the other antibiotics tested. In this case, neomycin sulfate possessed substantivity almost thirteen times that of the second best antibiotic at a temperature of 95° C. and a concentration of treating solution of 20 micrograms per milliliter. This table is deemed to be the most indicative of the superiority of neomycin sulfate inasmuch as such temperatures and concentrations are closest to that found in the industry.

EXAMPLE 4

The methods set forth in the description of Examples 1, 2, and 3 were carried out substantially as set forth therein with the sole exception that dyed cotton was substituted for the white cotton cloth in order to determine if the dye would interfere with the substantivity of the neomycin to the cotton fabric. The results were substantially as set forth in Tables I, II, and III, thus indicating no interference with the substantivity characteristic.

EXAMPLE 5

The methods set forth in the description of Examples 1, 2, and 3 were also applied to linen fabrics and the testing conditions were carried out under similar conditions as indicated for cotton, with the exception that an ironing test at a temperature of approximately 190° C. was added. The substantivity tests indicated results very comparable to that set forth in Tables I, II and III and the ironing tests merely reduced the concentration of the antibiotic (neomycin sulfate) by 30 percent; the samples prior to ironing containing 0.1 microgram per square centimeter and the samples after ironing containing 0.07 microgram per square centimeter.

EXAMPLE 6

Evaluations of the substantivity of neomycin sulfate to cotton cloth were carried out in washing machine tests as follows:

White cotton cloth (approximately 80 x 80 count) measuring approximately 13.5 inches square and weighing approximately 10 grams each were used. One kilogram of cloth squares (100 squares) were weighed out, rinsed twice with hot tap water and then dried at 175° C. for about two hours. A Bendix automatic washer, model B–211, was used and the water temperature dial was set at the hottest point whereby the entering hot tap water had a temperature of approximately 58° C. The water quantity dial was set at "low" whereby approximately 4.5 gallons (17.1 liters) was used.

Neomycin sulfate (700 micrograms base per milligram) was used on a weight basis of 34.2 milligrams neomycin for 17.1 liters of water (approximately 2 micrograms per milliliter).

The kilogram of cotton cloth squares was divided into five equal parts and each part separately loaded into the machine and tested. The cycle was initiated in each

series by a 13-minute soaking period followed by a washing, rinsing and "spin dry" period of 35 minutes. The 34.2 milligrams of neomycin were added during the soaking cycle.

The treated cloths were randomly sampled by removing 10–11 mm. diameter discs (approximately 0.94 cm.^{2}) with a cork borer and were tested for activity by the *B. subtilis* plate method previously described. The results are tabulated below.

The Bendix cycled cotton cloths were sampled immediately after the washing and assays indicated that there remained approximately 0.097 microgram per disc or 9700 micrograms per kilogram of cloth. The cloths were then air dried and ironed by hand at a temperature of approximately 175° C. Assays of the ironed cloths indicated that there remained 0.061 microgram per disc or 6100 micrograms per kilogram of cloth.

EXAMPLE 7

The substantivity of various neomycin salts on cotton cloths following immersion at 52° C. for approximately 30 minutes with agitation every ten minutes, followed by three rinses in tap water, squeezing and wringing out by hand and drying at 37° C. for approximately one hour is illustrated by the following tests. 17.5 cm. x 13.5 cm. swatches weighing 2.5 grams each were used in 50 milliliters of aqueous solution of neomycin. Discs measuring approximately 10–11 mms. diameter (actually 0.94 cm.^{2}) were cut from the swatches and assayed as described previously.

Antibiotic	Solution, mgm./ml.	Solution, total mgms. antibiotic	Disc, mgm./0.94 cm.^{2}	Swatch total mgms. antibiotic	Percent activity on swatch
Neomycin sulfate	20	1,000	4.2	1,000	100
Do	2	100	0.4	100	100
Neomycin p-hydroxybenzoate	20	1,000	2.4	600	60
Neomycin N-tartrate	20	1,000	2.2	550	55
Do	2	100	0.2	50	50
Neomycin propionate	20	1,000	2.7	680	68
Do	2	100	0.2	50	50
Neomycin aconitate	2	100	0.22	55	55
Neomycin iso-nicotinate	2	100	0.24	60	60
Neomycin phthalate	2	100	0.2	50	50

EXAMPLE 8

Cotton fabrics treated as set forth in Table III and containing approximately 1.39 micrograms per square centimeter were made up into handkerchiefs and then sterilized by exposure to heat at 175° C. for two hours. These handkerchiefs were used under normal conditions and were found to remain in a sterile state when in contact with a limited number of bacteria such as might be found in the air from effluvium, scattered nasal secretions, and the like. After being used, the handkerchiefs were washed in a Bendix washer and dried and ironed at normal ironing temperatures (175° C.) and it was established that the handkerchiefs still possessed substantial antibacterial activity.

EXAMPLE 9

Neomycin was incorporated and substantively adhered to cellulosic personal tissues of a single-use applicability as follows:

A high grade bleached sulfite pulp which had been lightly refined in continuous refiners was treated with sufficient neomycin sulfate (approximately 20 micrograms per milliliter of total pulp volume) with agitation for approximately 20 minutes. The neomycin-pulp was then felted on a Fourdrinier wire, pressed lightly in a press section and then dried on a Yankee drier having a diameter of 14 feet approximately and operating at a surface temperature of 250° C.

The dried continuous paper web was then processed, cut, folded and packaged. Representative samples selected at random after the drying were tested and indicated the presence of antibacterial activity.

EXAMPLE 10

The procedures set forth in Example 9 were followed substantially as set forth therein except that a heavier grade of paper was manufactured with the neomycin substantively adhered thereto. A 10-drum drier section was used to dry the paper and the surface temperatures of such drums ranged from 180° F. to 270° F. The time of contact of the paper with these drums was about sixty seconds. Representative samples selected after the drying were tested and possessed antibacterial activity.

EXAMPLE 11

To 100 milliliters of an aqueous solution containing 19 micrograms per milliliter of neomycin was added a 1-gram swatch of 80 x 80 cotton percale and shaken at 35.4° C. for 48 hours. The fabric was removed from the solution, rinsed with water and dried. On analysis, the fabric was found to have adsorbed thereon 0.17 percent by weight of neomycin. Less than 2 micrograms per milliliter of the neomycin remained in the solution. This test demonstrated an 89.5 percent exhaustion of the neomycin from the solution by adsorption on the cellulosic fibers as a result of the treatment.

EXAMPLE 12

To 100 milliliters of an aqueous solution containing 4.9 micrograms per milliliter of neomycin was added a 1-gram swatch of 80 x 80 cotton percale and shaken at 35–4° C. for 48 hours. At the end of this time, the fabric was removed from the solution, thoroughly rinsed with water and dried. Bacteriological tests proved the fabric to have an antibacterial activity against *S. aureus* and *E. coli*. This test demonstrated the very high adsorptive properties of cellulosic fibers for neomycin when brought into contact in an aqueous solution.

EXAMPLE 13

A textile finishing solution comprising water having dissolved therein 0.1 percent by weight of neomycin added as neomycin sulfate and 0.02 percent by weight of sodium metabisulfite was prepared. This solution was applied to a group of textile fabrics by padding with pick-up of the finishing solution ranging from 60 percent to 100 percent. The treated fabrics were then dried at 225° F. for two minutes and tested for antibacterial activity against *S. aureus*. These fabrics were then washed in a Westinghouse Laundromat washing machine with the water at 140° F. and containing 0.10 percent by weight of neutral soap chips. The machine was operated on a fifteen-minute washing cycle with two 15-minute rinses making a total washing cycle of 45 minutes. The fabrics were then dried at 225° C. for two minutes as before and tested for antibacterial activity. The results of these tests are shown in the following table.

The test organism used was *Staphylococcus aureus*, the size of the cloth discs was 11.5 mm., and a test zone larger than this indicates definite antibacterial activity.

The letter P stands for partial, S slight, VS very slight, and N none. The letter C indicates that the growth medium under the sample disc was clear of bacterial growth showing that the fabric had good antibacterial activity.

Fabric	Percent neomycin in cloth	Number of laund. washes	Zone of inhibition against *Staph. aureus*, mm.
Nylon taffeta	0.10		21.1
		1	13.7
		3	13.6
		5	<12.0
Acetate taffeta	0.10		18.8
		1	12.9
		3	P
		5	VS
Rayon challis	0.10		21.7
		1	18.6
		3	18.5
		5	17.9
		10	17.0
		25	16.8
Rayon challis	0.06		20.3
		1	17.4
		3	17.6
		5	16.8
Wool flannel	0.08		18.4
		1	12.9
		3	12.0
		5	C
50/50 viscose/acetate	0.10		20.4
		1	16.9
		3	17.6
		5	16.6
		10	16.2
		25	14.1
Do	0.06		20.0
		1	17.8
		3	17.1
		5	17.1
Orlon	0.08		18.1
		1	C
		3	C
		5	VS
Dacron	0.10		20.0
		1	12.6
		3	C
		5	S
Cotton, 80 x 80 percale	0.10		19.5
		1	17.0
		5	16.5
		9	16.0
		15	15.9
		25	14.9
		50	12.4
Dynel	0.10		18.5
		1	13.7
		3	12.2
		5	PC
65/35 dacron/cotton shirting	0.06		17.7
		1	16.6
		3	15.5
		5	15.8
		10	15.3
		25	C

EXAMPLE 14

Swatches of wool flannel, 80 x 80 cotton percale, nylon sheer, and rayon challis were treated with an equal weight of an aqueous solution containing 0.1 percent neomycin by the padding operation and then dried for two minutes at 225° F. The treated cloth was then sent to a commercial dry cleaning establishment where it was dry cleaned by the dry cleaning method in use in that establishment. The fabrics were then tested for antibacterial activity against *E. coli* and *S. aureus* and it was found that the original antibacterial activity was substantially unchanged as a result of the dry cleaning operation. The antibacterial activity which survived after repeated commercial dry cleaning operations is shown in the following table.

Fabric	Number of dry cleanings	Zone of inhibition against *Staph. aureus*, mm.
Cotton percale	Initial	19.2
	1	18.5
	9	C
	25	C
Rayon challis	Initial	19.0
	1	20.1
	9	12.5
	25	12.9
Wool flannel	Initial	19.0
	1	18.0
	9	11.5
	25	C
Nylon sheer	Initial	19.0
	1	18.2
	9	C
	25	C

EXAMPLE 15

To evaluate the effect of contact with acid or alkaline perspiration, cotton percale was treated with 0.1 percent neomycin dried two minutes at 225° F., immersed for 30 minutes in solutions simulating acid or alkaline perspiration as described in the Standard AATCC Test, and dried for six hours at 100° F. under 10 p. s. i. The alkaline solution consists of:

10 gm. NaCl
4 gm. $(NH_4)_2CO_3$
1 gm. ortho-Na_2HPO_4

dissolved in 1 liter of water. The acid solution consists of:

10 gm. NaCl
2 gm. lactic acid
1 gm. ortho-Na_2HPO_4

dissolved in 1 liter of water.

Antibacterial tests indicated that neomycin-treated cotton is still active after contact with alkaline or acid perspiration test solution.

EXAMPLE 16

To determine the effect of light on the antibacterial properties of treated cloth, 80 x 80 cotton percale was treated with 0.1 percent neomycin by padding, dried for two minutes at 225° F. and exposed in an Atlas Fade-Ometer. The data shown in the table below indicates little effect of light on the antibacterial activity after as much as 80 hours exposure.

Hours of exposure in Fade-Ometer	Zone of inhibition against *Staph. aureus*, mm.
0	19.2
20	18.1
40	17.3
80	17.1

EXAMPLE 17

To demonstrate the stability of treated fabric to wet heat, a swatch of 80 x 80 cotton percale, treated with 0.1 percent neomycin, was exposed for 15 minutes in a steam sterilizer at 250° F. The zone of inhibition to *S. aureus* was decreased only from 19.4 to 18.6 mm. by this treatment.

EXAMPLE 18

The effect of dry heat on treated fabric was demonstrated by placing a swatch of 80 x 80 cotton percale treated with 0.1 percent neomycin between two metal plates heated at 365° F. and allowed to remain there for ten minutes. As a result of this treatment, the zone of inhibition was decreased only from 19.4 to 16.1 mm.

We claim:

1. A method of imparting a durable antibacterial finish to textile fibers which comprises the steps of bringing said fibers into contact with an aqueous solution containing from at least 0.0001 percent by weight of neomycin and thereafter drying said fibers.

2. A method of finishing textile fabrics to impart a durable antibacterial activity thereto which comprises padding said textile fabric with an aqueous solution containing at least 0.001 percent by weight of neomycin and thereafter drying said fabric.

3. A method of making felted cellulosic articles having a uniformly dispersed antibacterial activity throughout which comprises the steps of dispersing cellulosic fibers in an aqueous suspension containing at least 0.0006 percent of neomycin and thereafter draining off the aqueous solution from said fibers and felting the same on a screen and drying said felted cellulosic fibers.

4. A method of finishing textile fabrics containing cotton fibers to impart a durable antibacterial finish thereto which comprises the steps of wetting said fabric with a solution containing at least 0.0006 percent by weight of neomycin and thereafter drying said fabric.

5. A method of finishing fabrics containing cellulosic fibers which comprises the steps of contacting said fabric with an aqueous solution containing at least 0.0001 percent by weight of neomycin, allowing the aqueous solution to remain in contact with said cellulosic fibers for a period of at least five minutes, removing the fabric from the aqueous finishing solution and drying to obtain a fabric having durable antibacterial activity distributed uniformly throughout.

6. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising cellulosic fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

7. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising cotton fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

8. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising polyamide fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

9. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising wool fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

10. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising nylon fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

11. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising polyacrylic fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

12. A dry textile fabric having a durable antibacterial finish resistant to washing with water comprising polyacrylonitrile fibers having uniformly adsorbed thereon neomycin in amounts such that the fabric contains at least 0.0001 percent by weight of neomycin.

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