(19) European Patent Office
Office européen des brevets

(11) EP 0 923 950 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.06.1999 Bulletin 1999/25

(51) Int Cl.[6]: **A61L 2/18**, C11D 3/48, C11D 3/33, C11D 3/37

(21) Application number: **98310417.5**

(22) Date of filing: **18.12.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **18.12.1997 JP 34927397**
30.10.1998 JP 31017598

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(54) Liquid agent for contact lens

(57) A liquid agent for a contact lens, containing at least one disinfecting component selected from the group consisting of Polyquaternium-6, Polyquaternium-7, Polyquaternium-16 and Polyquaternium-22, and a nonionic tonicity agent and/or an amino acid.

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Description

[0001] The present application is based on Japanese Patent Applications Nos. 9-349273 and 10-310175 filed December 18, 1997 and October 30, 1998, respectively, the content of which is incorporated hereinto by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a liquid agent for a contact lens, which exhibits an excellent disinfecting effect and assures a sufficiently high degree of safety to the eyes of the user, and which liquid agent can be suitably used as a cleaning and storing or preserving liquid for the contact lens.

Discussion of the Related Art

[0003] The contact lenses worn on the eyes of the user is likely to be soiled with deposits such as proteins and lipids which are included in the tear. The contact lenses need to be cleaned to remove such deposits therefrom. Further, during a long period of use of the contact lenses, microorganisms such as bacteria tend to adhere to and proliferate on the surfaces of the contact lenses while the contact lenses are stored after they have been removed from the eyes. Such microorganisms may cause infectious diseases, giving adverse influences on the eyes of the user. In view of the above, the contact lenses need to be cleaned before they are worn on the eyes. In particular, it is indispensable to disinfect soft contact lenses since the microorganisms are likely to proliferate on the surfaces of the soft contact lenses more often than those of the hard contact lenses, increasing a risk of causing the infectious diseases.

[0004] For disinfecting the contact lenses, there have been practiced a thermal disinfecting method using a suitable boiling device for boiling the contact lenses, and a chemical disinfecting method using a suitable chemical disinfectant. The thermal disinfecting method requires a relatively long period of time to disinfect the contact lenses, using the boiling device. Accordingly, in recent years, the chemical disinfecting method has been attracting a greater attention than the thermal disinfecting method.

[0005] In the chemical disinfecting method, the contact lenses are immersed in a liquid agent which exhibits a chemical disinfecting effect, so that the contact lenses can be sufficiently disinfected. Such a liquid agent is required to exhibit not only a high disinfecting effect, but also low toxicity to the eyes since the contact lenses are immersed in the liquid agent for a long time for disinfection.

[0006] As the chemical disinfectant used in the chemical disinfecting method, chlorhexidine, quaternary ammonium salt and thimerosal are disclosed in JP-A-52-109953, JP-A-62-153217 and JP-A-63-59960. In order to obtain a sufficiently high disinfecting effect, these chemical disinfectants are included generally at a relatively high concentration in the liquid agent. In this case, the chemical disinfectants are likely to be uptaked in or adsorbed on the contact lenses, especially the soft contact lenses. It is reported that the eyes of the lens wearer suffer from troubles due to direct contact thereof with the contact lenses on which the disinfectants are adsorbed after the disinfecting treatment ("Journal of Japan Contact Lens Society" 34:267-276, 277-282, 1992, 35:219-225, 1993, 36:57-61, 1994, 37:35-39, 154-157, 1995).

[0007] To avoid the above problem, the contact lens may be disinfected by using a contact lens liquid agent in which the chemical disinfectant (germicide) is included at a relatively low concentration for assuring safety of the eyes. In this case, however, the disinfecting effect to be exhibited by the liquid agent is inevitably lowered, whereby the liquid agent cannot provide a satisfactory disinfecting or sterilizing effect, causing contamination of the contact lenses by the microorganisms.

[0008] In order to solve the problem of adsorption of the disinfectants on the contact lenses, it is proposed to use a high molecular weight quaternary ammonium which exhibits a high disinfecting effect. By using the quaternary ammonium having a high molecular weight, the entry of the germicide into the contact lens is prevented. Examples of such a method are disclosed in JP-B-2-54804 which teaches the use of Polyquaternium-1, and U.S. Patents Nos. 4361548 and 4443429, which teach the use of Polyquaternium-6. None of the germicides disclosed in these patents, however, exhibit a satisfactory disinfecting effect when used in the formulations and compositions taught in those patents. Therefore, it has been desired to provide a contact lens liquid agent capable of exhibiting a sufficiently high disinfecting effect and a high degree of safety to the eyes.

SUMMARY OF THE INVENTION

[0009] It is therefore an object of the present invention to provide a liquid agent for a contact lens, which is capable of providing sufficiently high disinfecting efficacy while having a low degree of toxicity to the eyes, and which can be

safely used in disinfecting the contact lens.

[0010] The inventors have made an extensive study on various known cation polymers which are considered to have an antimicrobial activity or a disinfecting effect, in an attempt to utilize those cation polymers in a contact lens liquid agent as a disinfecting or sterilizing component. The study has revealed that some kinds of the cation polymers which are used as the materials of hair-care and skin-care cosmetics and which are called "Polyquaternium" under the CTFA (The Cosmetic Toiletry and Fragrance Association, Washington D.C.), have a low degree of toxicity to the eyes and a high degree of safety suitable as the disinfecting component to be used in the contact lens liquid agent. Further, the inventors have found that a combined use of a suitable cation polymer with a nonionic tonicity agent and/or an amino acid in the contact lens liquid agent effectively intensifies or enhances the antimicrobial activity or the disinfecting action of the cation polymer.

[0011] The above object of the present invention may be attained according to the principle of the invention, which provides a liquid agent for a contact lens, containing at least one disinfecting component selected from the group consisting of Polyquaternium-6, Polyquaternium-7, Polyquaternium-16 and Polyquaternium-22, and a nonionic tonicity agent and/or an amino acid.

[0012] The contact lens liquid agent according to the present invention contains suitably selected Polyquaternium as a component effective for disinfecting or sterilizing the contact lens, so that it exhibits an excellent disinfecting action and a high degree of safety owing to the considerably low toxicity of the Polyquaternium. Further, the combined use of the Polyquaternium and the nonionic tonicity agent and/or the amino acid provides a synergistically enhanced disinfecting effect, whereby the present contact lens liquid agent can exhibit an excellent disinfecting effect even when the concentration of the Polyquaternium included therein is relatively low.

[0013] Preferably, the disinfecting component is contained in the liquid agent at a concentration of 0.00000001-1.0 w/v%, and the nonionic tonicity agent and/or the amino acid is/are contained at a concentration of 0.01-20 w/v%.

[0014] In the present invention, at least one of glycerin, propylene glycol and mannitol is preferably used as the nonionic tonicity agent while a low molecular weight amino acid having a molecular weight of 75-250 is preferably used as the amino acid. This arrangement is effective to synergistically enhance the disinfecting activity of the suitably selected Polyquaternium.

[0015] The present contact lens liquid agent may further contain a buffer. Owing to the use of the buffer together with the suitable Polyquaternium (as the disinfecting component) and the nonionic tonicity agent and/or the amino acid, the disinfecting and sterilizing effect to be exhibited by the Polyquaternium is significantly enhanced. As the buffer, a borate buffer, a phosphate buffer, a citrate buffer or a tris(hydroxymethyl)aminomethane buffer is preferably used.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] The disinfecting component of the present contact lens liquid agent is selected from substances called "Polyquaternium" under the CTFA indicated above. In other words, at least one of Polyquaternium-6, Polyquaternium-7, Polyquaternium-16 and Polyquaternium-22 is used as the disinfecting component. Owing to the combined use of the suitably selected Polyquaternium and a nonionic tonicity agent and/or an amino acid, the present contact lens liquid agent exhibits a synergistically enhanced disinfecting effect.

[0017] The above-described Polyquaternium is explained in detail on pages 462-463 of "C.T.F.A International Cosmetic Ingredient Dictionary". For instance, the Polyquaternium-6 is a homopolymer of dimethyl diallyl ammonium chloride. The Polyquaternium-7 is a polymeric quaternary ammonium salt formed of acrylamide and dimethyl diallyl ammonium chloride. The Polyquaternium-16 is a polymeric quaternary ammonium salt formed of methylvinylimidazolium chloride and vinylpyrrolidone. The Polyquaternium-22 is a copolymer of dimethyl diallyl ammonium chloride and acrylic acid.

[0018] Among various kinds of the Polyquaternium indicated above, the Polyquaternium-6 which is the homopolymer of dimethyl diallyl ammonium chloride, and the Polyquaternium-7 which is a copolymer of dimethyl diallyl ammonium chloride are preferably used in the present contact lens liquid agent since they exhibit a high disinfecting effect and assure a high degree of safety. As the Polyquaternium-6, "Merquat-100" which is available from CALGON CORPORATION, U.S.A., and which is used as a material of hair-care and skin-care products is preferably used.

[0019] The Polyquaternium suitably selected as the disinfecting component is used in combination with the nonionic tonicity agent and/or the amino acid, so that the antimicrobial action of the Polyquaternium is effectively enhanced, so that the contact lens liquid agent of the present invention can exhibit a sufficiently high disinfecting effect even if the concentration of the disinfecting component is considerably low, e.g., as low as 0.00000001 w/v%, as compared with that of the conventional contact lens liquid agents. In the present invention, the disinfecting component is included in the contact lens liquid agent at a concentration of generally at least 0.00000001 w/v%, preferably at least 0.0000001 w/v%, more preferably at least 0.000001 w/v%. The upper limit of the disinfecting component included in the present contact lens liquid agent is generally 1.0 w/v%, preferably 0.1 w/v%, more preferably 0.01 w/v%.

[0020] The nonionic tonicity agent used in combination with the suitable Polyquaternium as the disinfecting compo-

nent is selected from among various known nonionic tonicity agents such as glycerin, propylene glycol, mannitol, polyethylene glycol (having an average molecular weight of 100-400), glucose, diethylene glycol, sorbitol, xylitol and cyclodextrin. In addition, any other known nonionic tonicity agents may be used, provided that they assure sufficiently high safety suitable for the present contact lens liquid agent. Any one of, or any combination of, those nonionic tonicity agents may be employed. In particular, at least one of glycerin, propylene glycol and mannitol is preferably used as the nonionic tonicity agent to be included in the present contact lens liquid agent. The nonionic tonicity agent is also effective to adjust the osmotic pressure of the contact lens liquid agent. The osmotic pressure of the present contact lens liquid agent is adjusted to within a range of 200-400 mOsm, which substantially corresponds to a physiological osmotic pressure, to thereby prevent the eye irritation which would be otherwise caused when the contact lenses which have been treated by the liquid agent are worn on the eyes.

[0021] The amino acid used in combination with the suitable Polyquaternium as the disinfecting component is selected from among various known compositions, each of which has a carboxyl group and an amino group in each molecule thereof. As the amino acid, it is preferable to use a low molecular weight amino acid having a molecular weight of 75-250 such as alanine, α-aminoadipic acid, α-aminobutyric acid, α-aminoisobutyric acid, arginine, asparagine, aspartic acid, isoleucine, creatine, glutamine, glutamic acid, glycine, histidine, cystine, tyrosine, tryptophan, valine, methionine, lysine, leucine, ornithine, phenylalanine, proline, phosphoserine, sarcosine, threonine, cysteine, serine, and salts thereof. Particularly preferably used are sodium L-glutamate, glycine, DL-alanine, DL-serine, L-histidine and L-glutamine. In particular, the sodium L-glutamate or glycine is preferably used as the low molecular weight amino acid. The amino acid also functions as a buffer, and it does not give an adverse influence on the size of the contact lens which is immersed in the liquid agent, so that the amino acid can be preferably used in the present contact lens liquid agent.

[0022] The nonionic tonicity agent and/or the amino acid used in combination with the suitable Polyquaternium is/are included in the present contact lens liquid agent generally at a concentration of 0.01-20 w/v%, preferably at a concentration of 0.05-10 w/v%. If the amount of the nonionic tonicity agent and/or the amino acid is too small, the osmotic pressure of the contact lens liquid agent is undesirably low. On the other hand, an excessive amount of the nonionic tonicity agent and/or the amino acid increases the osmotic pressure of the liquid agent to an undesirably high level.

[0023] The pH of the present contact lens liquid agent is adjusted to be held within a substantially neutral range, namely, in a range of 5-9, preferably in a range of 6-8, to permit the disinfecting component to exhibit a sufficiently high disinfecting and sterilizing effect while preventing the eye irritation when the contact lenses treated by the liquid agent are worn on the eyes. The pH value outside the above range of 5-9 may cause an eye irritation and other troubles.

[0024] For effectively keeping the pH of the present contact lens liquid agent in the above range of 5-9 which assures the safety of the eyes, at least one buffer is added to the liquid agent. The buffer is added to the present contact lens liquid agent in order to permit the disinfecting component to exhibit a satisfactory disinfecting and sterilizing effect while avoiding the eye irritation when the contact lenses which have been treated by the contact lens liquid agent are worn on the eyes.

[0025] The buffer to be added to the present contact lens liquid agent may be suitably selected from among any known buffers such as a borate buffer, a phosphate buffer, a tris(hydroxymethyl)aminomethane buffer, and a citrate buffer. The buffer is included in the contact lens liquid agent in an amount of 0.05 w/v% or more, preferably 0.1 w/v% or more, since the buffering action of the buffer tends to be insufficient if the amount of the buffer is excessively small. On the other hand, an excessive amount of the buffer may cause an eye irritation when the contact lenses treated by the contact lens liquid agent are worn on the eyes. In view of this, the buffer is added to the liquid agent in an amount of not larger than 1.2w/v%, preferably not larger than 0.8 w/v%.

[0026] The present contact lens liquid agent may further contain a surface active agent for improving a cleaning effect to remove deposits such as lipids adhering to the contact lenses, and for increasing the viscosity of the liquid agent. Any kinds of the surface active agent such as cationic, anionic, amphoteric and nonionic may be employed at concentrations which do not adversely influence the effect of the present invention, as long as the selected surface active agent is safe to the living body without adversely influencing the material of the contact lenses.

[0027] The present contact lens liquid agent may further contain other known additives such as a chelating agent, a thickener and a protein removing agent, provided that they are safe to the living body and do not give an adverse influence on the material of the contact lenses. The additives may be employed in combination, as needed, in amounts that do not inhibit the effect of the present invention.

[0028] The present contact lens liquid agent which contains the suitably selected Polyquaternium (as the disinfecting component), the nonionic tonicity agent and/or the amino acid is/are easily prepared in a way as usually used for preparing an aqueous solution, without requiring any special procedure. Namely, the present contact lens liquid agent is obtained by dissolving each component in a predetermined amount of purified sterile water. The obtained contact lens liquid agent is transparent or clear, and is subjected to sterile filtration as needed.

[0029] The contact lens is treated with the thus obtained liquid agent in the following manner. The contact lens which

has been removed from the eye is accommodated in a container filled with the present contact lens liquid agent. The contact lens is immersed for disinfection in the contact lens liquid agent for a time period of from 10 minutes to 24 hours, preferably from 30 minutes to 8 hours, more preferably from 1 hour to 6 hours. It is to be understood that the contact lens may be otherwise treated using the present contact lens liquid agent.

[0030] According to the procedure described above, the contact lens can be easily and effectively disinfected without using the conventionally required boiling device. Since the suitably selected Polyquaternium as the disinfecting component assures a high degree of safety to the eyes, the contact lens can be disinfected with safety without causing any troubles with the eyes even when the contact lens is immersed in the present contact lens liquid agent for a relatively long period of time.

[0031] The contact lens liquid agent according to the present invention can be applied to any known kinds of contact lenses such as low-water-content and high-water-content soft contact lenses, and hard contact lenses, irrespective of the materials of those contact lenses.

[0032] To further clarify the concept of the present invention, some examples of the invention will be described. It is to be understood that the invention is not limited to the details of the illustrated examples, but may be embodied with various changes, modifications and improvements, which may occur to those skilled in the art without departing from the scope of the invention defined in the attached claims. The percentage in the following examples are on a weight/volume (w/v) basis unless otherwise specified.

--Test for checking the disinfecting efficacy--

[0033] As the test bacteria or fungi, *S. m. (Serratia marcescens* ATCC 13880) or C. *a. (Candida albicans* ATCC 10231) was used. The *S. m.* was cultured by using a soybean-casein medium at 30°C for 24 hours while the *C. a.* was cultured by using a Glucose-Peptone medium at 30°C for 24 hours. Each of the thus cultured *S. m.* and *C. a.* was suspended with saline, to thereby provide a bacteria or fungi suspension of 10^8 cfu/ml.

[0034] To evaluate the disinfecting effect of the present contact lens liquid agent, 10 ml of the liquid agent was poured into a disinfected test tube. 0.05 ml of the bacteria or fungi suspension prepared as described above was introduced into the test tube, and the test tube was stored in a thermostat kept at 23°C for a suitable period of time. Thereafter, a predetermined amount of the mixture was taken out of the test tube, and diluted with sterilized saline. For 1 ml of the diluted solution, a viable cell count was measured by a mixing dilution method. In the mixing dilution method, the mixture including the bacteria (*S.m.*) was cultured by using the soybean-casein medium at 30°C for 3 days while the mixture including the fungi *(C.a.)* was cultured by using the Glucose-Peptone medium at 30°C for 5 days. On the basis of the measured viable cell count, there was calculated a viable cell count of the mixture of the contact lens liquid agent and the bacteria or fungi suspension a predetermined time after mixing of the liquid agent and the bacteria or fungi suspension. Then, an amount of reduction of the bacteria or fungi was calculated in logarithm according to the following equation.

Reduction amount [in logarithm] =

LOG (the viable cell count per 1 ml of each bacteria or fungi suspension immediately after the preparation) -

LOG (the viable cell count per 1 ml of each bacteria or fungi suspension after the treatment by the contact lens liquid agent)

<Example 1>

[0035] To examine the disinfecting efficacy of the present contact lens liquid agent, the following experiment was conducted. Initially, various specimens (Nos. 1-10) of the contact lens liquid agent were prepared so as to have respective compositions as indicated in the following Tables 1 and 2, by dissolving respective components in purified sterile water. As the disinfecting component, "Merquat 550" available from CALGON CORPORATION, U.S.A., "Luviquat FC 370" available from BASF, Germany, "SWANOL AM-101" available from Nikko Chemicals, Co., Ltd, Japan, "Merquat 280" and "Merquat 100" both available from CALGON CORPORATION, U.S.A. were used. Described in detail, the Merquat 550 is Polyquaternium-7 which is a copolymer of acrylamide and dimethyl diallyl ammonium chloride.

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