

ORAL CARE PREPARATIONS COMPRISING CHLORHEXIDINE AND ARGININE OR THEIR SALTS

This invention relates to a liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising chlorhexidine or a salt thereof which is effective in preventing or reducing symptoms associated with halitosis.

BACKGROUND OF THE INVENTION

Oral hygiene is an important consideration in the daily life of children and adults around the globe. The maintenance of good oral hygiene is vital to keep the mouth, teeth and gums free from disease, and to prevent the growth of bacteria which can lead to the development of halitosis (bad breath).

10 Bacteria located in periodontal pockets and at the back of the tongue break down sulfur-containing amino acids, in particular cysteine and methionine, to produce the volatile sulfur compounds, including hydrogen sulfide and methyl mercaptan.

These volatile sulfur compounds have an extremely unpleasant odor, even at low concentrations, and also penetrate the epithelium and cause damage to cells of the underlying tissue. It has also been suggested that volatile sulfur compounds produced by bacteria located within periodontal pockets may be an important factor in the development of periodontal disease.

Therefore, antibacterial agents are often used in preventive dentistry to reduce the levels of these bacteria and thereby prevent the formation of volatile sulfur compounds. One known antibacterial agent used in preventative dentistry is chlorhexidine, which is frequently formulated in a mouthwash.

WO 00/051559 discloses a mouthwash comprising chlorhexidine and zinc acetate, wherein the combination of zinc and chlorhexidine synergistically reduces the production of volatile sulfur compounds.

20 Unfortunately, the applicant has surprisingly discovered that chlorhexidine is unstable in the mouthwash, and degrades overtime. Such degradation is clearly undesirable because the efficacy of the product will be reduced and undesired degradation products form in a product ingested by humans.

Accordingly, it is an object of the present invention to provide a liquid oral care composition comprising chlorhexidine wherein the chlorhexidine has improved chemical stability.

SUMMARY OF THE INVENTION

In a first aspect, the invention provides the use of arginine or a salt thereof for stabilising chlorhexidine or a salt thereof in a liquid oral care composition that is a mouthwash, mouthrinse or a spray.

In a second aspect, the invention provides a liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 1% w/w chlorhexidine or a salt thereof;
- arginine or a salt thereof; and
- a zinc salt.

In a third aspect, the invention provides the liquid oral care composition that is a mouthwash, mouthrinse or a spray as defined by the second aspect of the invention for use in therapy.

Surprisingly, the applicant has found that arginine improves the chemical stability of chlorhexidine in a liquid oral care composition that is a mouthwash, mouthrinse or a spray.

Additional aspects of the invention are more fully described in the following detailed description of the various embodiments.

10 DEFINITIONS

The proportions of each component of the liquid composition that is a mouthwash, mouthrinse or a spray used herein are defined as “% w/w”, i.e. weight by weight, which is calculated by the following formula:

$$\% \text{ w/w} = [(\text{weight of solute})/(\text{total weight of solution})] * 100.$$

If the relevant solute is added in the form of a salt, the weight of the solute is the weight of the salt before it is added to the liquid composition i.e. the anion(s) and the cation(s).

For the avoidance of doubt, each component in the composition may comprise one member of that class of components or more than one member of that class of component. For example, the chlorhexidine or a salt thereof can comprise a mixture of chlorhexidine and one or more salts of chlorhexidine, the arginine or a salt thereof can comprise a mixture of arginine and one or more salts of arginine, and the zinc salt can comprise a mixture of more than one zinc salts.

DETAILED DESCRIPTION OF THE INVENTION

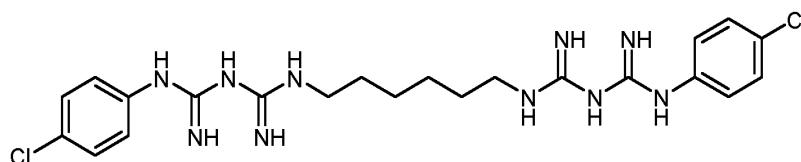
Compositions

The invention provides a liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 1% w/w chlorhexidine or a salt thereof;
- Arginine or a salt thereof; and
- a zinc salt.

Chlorhexidine

The liquid oral care composition that is a mouthwash, mouthrinse or a spray contains chlorhexidine or a salt thereof. Chlorhexidine is a bis-biguanide with the chemical name N,N''-bis(4-chlorophenyl)-3,12-diimino-2,4,11,13-tetraazatetradecanediimidamide):



Chlorhexidine is an antibacterial agent which is commonly used in oral care compositions.

In one embodiment of the invention, the composition includes a salt of chlorhexidine, for example a salt with acetic acid (e.g. chlorhexidine diacetate), a salt with hydrogen chloride (e.g. chlorhexidine dihydrochloride) or a salt with gluconic acid (e.g. chlorhexidine digluconate), or mixtures thereof.

- 10 The composition comprises 0.005 to 1% w/w chlorhexidine or a salt thereof.

In one embodiment, the composition comprises 0.005 to 0.5% w/w, 0.01 to 0.3% w/w, 0.01 to 0.08% w/w, 0.01 to 0.05% w/w, or 0.02 to 0.04% w/w chlorhexidine or a salt thereof. In particular, the composition includes 0.02 to 0.04% w/w e.g. 0.025% w/w chlorhexidine or a salt thereof.

In particular, the composition includes chlorhexidine diacetate. In one embodiment, the composition comprises 0.005 to 1% w/w, 0.005 to 0.5% w/w, 0.005 to 0.1% w/w, 0.01 to 0.3% w/w, 0.01 to 0.08% w/w, 0.01 to 0.05% w/w, or 0.02 to 0.04% w/w chlorhexidine diacetate. In particular, the composition includes 0.02 to 0.04% w/w chlorhexidine diacetate e.g. 0.03% w/w chlorhexidine diacetate.

- 20 Chlorhexidine is known to have a prolonged and broad spectrum antimicrobial effect, and also to have plaque inhibitory potential (Vrani "Formulation ingredients for toothpastes and mouthwashes" Bosnian Journal of Basic Medical Sciences 2004, 4, 51-58). The antimicrobial effect reduces offensive oral odor caused by VSCs (N. Lourith "Oral malodour and active ingredients for treatment" International Journal of Cosmetic Science 2010, 32, 321-329).

Chlorhexidine is an amphipathic molecule with hydrophilic and hydrophobic groups. At physiological pH, chlorhexidine is cationic and exhibits its antimicrobial activity as a "membrane-active agent" that binds to negatively charged bacterial cell walls. Chlorhexidine establishes a bridge between pairs of adjacent phospholipids within the cell wall and displaces the associated divalent cations, thereby increasing the permeability of the cell membrane, facilitating the release of intracytoplasmic material and ultimately resulting in cell death. The cationic molecule will bind principally to anionic compounds within the cell wall, such as free

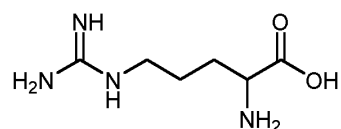
sulphates, lipopolysaccharide phosphate groups and protein carboxyl groups (Rölla and Melsen "On the mechanism of the plaque inhibition by chlorhexidine" Journal of Dental Research 1975, 54, 57-62).

However, chlorhexidine and chlorhexidine salts can suffer from hydrolytic degradation. It is known that in acidic conditions chlorhexidine degrades by two major pathways: one that leads to direct formation of its primary degradation product *p*-chloroaniline (PCA) and the other that leads to indirect formation of *p*-chloroaniline via the formation of the intermediate (*p*-chlorophenyl)biguanide- N-amidino-N'-(*p*-chlorophenyl)urea (PBG-PAU) with loss of ammonia. In alkaline conditions, chlorhexidine degrades by a different single pathway leading indirectly to *p*-chloroaniline. Postulated chlorhexidine degradation mechanisms are set out in (Zong "Studies on the Instability of Chlorhexidine, Part I: Kinetics and Mechanisms" Journal of Pharmaceutical Sciences 2012, 101, 2417-2427).

The applicant has discovered that this decomposition pathway can occur in mouthwash compositions.

Arginine

The liquid oral care composition that is a mouthwash, mouthrinse or a spray contains arginine or a salt thereof. Arginine is an α -amino acid including a guanidine group with the chemical name 2-amino-5-guanidinopentanoic acid:



In one embodiment of the invention, the composition includes free arginine.

In one embodiment of the invention, the composition includes a salt of arginine, for example arginine bicarbonate, arginine hydroxide, arginine carbonate or arginine phosphate, or mixtures thereof.

20 In one embodiment, the liquid oral care composition that is a mouthwash, mouthrinse or a spray comprises 0.1 to 1% w/w, 0.2 to 0.8% w/w or 0.3 to 0.6% w/w arginine or a salt thereof. In particular, the composition comprises 0.4 to 0.5% w/w e.g. 0.5% w/w arginine or a salt thereof.

Surprisingly, the inventors discovered that in an oral care composition that is a mouthwash, mouthrinse or a spray, chlorhexidine decomposition can be reduced by arginine or a salt thereof. In other words, the amount of chlorhexidine that chemically decomposes is less in the presence of arginine or a salt thereof.

By reducing the rate of degradation of chlorhexidine the antibacterial effect of the active ingredient is prolonged and the shelf life of the liquid oral care composition extended (see Example 3).

Zinc salt

The liquid oral care composition that is a mouthwash, mouthrinse or a spray contains a zinc salt.

In one embodiment, the zinc salt is zinc oxide, zinc lactate, zinc chloride, zinc citrate, zinc acetate, zinc borate, zinc butyrate, zinc carbonate, zinc formate, zinc gluconate, zinc glycerate, zinc glycolate, zinc phosphate, zinc picolinate, zinc propionate, zinc salicylate, zinc silicate, zinc stearate, zinc tartrate, zinc undecylenate, zinc phosphate, zinc ricinoleate, zinc nitrate or zinc sulfate or mixtures thereof.

In one embodiment, the zinc salt is zinc lactate, zinc chloride or zinc citrate, or mixtures thereof.

In one embodiment, the zinc salt is zinc lactate. In one embodiment, the zinc salt is zinc chloride. In one embodiment, the zinc salt is zinc citrate.

10 In one embodiment, the zinc salt is zinc lactate.

In particular, the zinc salt is zinc acetate. In one embodiment, the zinc acetate is zinc acetate dihydrate.

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray comprises 0.1 to 1% w/w zinc salt. Alternatively, the composition contains 0.2 to 0.9% w/w, 0.3 to 0.8% w/w or 0.4 to 0.7% w/w zinc salt. In a further embodiment, the composition contains 0.2 to 0.5% w/w zinc salt. In a preferred embodiment, the composition contains 0.3% w/w zinc salt.

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray comprises 0.1% to 1% w/w zinc acetate. Alternatively, the composition contains 0.2 to 0.9% w/w, 0.3 to 0.8% w/w or 0.4 to 0.7% w/w zinc acetate. In a further embodiment, the composition contains 0.2 to 0.5% w/w zinc acetate. In a preferred embodiment, the composition contains 0.3% w/w zinc acetate.

20 Zinc ions also reduce the production of volatile sulfur compounds in the oral cavity. It is thought that a reaction between zinc and sulfur produces a non-volatile sulfide product, thereby preventing the transformation of sulfur containing substrates to volatile sulfur compounds. In addition, zinc ions possess certain antibacterial activity known to inhibit plaque formation and reduce acid formation in dental plaque (see "Oral malodour and active ingredients for treatment", International Journal of Cosmetic Science, 2010, 32, 321-329).

As explained below, the combination of zinc acetate and chlorhexidine provides a synergistic effect against the production of volatile sulfur compounds.

The compositions

30 The liquid oral care composition is a mouthwash, mouthrinse or a spray. In particular, the liquid oral care composition is a mouthwash, for example an aqueous mouthwash. Accordingly, the composition has a form and consistency that allows the composition to be washed around the mouth and to be sprayed into the mouth,

Other components

The oral care composition that is a mouthwash, mouthrinse or a spray generally includes water. In addition, the oral care composition includes other additives and adjuvants commonly found in oral care compositions, for example an antiplaque agent, a masking agent, a humectant, a flavoring agent, and a buffering agent.

Water

Typically, water (i.e. demineralised water) is present as the balance of the composition. In other words, the composition is an aqueous oral care composition.

Fluoride

10 In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes one or more fluoride salts.

In one embodiment, the fluoride salt is selected from stannous fluoride, sodium fluoride, potassium fluoride, potassium monofluorophosphate, sodium monofluorophosphate, ammonium monofluorophosphate, sodium fluosilicate, ammonium fluosilicate, amine fluorides such as ammonium fluoride, and combinations thereof.

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes an amount of a fluoride salt such that the composition includes from 50 to 5000 ppm, 100 to 1000 ppm fluoride ions, 200 to 500 ppm fluoride ions e.g. about 250 ppm fluoride ions.

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray comprises 0.01 to 1% w/w, 0.01 to 0.1% w/w, or 0.02 to 0.07% w/w e.g. 0.01% w/w fluoride salt.

Masking agent

20 In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes a masking agent, such as tannic acid, glycyrrhizin derivatives, or acesulfame e.g. acesulfame potassium. The masking agent is present in an amount sufficient to reduce the aftertaste of any minerals present in the oral care preparation that is a mouthwash, mouthrinse or a spray. In particular, when present, the composition includes 0.01 to 0.1% w/w masking agent, for example 0.01 to 0.05% w/w masking agent.

Humectant

30 In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes one or more humectants, such as hydrogenated starch hydrolysate, glycerin, and sorbitol. The humectant is present in an amount sufficient to increase the viscosity and provide a certain mouth feel to the oral care composition that is a mouthwash, mouthrinse or a spray. In one embodiment, the composition includes 1 to 10% w/w humectant, for example 5 to 10% w/w e.g. 7.50% w/w of humectant.

Flavouring agent

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes one or more flavouring agents, such as peppermint, spearmint, cinnamon, wintergreen oils, menthol, or methyl salicylate derivatives. Other flavouring agents may be used individually or in combination. In one embodiment, the composition includes 0.01 to 1% w/w e.g. 0.2 to 0.5% w/w of a flavouring agent.

Emulsifying agent

In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes one or more emulsifying agents, such as PEG-40 hydrogenated castor oil, or polysorbate-20. In one embodiment, the composition includes 0.1 to 10% w/w e.g. 1% w/w of a flavouring agent.

10 *Buffering agent*

In another embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes a buffering agent, such as citric acid, and benzoic acid. In one embodiment, the oral care composition that is a mouthwash, mouthrinse or a spray includes a buffering agent in an amount such that the pH of the oral care preparation is from 5 to 8, for example from 5 to 7, and in particular from 5 to 6.

Other components

A variety of additives and adjuvants can be included to make the oral care composition that is a mouthwash, mouthrinse or a spray more amenable for use in a particular end-use application without negatively affecting its efficacy or the stability of chlorhexidine in a substantial manner. Examples include, but are not limited to, emollients, fragrances, pigments, dyes, flavors, abrasives, bleaching agents, preservatives, antioxidants, and
20 the like.

Other compositionsFurther aspects of the invention

Other compositions that form part of the invention include the following:

In a fourth aspect, the invention provides a liquid oral care composition (e.g. an aqueous oral care composition, in particular a mouthwash or spray) comprising:

- chlorhexidine or a salt thereof;
- arginine or a salt thereof; and
- zinc acetate.

In a fifth aspect, the invention provides a liquid oral care composition comprising:

- chlorhexidine or a salt thereof;
- arginine or a salt thereof; and
- a zinc salt,

wherein the liquid oral care composition is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

In a sixth aspect, the invention provides a liquid oral care composition (e.g. a mouthwash or a spray) comprising:

- 10
- chlorhexidine or a salt thereof;
 - arginine or a salt thereof; and
 - a zinc acetate,

wherein the liquid oral care composition is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

In a seventh aspect, the invention provides a liquid oral care composition (e.g. an aqueous oral care composition, for example a mouthwash or spray) comprising:

- chlorhexidine or a salt thereof;
- 0.1 to 1% w/w arginine or a salt thereof;
- a zinc salt.

In a eighth aspect, the invention provides a liquid oral care composition comprising:

- 20
- chlorhexidine or a salt thereof;
 - arginine or a salt thereof; and
 - a zinc salt,

wherein the composition is an aqueous mouthwash.

In a eighth aspect, the invention provides a liquid oral care composition comprising:

- chlorhexidine or a salt thereof;
- arginine or a salt thereof; and
- a zinc salt,

wherein the composition is an aqueous spray.

It should be understood that the above aspects are general statements of compositions and can be combined with the other embodiments of the invention described herein.

Preferred compositions

Further aspects of the invention

Particular compositions according to the invention include the following.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 0.2% w/w chlorhexidine or a salt thereof;
- 0.1 to 1% w/w arginine or a salt thereof; and
- 0.1 to 1% w/w zinc salt.

10 A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 0.2% w/w chlorhexidine or a salt thereof;
- 0.1 to 1% w/w arginine or a salt thereof; and
- 0.1 to 1% w/w zinc salt.

wherein the that is a mouthwash, mouthrinse or spray is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 0.2% w/w chlorhexidine or a salt thereof;
- 0.1 to 1% w/w arginine or a salt thereof; and
- 0.1 to 1% w/w zinc acetate.

20 A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.005 to 0.2% w/w chlorhexidine or a salt thereof;
- 0.1 to 1% w/w arginine or a salt thereof; and
- 0.1 to 1% w/w zinc acetate,

wherein the mouthwash, mouthrinse or a spray is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

Further particular compositions according to the invention include the following.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.02 to 0.04% w/w chlorhexidine or a salt thereof;
- 0.3 to 0.6% w/w arginine or a salt thereof; and
- 0.2 to 0.5% w/w zinc salt.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.02 to 0.04% w/w chlorhexidine or a salt thereof;
- 0.3 to 0.6% w/w arginine or a salt thereof; and
- 0.2 to 0.5% w/w zinc salt.

10 wherein the mouthwash, mouthrinse or spray is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.02 to 0.04% w/w chlorhexidine or a salt thereof;
- 0.3 to 0.6% w/w arginine or a salt thereof; and
- 0.2 to 0.5% w/w zinc acetate.

A liquid oral care composition that is a mouthwash, mouthrinse or a spray comprising:

- 0.02 to 0.04% w/w chlorhexidine or a salt thereof;
- 0.3 to 0.6% w/w arginine or a salt thereof; and
- 0.2 to 0.5% w/w zinc acetate,

20 wherein the mouthwash, mouthrinse or a spray is an aqueous solution, and the aqueous solution has a pH of from 5 to 6.

Uses of the invention

Stabilisation of chlorhexidine

The invention is based on the surprising finding that arginine or a salt thereof can be used to stabilise chlorhexidine. Accordingly, the invention also provides the use of a compound containing arginine or a salt thereof, for stabilising chlorhexidine or a salt thereof in a liquid composition.

In particular, the invention provides the use of arginine or a salt thereof for stabilising chlorhexidine or a salt thereof in an oral care composition.

In one embodiment, the invention provides the use of arginine or a salt thereof, for stabilising chlorhexidine or a salt thereof in a liquid composition that is a liquid oral care composition. In one embodiment, the liquid oral care composition is the mouthwash, mouthrinse or a spray.

In one embodiment, the invention provides the use of arginine or a salt thereof, for stabilising chlorhexidine or a salt thereof in a liquid composition that is a liquid antiseptic.

In one embodiment, the invention provides the use of arginine or a salt thereof, for stabilising chlorhexidine or a salt thereof in a liquid composition that is a liquid disinfectant.

Use of the mouthwash

The compositions of the invention include antibacterial agents i.e. chlorhexidine and a zinc salt.

- 10 Accordingly, the invention provides the liquid oral care compositions for use in therapy. In particular, the compositions are administered to a patient orally.

In one embodiment, the invention provides the liquid oral care compositions for use in the treatment or prophylaxis of a bacterial infection.

In one embodiment, the invention provides a method of treating a bacterial infection by administering the liquid oral care composition to a patient in need thereof.

The compositions of the invention include agents which reduce the formation of volatile sulfur compounds. Chlorhexidine has an antibacterial effect against the microorganisms that breakdown sulfur containing amino acids. Zinc compounds are thought to react with sulfur containing compounds to give non-volatile sulfur compounds.

- 20 Accordingly, the invention provides the use of the liquid oral care compositions for neutralising bad breath i.e. halitosis.

EXAMPLES

The invention will now be illustrated by reference to the following examples.

Example 1: Efficacy of combinations (background example)

In vitro experiments were performed to test efficacy of zinc acetate and chlorhexidine to inhibit formation of volatile sulfur compounds (VSC).

10 microlitres of the following solutions were added to a 1 ml sample of freshly collected human saliva in a test tube:

- 0.3% zinc acetate (1);
- 0.025% chlorhexidine (2); and
- 0.025% chlorhexidine + 0.3% zinc acetate (3).

The test tubes were closed with a stopper and incubated overnight at 37°C. A tube which contained saliva only was used as a control. The gaseous VSCs produced by the samples were measured by gas chromatography, and compared to pure samples of hydrogen sulfide and methyl mercaptan.

Composition	HS	FIC index	MM	FIC index
Control	> 27 000 000		> 41 000 000	
1	150 000		4 000 000	
2	443 000		355 000	
3	82 000	0.33	34 000	0.01

The composition comprising saliva alone (control) contained very high amounts of both hydrogen sulfide (HS) and methyl mercaptan (MM).

10 The composition which contained zinc acetate alone (1) had lower amounts of both HS and MM. However, zinc acetate reduced the amount of HS much more than the amount of MM.

The composition comprising chlorhexidine alone (2) had lower amounts of both HS and MM.

However, the combinations of zinc acetate and chlorhexidine provided a clear further reduction in VSCs, both for HS and MM.

An examination was conducted to investigate whether the effect of the combination was synergistic. This was performed according to the method of Behrenbaum (J. Inf. Dis. 137:122-130, 1978). The fractional inhibitory concentrations (the FIC index) was calculated based on the amounts (AUC) of hydrogen sulfide and methyl mercaptan formed under different conditions. A low AUC thus indicates presence of a strong inhibitor. The FIC index was calculated from the following formula: $(A+B)/A + (A+B)/B$, where A+B represents the combinations of zinc and antibacterial agent, whereas A and B alone represent the individual agents.

20 A FIC index below 1 indicates a synergistic effect. Accordingly, it can be seen that the combination had a synergistic effect against both HS and MM.

Example 2: Exemplary formulation

An example of a mouthwash according to the invention is as follows (Formulation 1)

Ingredient	Function	% w/w
Purified water	Solvent	Balance
Sodium fluoride	Antiplaque agent	0.01-0.1
Chlorhexidine diacetate	Antimicrobial agent	0.01-0.1
Zinc acetate	Antimicrobial agent	0.01-0.1
Acesulfame potassium	Masking agent	0.01-0.1
Hydrogenated starch hydrolysate	Humectant	1-10
Aroma	Flavoring agent	0.01-1
PEG-40 hydrogenated castor oil	Emulsifying agent	0.1-10
Glycerin	Humectant	1-20
Citric acid	Buffering agent	0.1-1
Arginine	Stabilising agent	0.1-1
pH	-	4-7

It will be appreciated that the above composition is only an example, and the invention is not limited to only such compositions.

Example 3: Stability studies

The following simplified formulations were used for these studies:

Ingredient	% w/w										
	1	2	3	4	5	6	7	8	9	10	11
Purified water	79.57	77.38	69.57	67.39	72.67	77.55	69.83	77.41	77.72	77.56	77.57
Chlorhexidine diacetate	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Arginine	0.5	0.5	0.5	0.5	-	-	-	-	-	-	-
Polyvinylpyrrolidone (PVP)	-	-	-	-	-	-	-	-	2.00	-	2.00
PEG-40 hydrogenated castor oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.40	1.70	2.40	1.70

The stability of the formulations was measured by HPLC-UV after storage at 60°C for 42 days. The formulations were stored in PET bottles with PP caps.

Compositions 1-4 include arginine as a stabilising agent. Compositions 5-11 do not include arginine. In particular, compositions 1-4 and compositions 5-7 differ only in the presence or absence of arginine. The data show that arginine improved the stability of the chlorhexidine.

Formulation	Chlorhexidine (mg/mL)				Chlorhexidine (% difference)			
	Time (days)				Time (days)			
	0	14	28	42	0	14	28	42
1	0.303	0.305	0.288	0.296	100.0	100.7	95.0	97.7
2	0.303	0.299	0.294	0.286	100.0	98.7	97.0	94.5
3	0.314	0.307	0.291	0.296	100.0	97.8	92.7	94.3
4	0.321	0.308	0.288	0.301	100.0	96.0	89.7	93.8
5	0.310	0.266	0.233	0.250	100.0	85.8	75.2	80.6
6	0.304	0.309	0.279	0.261	100.0	101.6	91.8	85.9
7	0.306	0.312	0.283	0.266	100.0	102.0	92.5	87.0
8	0.302	0.274	0.247	0.222	100.0	90.7	81.8	73.5
9	0.313	0.249	0.205	0.155	100.0	79.6	65.4	49.5
10	0.309	0.281	0.259	0.255	100.0	90.9	83.8	82.5
11	0.328	0.243	0.208	0.169	100.0	74.1	63.5	51.6