

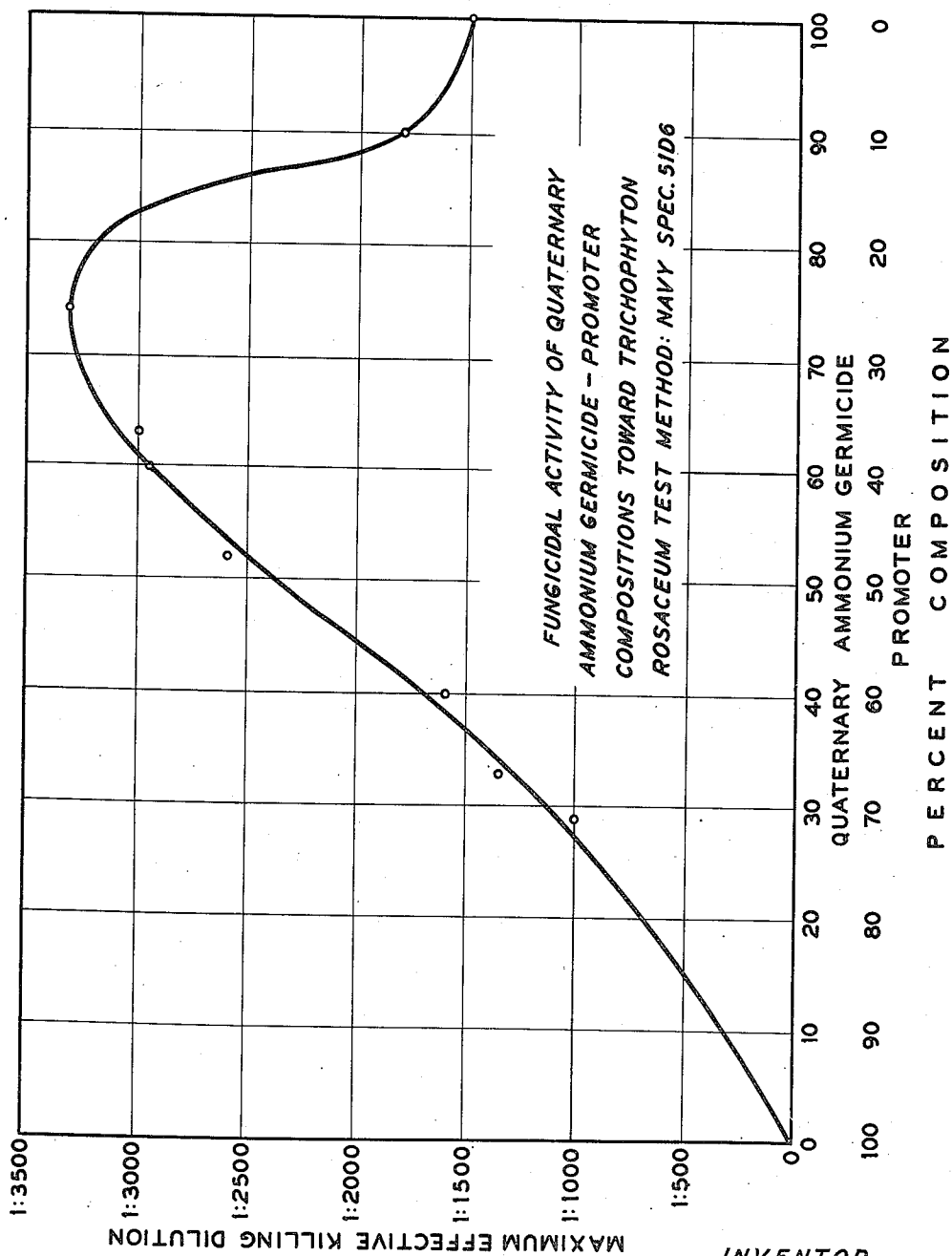
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QUATERNARY AMMONIUM GERMICIDAL COMPOSITIONS

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QUATERNARY AMMONIUM GERMICIDAL COMPOSITIONS

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5 Claims. (Cl. 167—30)

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This invention relates to new and improved compositions for the control of micro-organisms, such as bacteria, fungi, algae, protozoa and the like. More particularly, the invention relates to compositions which comprise a quaternary ammonium germicide and a promoter.

Prior to my invention quaternary ammonium compounds per se have been used as germicides. The activity of these compounds varies widely with different types of organic cation radicals contained therein. As a consequence, a great amount of experimental effort and expense has been necessary to develop more efficient types of quaternary ammonium germicide materials. Such quaternary ammonium compounds are usually costly and in many cases are characterized by their poor efficiency in the control of micro-organisms, particularly spore-forming bacteria, fungi, molds and the like.

It is an object of my invention to provide novel quaternary ammonium compositions which are economical to produce and more efficient than the quaternary ammonium compounds themselves as germicides, particularly toward spore-forming bacteria, fungi, molds, and the like.

Other objects and advantages of my invention will be apparent from the disclosure which hereinafter appears.

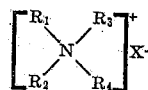
I have found that quaternary ammonium germicides and promoters of the type hereinafter described may be combined in such proportions as to produce strongly germicidal compositions having germicidal activity even exceeding that of the quaternary ammonium compounds themselves. This resultant improvement in efficiency is highly unexpected, since the promoters as hereinafter described are, of themselves, relatively poor germicides, particularly toward spore-forming bacteria, fungi, etc., against which even the quaternary ammonium compounds are relatively ineffective.

The production of these novel and more highly effective germicidal compositions according to my invention requires only the simplest of procedures. It involves none of the complicated experimentation that is necessary when improvement of the germicidal efficiency of a quaternary ammonium compound is attempted through modification of the hydrophobic cationic portion of the molecule.

The extraordinary effect of my discovery is illustrated graphically by the curve shown in Figure 1 of the accompanying drawing. Upon reference to this curve it will be seen that when certain substantial amounts of quaternary ammonium compound are combined with promoters of the type hereinafter described, the resultant composition possesses germicidal activity against a representative fungus far in excess of the quaternary alone.

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The quaternary ammonium germicides used in the compositions of my invention can be any of several various types which fall within the generic term. These compounds are generally characterized by the formula



wherein at least one of the radicals, R_1 , R_2 , R_3 and R_4 , attached to the nitrogen atom is a hydrophobic aliphatic, unsaturated aliphatic, cycloaliphatic, aryl, araliphatic or aliphaticaryl radical of from 6 to 26 carbon atoms. The hydrophobic radicals may be long-chain alkyl, long-chain alkenyl, cycloalkyl, long-chain alkoxyaryl, long-chain alkylaryl, halogen-substituted long-chain alkylaryl, long-chain alkylphenoxyalkyl, arylalkyl, etc., in nature. The remaining radicals on the nitrogen atom other than the hydrophobic radicals may be substituents of hydrocarbon structure ordinarily containing a total of no more than about 12 carbon atoms. Various compounds of these types are more fully illustrated in the disclosure which follows. Mixtures of quaternaries may be used as well as the single compounds.

As a brief description of the promoters in the compositions according to my invention any non-anionic organic materials having a solubility in water of less than about 5% and generally characterized by a high molecular weight hydrophobic group attached to a weakly hydrophilic radical may be used. The high molecular weight hydrophobic group is desirably aliphatic, unsaturated aliphatic, cycloaliphatic, aryl, araliphatic, or aliphaticaryl in nature, and contains from about 8 to 18 carbon atoms. Examples of such hydrophobic groups are the long-chain alkyl, long-chain alkenyl, cycloalkyl, phenyl, phenylalkyl, alkylphenyl, alkylphenoxyalkyl, alkylphenoxyalkoxyalkyl, etc. groups. Among the hydrophilic radicals which are characteristic of the more desirable promoters are radicals such as the hydroxyl and amino radicals.

The proportions of the quaternary ammonium germicide and the promoter are critical to the compositions according to my invention. However, these critical proportions may vary over a wide range from a minimum amount of promoter just sufficient to promote the germicidal activity of the quaternary ammonium compound up to a maximum amount of about 70 per cent by weight of the composition. A very marked improvement is obtained with proportions of promoter ranging from about 10 to about 60 per cent, while compositions containing the promoter in proportions of about 30 to about 50 per cent exhibit the greatest increase in germicidal activity.

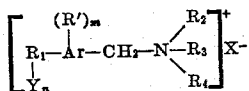
The improved quaternary ammonium germi-

cide compositions of my invention are suitably prepared by adding the promoter to the quaternary ammonium compounds in suitable proportions and mixing them together. Various means for mixing and handling the materials will be obvious to persons skilled in the art from this disclosure, and as such are contemplated by my invention.

As more specific examples of the various quaternary ammonium compounds used in my novel compositions alkyl ammonium halides such as cetyl trimethyl ammonium bromide, octadecyl dimethyl ethyl ammonium bromide, octadecyl dimethyl ethyl ammonium bromide, dioctadecyl dimethyl ammonium chloride, etc. are contemplated. Other related quaternary ammonium salts which also may be used are the alkylaryl ammonium halides such as the long-chain alkyl dimethyl benzyl ammonium chlorides in general, including octadecyl dimethyl benzyl ammonium bromide, alkyl dimethyl dichlorobenzyl ammonium chloride, lauryl dimethyl benzyl ammonium chloride, and the like. N-alkylmorpholinium and N-alkylpyridinium quaternary ammonium salts as illustrated by N-cetylpyridinium bromide, N-myristylpicolinium chloride, N-dodecyl-N-methylmorpholinium methosulfate, etc. are also suitable. Another type of quaternary ammonium salt which is contemplated is that wherein the molecule contains an ether linkage as exemplified by compounds such as para-tertiaryoctylphenoxyethoxyethyl dimethyl benzyl ammonium chloride and the like. Quaternary ammonium salts having oxygen in the form of amide or ester linkages, such as N-(laurylcolaminoformylmethyl)-pyridinium chloride and the like. Still other satisfactory types of quaternary ammonium compounds are those containing a sulfonamide group such as 2-phenyl-3-p-sulfamidophenyl-5-undecyltetrazolium chloride, etc. Another type of very effective quaternary ammonium germicide is that characterized by a substituted aromatic nucleus as in the case of lauryloxyphenyl trimethyl ammonium chloride, cetylaminophenyl trimethyl ammonium methosulfate, dodecylphenyl trimethyl ammonium methosulfate, dodecylbenzyl trimethyl ammonium chloride, chlorinated dodecylbenzyl trimethyl ammonium chloride, lauryl dimethyl chlorobenzyl ammonium chloride, cetyl dimethyl nitrobenzyl ammonium chloride, and the like.

Although any of the above types of quaternary ammonium germicides are ordinarily satisfactory in the compositions according to my invention, those which are particularly effective are the long-chain alkyl dimethyl benzyl quaternary ammonium salts, the alkylphenoxyalkoxyalkyl dimethyl benzyl quaternary ammonium salts, the N-(acylcolaminoformylmethyl)-pyridinium halides, the long-chain alkyl trimethyl ammonium halides, as well as the long-chain alkylarylmethyl quaternary ammonium compounds.

Long-chain alkylarylmethyl quaternary ammonium germicides which are particularly adapted to the novel compositions of my invention belong to the class of quaternary ammonium salts illustrated by the type formula



where R_1 is an alkyl group of 8 to 18 carbon atoms, Ar is an aryl hydrocarbon nucleus, R' is hydrogen or a methyl radical, m is from 1 to 4, Y is hydrogen or a halogen, n is from 1 to 8, R_2 , R_3 and R_4 are substituents of hydrocarbon structure containing a total of no more than 12 carbon atoms, and X is a salt-forming anionic radical which may be the same as Y.

R_3 and R_4 are substituents of hydrocarbon structure containing a total of no more than 12 carbon atoms, and X is a salt-forming anionic radical which may be the same as Y.

In the above long-chain alkylarylmethyl quaternary ammonium germicide the long-chain alkyl radical R_1 can be any alkyl group of from 8 to 18 carbon atoms. When the acyclic alkyl radicals are of a straight chain nature those containing as few as 8 to 10 carbon atoms are found to be very satisfactory. However, when branched-chain structures predominate in the acyclic radical, the most satisfactory groups are those containing from 10 to 18 carbon atoms. Suitable alkyl radicals can be obtained from various sources such as the long-chain olefins of 8 to 18 carbon atoms derived from cracked olefinic petroleum fractions or from Fischer-Tropsch synthesis. A preferred source of long-chain alkyl radicals is the class of acyclic propylene polymers having from 9 to 15 carbon atoms per molecule with from 12 to 15 carbon atoms being still more preferred.

The aryl nuclei of the long-chain alkylaryl quaternary ammonium germicides represented by the above formula can be benzene, toluene, xylene, naphthalene, anthracene, etc., with benzene and toluene being preferred. The N-substituted alkyl radicals in the formula preferably contain from 3 to 10 carbon atoms and may be separate alkyl radicals attached to the nitrogen atom or they may be combined alkyl and cycloaliphatic or aromatic hydrocarbon substituents as in the case of N-ethylpiperidine and pyridine.

Since the cationic portion of the above quaternary ammonium germicides is the active component, the salt-forming radicals are not generally regarded as being critical in nature. Any anionic radicals capable of yielding water-soluble salts can be used, such as the halides, sulfates, phosphates, carbonates, nitrites, alkylsulfates, alkylphosphates, formate, acetate, tartrate, and the like. Halide radicals such as chloride and bromide are preferred, and short-chain alkylsulfates such as methosulfate, ethylsulfate, and the like, are among the more satisfactory alkyl sulfates contemplated as anionic radicals.

The above long-chain alkylarylmethyl quaternary ammonium compounds can be appropriately prepared by chloromethylation of a long-chain alkylaryl compound to produce the corresponding alkylarylmethyl chloride which may then be condensed with any suitable tertiary amine to get the desired product. The halogenated long-chain alkylarylmethyl quaternary ammonium compounds, on the other hand, are conveniently prepared by direct halogenation of a long-chain alkylaryl compound having from 1 to 4 methyl radicals attached to the aryl nucleus. When the halogenation is carried out in the absence of any halogenation catalysts which might promote substitution of the aryl nucleus a product is derived containing halogen in the long-chain alkyl radical as well as in one of the methyl radicals substituted on the aryl nucleus. This compound which may be denominated a halogenated alkylarylmethyl chloride can then be condensed with any suitable tertiary amine as in the preceding example to give the desired halogenated long-chain alkylarylmethyl quaternary ammonium compound.

Promoters according to my invention which come within the scope of the above brief description are, for example, long-chain aliphatic amines, long-chain aliphatic alcohols, cycloali-

phatic alcohols, alkyl phenols, alkylcyclohexanols, and alkylphenylglycol ethers, alkylphenylpolyglycol ethers, and arolyglycol ethers having at least 10 carbon atoms, and the like. Esters, such as the class of aliphatic esters illustrated by ethyl acetate, etc., may also be used. More specific examples of the preceding types of promoters which are very effective are lauryl alcohol, cetyl amine, dodecylaniline, terpeneol, tetradecyl phenol, tertiary butylphenylmonoethylene glycol ether, dodecylcyclohexanol, pine oil, tetradecylphenylmonoethyleneglycol ether, octylphenylmonoethyleneglycol ether, and octylphenyldiethyleneglycol ether. Although some of these compounds are mildly germicidal of themselves, their primary function in the quaternary compositions is as activation agents to enhance the microbicidal effect of the quaternary ammonium germicides. Of the foregoing illustrative promoters, pine oil, octylphenylethyleneglycol ether and octylphenyldiethyleneglycol ether are the more satisfactory ones.

Various mixtures of representative quaternary ammonium germicides and promoters were prepared for testing to illustrate the present invention. Such mixtures were prepared by placing the quaternary ammonium germicide in a vessel and adding the promoter, following which the ingredients were intimately mixed to produce the new and greatly improved germicidal compositions of this invention. The efficacy of the different quaternary ammonium germicides and promoter compositions containing varying proportions of the quaternary and promoter is illustrated by the results of the tests which are set out in the following table.

TABLE

Fungicidal activity of quaternary ammonium germicide and promoter compositions toward Trichophyton rosaceum

Quaternary ammonium compound tested	Promoter tested	Proportions		Maximum effective killing dilution in water
		Quaternary, per cent by weight	Promoter, per cent by weight	
Dodecylbenzyl trimethyl ammonium chloride	Pine oil	0	100	1:30
Do.	do.	28.6	71.4	1:1000
Do.	do.	33.3	66.7	1:1330
Do.	do.	40.0	60.0	1:1600
Do.	do.	52.2	47.8	1:2630
Do.	do.	59.3	40.7	1:2960
Do.	do.	63.5	36.5	1:3080
Do.	do.	68.6	31.4	1:3463
Do.	do.	73.5	26.5	1:3340
Do.	do.	89.8	10.2	1:1800
Do.	do.	100	0	1:1500
Lauryl dimethyl benzyl ammonium chloride	do.	50	50	1:1500
Dodecylbenzyl trimethyl ammonium chloride	t-Octylphenyl monoethylene-glycol ether	50	50	1:3000
Do.	Lauryl amine	50	50	1:2500
Chlorinated dodecylbenzyl trimethyl ammonium chloride (approx. 5 chlorine atoms)	Pine oil	11.0	89.0	1:430
Do.	do.	12.4	87.6	1:500
Do.	do.	16.7	83.3	1:667
Do.	do.	100	0	1:500

The values for germicidal activity set out in the above table were obtained by determining the maximum effective killing dilutions of the different compositions prepared according to this invention as well as of the pure quaternary am-

monium germicide and promoter ingredients. The "maximum effective killing dilution" illustrates the killing power of the different materials against a representative fungus such as *Trichophyton rosaceum* and was obtained by the testing method set out in Navy Department Specification 51D6. The higher the effective dilution, the greater the germicidal power of the composition tested.

From the above table of results and reference to the curve in Figure 1 of the accompanying drawing which was obtained by plotting the maximum effective killing dilution against various proportions of quaternary and promoter, the unexpectedly high germicidal activity of compositions according to my invention is readily apparent. It can be seen that my germicidal compositions containing substantial proportions of quaternary ammonium germicides and less than about 70 per cent by weight of promoter are decidedly superior to the quaternary ammonium compound in germicidal efficiency. Any lowering of germicidal activity, which would ordinarily be expected when a strongly germicidal material such as the quaternary is diluted with a material having little or no germicidal action as in the case of the promoters of the present invention, is surprisingly absent when proportions according to the teaching of my invention are utilized.

Because of their higher germicidal activity, my novel compositions are more efficacious than either quaternary ammonium germicide or promoter alone. Their greater efficacy renders them extraordinarily useful in the control of microorganisms such as spore-forming bacteria, fungi, and the like. Such uses include the disinfection of utensils and equipment used in drinking, eating and the preparation of foods, etc. Wearing apparel, bedding, upholstery, and the like, can also be effectively sterilized by the use of my germicidal compositions. Floors and walls as well as various equipment such as lavatories and toilets in the areas where it is desirable to promote germ-free surroundings can be conveniently disinfected with these germicidal compositions because of their greater germicidal activity. Other applications, such as their use as antiseptic ingredients in germicidal detergents, ointments, cosmetics, etc., are also indicated.

The germicidal compositions according to my invention may contain various dyes or coloring agents which are compatible with the quaternary ammonium germicides and the promoters in order to improve the general appearance of the compositions. The use of various perfumes and odor masking agents is also contemplated.

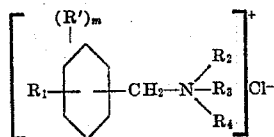
In some instances the germicidal compositions of this invention may contain water, as for example, when a composition is prepared by adding the promoter to a 50 per cent aqueous solution of the quaternary ammonium germicide. In the presence of certain amounts of water, as for example amounts exceeding about 30 per cent and less than about 90 per cent of the aqueous quaternary ammonium germicide solution, a separation of the promoter and aqueous quaternary ammonium germicide mixture may occur. Although such separation has no effect on the germicidal activity of my compositions, it will be preferred to maintain the water in amounts of less than about 30 per cent or more than about 90 per cent by weight whenever clear and completely miscible or homogeneous mixtures are desired for the sake of appearances.

The foregoing description and examples of the

germicidal compositions according to my invention are intended as illustrative only. Many obvious variations and modifications of the invention will be apparent to those skilled in the art. All such variations and modifications as come within the scope of the appended claims are contemplated by my invention.

I claim:

1. A germicidal composition which comprises as its active ingredient a substantial proportion of a quaternary ammonium compound having the formula



where R_1 is an alkyl group of 8 to 18 carbon atoms, R' is a member of the group consisting of hydrogen and a methyl radical, m is from 1 to 4, and R_2 , R_3 and R_4 are substituents of hydrocarbon structure containing a total of no more than 12 carbon atoms, said quaternary being admixed with a member of the group consisting of octylphenylmonoethyleneglycol ether and octylphenyldiethyleneglycol ether as a promoter, the promoter being present in amounts sufficient to improve the germicidal activity of the quaternary ammonium compound but not to exceed 70 per cent by weight of the composition.

2. A germicidal composition which comprises from 10 to 70 per cent by weight of octylphenylmonoethyleneglycol ether and from 30 to 90 per cent by weight of an alkylaryl quaternary ammonium compound as defined in claim 1, wherein R_1 is an alkyl radical of polypropylene structure containing from 12 to 15 carbon atoms.

3. A germicidal composition which comprises from 10 to 70 per cent by weight of octylphenyldiethyleneglycol ether and from 30 to 90 per cent by weight of an alkylaryl quaternary ammonium compound as defined in claim 1, wherein R_1 is an alkyl radical of polypropylene structure containing from 12 to 15 carbon atoms.

4. A germicidal composition which comprises from 10 to 70 per cent by weight of octylphenylmonoethyleneglycol ether and from 30 to 90 per cent by weight of dodecylbenzyl trimethyl ammonium chloride.

5. A germicidal composition which comprises from 10 to 70 per cent by weight of octylphenyldiethyleneglycol ether and from 30 to 90 per cent by weight of dodecylbenzyl trimethyl ammonium chloride.

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