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(54) Title: METHODS FOR TREATING KERATIN FIBERS WITH OSMOLYTES, CARBOXYLIC ACID AND AMINO ACIDS

(57) Abstract: The disclosure relates to compositions and methods for treating hair, for example for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers, as well as to increasing shine of the treated hair. The compositions comprise (a) at least one amino acid, (b) at least one osmolyte, (c) at least one carboxylic acid, and (d) at least one solvent. The methods comprise applying the compositions to the hair.

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METHODS FOR TREATING KERATIN FIBERS WITH OSMOLYTES, CARBOXYLIC ACID AND AMINO ACIDS

TECHNICAL FIELD

The present disclosure relates to methods for treating hair, for example for removing minerals from hair fibers and/or for limiting mineral uptake of hair fibers.

5 The methods also improve the shine of treated hair.

BACKGROUND

Consumers desire to have healthy, strong hair. However, although consumers regularly care for their hair in the course of ordinary hygiene routines, e.g. washing and conditioning their hair, this can negatively impact the hair's appearance
10 due to impurities in the water such as minerals. In addition, various hair treatments, such as those for changing or enhancing the appearance of hair, e.g., by changing the color, style, and/or shape of the hair, can damage the hair as a result of the harsh chemicals used. This damage can actually lead to a greater degree of mineral uptake into the hair fiber, not just from water but from the hair treatment products themselves.
15 For example, hair that has been dyed and/or bleached may have increased levels of minerals such as copper, magnesium, calcium, zinc, and silicon. As a result, hair that has been bleached, dyed, relaxed, straightened, repeatedly styled, etc., is often dull, dry, frizzy, and generally unhealthy in feel and appearance. Consumers thus seek compositions and processes for enhancing the general health of the hair, as well as
20 the look and feel, for example to provide hair that is soft and smooth to the touch and also appears shiny and healthy.

However, formulating compositions that satisfactorily address these issues has proven to be challenging. For example, some compositions that attempt to address the problem of damage simply coat the hair with compounds that can improve
25 the feel and appearance of the hair; however, this approach is only temporary and superficial. Instead of preventing or repairing the hair, this approach simply masks hair damage until the hair is next rinsed or washed. Other compositions attempt to address the damage within the hair fiber such as by chelating or complexing minerals have been offered, but to date they have not been satisfactory.

30 The present inventors have now discovered a synergistic combination of components that is surprisingly effective for treating damaged hair by limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers. Hair treated with compositions according to the disclosure exhibit surprisingly increased shine and

reduced signs of damage, in particular in hair that has been damaged by harsh chemical treatments.

SUMMARY

The disclosure relates to methods for treating hair, for example for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers, as well as increasing shine of the treated hair. The compositions that can be used in the methods (also referred to as "treatment composition") comprise a synergistic combination of one or more amino acids, one or more osmolytes, and one or more carboxylic acids.

In various embodiments, treatment compositions that can be used in methods according to the disclosure comprise (a) at least one amino acid, (b) at least one osmolyte, (c) at least one carboxylic acid, and (d) at least one solvent. The compositions optionally further include (e) at least one additional component chosen from fatty compounds, surfactants, thickening agents, or combinations thereof. The pH of the compositions is generally less than 7 or less than about 6, for example ranging from about 2 to about 5, or from about 3 to about 4.

In some embodiments, treatment compositions that can be used in methods according to the disclosure comprise at least one amino acid chosen from basic amino acids, for example arginine, histidine, lysine, salts thereof, or combinations thereof. In various embodiments, the total amount of basic amino acids and salts thereof ranges from about 0.1% to about 15%, preferably from about 1% to about 12%, more preferably from about 2% to about 10%, more preferably still from about 3% to about 7%, and most preferably from about 4% to about 6% by weight, relative to the total weight of the composition. In further embodiments the compositions comprise at least one amino acid chosen from acidic or neutral amino acids and salts thereof, for example serine. In various embodiments, the total amount of acidic and/or neutral amino acids and salts thereof ranges from about 0.01% to about 5%, preferably from about 0.05% to about 4%, more preferably from about 0.1% to about 3%, and most preferably from about 0.25% to about 2.5% by weight, relative to the total weight of the composition. In still further embodiments, the compositions comprise a mixture of basic, acidic, and/or neutral amino acids, for example the compositions may comprise arginine and serine. In various embodiments, the total amount of amino acids and salts thereof present in the composition ranges from about 0.1% to about 15%, preferably from about 1% to about 12%, more preferably from about 2% to about 10%,

more preferably still from about 3% to about 7%, and most preferably from about 4% to about 6% by weight, relative to the total weight of the composition.

In some preferred embodiments, treatment compositions that can be used in methods according to the disclosure comprise one or more amino acids chosen from glycine, proline, methionine, serine, arginine, lysine, histidine, salts of any of the foregoing (in particular alkali metal, alkaline earth metal, or zinc salts), and combinations of two or more thereof.

In various embodiments, treatment compositions that can be used in methods according to the disclosure comprise at least one osmolyte chosen from carbohydrate sugars, methylsulfonium compounds, polyamines, and/or amino acid derivatives such as betaines, preferably chosen from compounds of formula (II). In various embodiments, the total amount of osmolytes present in the composition ranges from about 0.01% to about 10%, preferably from about 1% to about 5%, more preferably from about 1.25% to about 4%, more preferably still from about 1.5% to about 3%, and most preferably from about 2% to about 2.5% by weight, relative to the total weight of the composition. In various embodiments, the treatment composition has a weight ratio of the total amount of amino acids to the total amount of osmolytes that is equal to or greater than about 0.5, such as greater than about 1, preferably ranging from about 1.25 to about 3.5, more preferably from about 1.5 to about 3, more preferably still from about 1.75 to about 2.5, and most preferably from about 1.75 to about 2.25.

In various embodiments, the treatment compositions comprise at least one carboxylic acid chosen from oxalic acid, malonic acid, glutaric acid, succinic acid, adipic acid, glycolic acid, citric acid, tartaric acid, malic acid, maleic acid, lactic acid, salts thereof, or combinations of two or more thereof, and preferably citric acid, lactic acid, salts thereof, or combinations of two or more thereof. In various embodiments, the total amount of carboxylic acids and salts thereof may range from about 0.5% to about 20%, preferably from about 1% to about 15%, more preferably from about 2% to about 12%, more preferably still from about 3% to about 10%, and most preferably from about 4% to about 7% by weight, relative to the total weight of the composition. In various embodiments, the composition has a weight ratio of the total amount of amino acids and salts thereof to the total amount of carboxylic acids and salts thereof of greater than about 0.5, such as greater than about 0.7, preferably ranging from about 0.75 to about 2, and more preferably from about 0.8 to about 1.5.

The solvent may comprise water and/or at least one non-aqueous solvent, and in some embodiments comprises water and at least one non-aqueous solvent. Optionally, the treatment compositions comprise water and at least one non-aqueous solvent, and have a total amount of non-aqueous solvents ranging from about 1% to about 20%, preferably from about 5% to about 20%, more preferably from about 5% to about 15%, and most preferably from about 8% to about 12% by weight, relative to the total weight of the composition.

The treatment compositions may optionally also include at least one additional component chosen from fatty compounds, surfactants, thickening agents, or combinations thereof.

In certain embodiments, treatment compositions that can be used in methods according to the disclosure comprise (a) at least one amino acid and/or a salt thereof, preferably at least one basic amino acid and/or a salt thereof, (b) at least one betaine, preferably at least one compound of formula (II), for example glycine betaine, in an amount ranging from about 0.5% to about 5% by weight, relative to the total weight of the composition, (c) at least one carboxylic acid and/or a salt thereof, (d) at least one solvent, preferably comprising at least one polyol, and (e) optionally at least one additional component chosen from fatty compounds, surfactants, thickening agents, or combinations thereof. For example, in at least some embodiments, the treatment composition comprises arginine and the total amount of amino acids ranges from about 1% to about 10% by weight, relative to the total weight of the composition, and the total amount of carboxylic acids ranges from about 0.5% to about 20% by weight, relative to the total weight of the composition. The pH of the compositions is generally less than 7, for example ranging from about 2 to about 5, or from about 3 to about 4. In various embodiments, the total amount of non-aqueous solvents ranges from about 1% to about 20%, preferably from about 2% to about 18%, more preferably from about 3% to about 15%, and most preferably from about 4% to about 10% by weight, relative to the total weight of the composition. In some embodiments, the treatment composition has a weight ratio of the total amount of amino acids and salts thereof, for example arginine, serine, salts thereof, or combinations thereof, to the total amount of betaines, preferably chosen from compounds of formula (II) and salts thereof, for example glycine betaine, that is equal to or greater than about 0.5, such as greater than about 1, preferably from about 1.25 to about 3.5, more preferably from about 1.5 to about 3, more preferably still from about 1.75 to about 2.5, and most

preferably from about 1.75 to about 2.25. In some embodiments, the treatment composition has a weight ratio of the total amount of amino acids and salts thereof to the total amount of carboxylic acids and salts thereof that is greater than about 0.5, such as greater than about 0.7, preferably ranging from about 0.75 to about 2, and
5 more preferably from about 0.8 to about 1.5.

In preferred embodiments, the treatment compositions comprise (a) at least one amino carboxylic acid or a salt thereof, preferably chosen from arginine and/or a salt thereof, (b) at least one betaine derivative, preferably chosen from glycine betaine, (c) at least one carboxylic acid, preferably chosen from citric acid, lactic acid,
10 and/or salts thereof, and (d) water. For example, the composition may comprise (a) from about 2% to about 6% of arginine and/or a salt thereof, (b) from about 0.5% to about 3.5% of glycine betaine, (c) at least one carboxylic acid, preferably chosen from citric acid, lactic acid, and/or salts thereof, and (d) water and optionally at least one non-aqueous solvent, preferably comprising at least one polyol, wherein the total
15 amount of carboxylic acids and salts thereof ranges from about 2% to about 10%, and wherein all amounts are by weight, relative to the total weight of the composition. The pH of the compositions is generally less than 7, for example ranging from about 2 to about 5, or from about 3 to about 4. In various embodiments, the total amount of non-aqueous solvents ranges from about 1% to about 20%, preferably from about 2% to
20 about 18%, more preferably from about 3% to about 15%, and most preferably from about 4% to about 12% by weight, relative to the total weight of the composition. In some embodiments, the treatment composition has a weight ratio of the total amount of amino acids and salts thereof to glycine betaine of equal to or greater than about 0.5, such as greater than about 1, preferably from about 1.25 to about 3.5, more
25 preferably from about 1.5 to about 3, more preferably still from about 1.75 to about 2.5, and most preferably from about 1.75 to about 2.25. In some embodiments, the composition has a weight ratio of the total amount of amino acids and salts thereof to the total amount of carboxylic acids and salts thereof of greater than about 0.5, such as greater than about 0.7, preferably ranging from about 0.75 to about 2, more
30 preferably from about 0.8 to about 1.5. In some embodiments, the compositions include at least one additional component chosen from fatty compounds, surfactants, thickening agents, or combinations thereof. If present, the compositions comprise serine in an amount ranging from about 0.01% to about 2%, preferably from about 0.05% to about 1.5%, more preferably from about 0.05% to about 1%, and most

preferably from about 0.05% to about 0.5% by weight, relative to the total weight of the composition. When the compositions comprise serine, the compositions may optionally have a weight ratio of the total amount of amino acids to serine of greater than about 2, preferably ranging from about 2 to about 15, more preferably from about 4 to about 14, more preferably still from about 6 to about 13, and most preferably from about 8 to about 12. When the compositions comprise serine, the compositions may optionally have a weight ratio of glycine betaine to serine of greater than about 2, preferably ranging from about 2 to about 10, more preferably from about 3 to about 8, more preferably still from about 3.5 to about 7, and most preferably from about 4 to about 6.

The methods comprise applying a treatment composition according to the disclosure onto the hair in order to limit uptake of minerals into hair fibers, remove minerals from hair fibers, and/or increase shine of the treated hair. The composition may be left on the hair for an optional leave-in period, and optionally rinsed from the hair.

BRIEF DESCRIPTION OF THE FIGURES

FIGS. 1A-1B are graphs showing the elasticity of hair fibers of swatches S1-S8 after one treatment (1A) and five treatments (1B).

FIGS. 2A-2B are graphs showing the elasticity of hair fibers of swatches S9-S16 after one treatment (2A) and five treatments (2B).

FIG. 3 is a graph showing the elasticity of hair fibers of swatches S17-S21 after five treatments.

FIGS. 4A-4B are graphs showing the break stress of hair fibers treated with compositions according to the disclosure and comparative compositions.

FIGS. 5A-5B show the structures of certain exemplary osmolytes that can be included in compositions according to the disclosure.

DETAILED DESCRIPTION

The disclosure relates to methods for treating hair, for example for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers. Hair treated according to the disclosure exhibits surprisingly increased shine and reduced signs of damage. While not intending to be bound by theory, it is believed that this is due to the unexpectedly synergistic ability of the combination of amino acids, osmolytes, and carboxylic acids to limit uptake of minerals into hair fibers and/or remove minerals from hair fibers, which was not previously known for this effect.

I. COMPOSITIONS

The treatment compositions that can be used in methods according to the present disclosure comprise (a) at least one amino acid, (b) at least one osmolyte, (c) at least one carboxylic acid, and (d) at least one solvent. The compositions may optionally comprise one or more additional components, such as fatty compounds, surfactants, thickening agents, or combinations thereof.

Amino Acids

Compositions that can be used in methods according to the disclosure comprise at least one amino acid. Optionally, in various embodiments, compositions according to the disclosure can comprise one, two, or three amino acids. Amino acids that can be chosen include those that are basic, acidic, or neutral at neutral pH. In preferred embodiments, compositions comprise at least one basic amino acid.

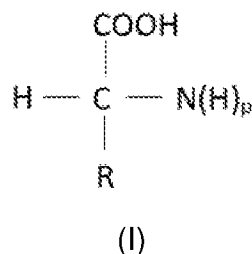
As used herein, the term "amino acid" includes amino carboxylic acids and salts thereof as well as amino sulfonic acids and salts thereof. As used herein, amino acids are understood to refer to organic compounds containing a carboxylic acid group (—COOH) (amino carboxylic acids) and/or sulfonic acid group ($\text{—S(=O)}_2\text{—OH}$) (amino sulfonic acids) and an amino group (—NH_2) which may be primary or secondary, or may be intra-cyclic, along with a side chain (R group) specific to each amino acid.

Amino carboxylic acids that may be chosen include, for example, alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine, valine, and combinations of two or more thereof. Exemplary amino sulfonic acids include aminomethane sulfonic acid, 2-aminoethane sulfonic acid (taurine), aminopropane sulfonic acid, aminobutane sulfonic acid, aminohexane sulfonic acid, aminoisopropyl sulfonic acid, aminododecyl sulfonic acid, aminobenzene sulfonic acid, aminotoluene sulfonic acid, sulfanilic acid, chlorosulfanilic acid, diamino benzene sulfonic acid, amino phenol sulfonic acid, amino propyl benzene sulfonic acid, amino hexyl benzene sulfonic acid, and combinations of two or more thereof.

Salts of amino acids are also included in the term "amino acid," whether or not so stated. By way of non-limiting example, salts that may be chosen include salts with organic or mineral bases, for example the salts of alkali metals, such as the lithium, sodium, or potassium salts; the salts of alkaline earth metals, such as the magnesium or calcium salts, and the zinc salts.

Furthermore, amino acids can be in either the D-, L-, or DL- configuration. In some preferred embodiments, it is advantageous to choose amino acids in the L- configuration, for example L-proline, L-methionine, L-serine, L-arginine, L-lysine, or combinations of two or more thereof.

5 In some embodiments it is particularly advantageous to choose one or more amino carboxylic acids. Thus, in various embodiments, the compositions according to the disclosure comprise one or more amino acids of formula (I):



10 wherein:

-p is an integer equal to 1 or 2, and

-when $p = 1$, R forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 ring members, it being possible for this ring to be substituted by one or more groups chosen from hydroxyl or (C1-C4)alkyl;

15 or

-when $p = 2$, R represents a hydrogen atom or a saturated, linear, or branched (C1-C12)alkyl group, preferably a (C1-C4)alkyl group, optionally interrupted by one or more heteroatoms or groups chosen from -S-, -NH-, or -C(NH)-, and/or optionally substituted by one or more groups chosen from hydroxyl (-OH), amino (-NH₂), -SH, -COOH, -CONH₂, -NH-C(NH)-NH₂, or an imidazole ring.

20

In some embodiments when $p = 1$, R forms, together with the nitrogen atom, a saturated heterocycle comprising 5 ring members, this ring not being substituted.

In some embodiments when $p = 2$, R represents a hydrogen atom or a saturated, linear, or branched (C1-C4)alkyl group, optionally substituted by one or more groups chosen from hydroxyl (-OH), amino (-NH₂), -CONH₂, -NH-C(NH)-NH₂, or an imidazole ring. In some embodiments p is preferably 2.

25

In some embodiments, the treatment compositions comprise one or more amino acids chosen from arginine, glycine, proline, methionine, serine, lysine, histidine, salts of any of the foregoing (in particular alkali metal, alkaline earth metal, or zinc salts), or combinations of two or more thereof. In at least certain embodiments,

30

the amino acid compounds in the composition consist essentially of or consist of amino acids chosen from arginine, glycine, proline, methionine, serine, lysine, histidine, salts of any of the foregoing (in particular alkali metal, alkaline earth metal, or zinc salts), or combinations of two or more thereof.

5 In some embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of glycine and/or salts thereof. In other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of arginine and/or salts thereof. In other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or
10 consist of proline and/or salts thereof. In still other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of methionine and/or salts thereof. In other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of serine and/or salts thereof. In still other embodiments, the amino acid(s) useful in the compositions may
15 comprise, consist essentially of, or consist of arginine and/or salts thereof. In other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of histidine and/or salts thereof. In still other embodiments, the amino acid(s) useful in the compositions may comprise, consist essentially of, or consist of lysine and/or salts thereof. In still further embodiments, the amino acid(s)
20 useful in the compositions may comprise, consist essentially of, or consist of basic amino acids and/or salts thereof.

 In various embodiments, the total amount of amino acids may range from about 0.1% to about 15%, such as about 0.1% to about 12%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about
25 0.1% to about 6%, about 0.1% to about 5.5%, about 0.1% to about 5%, about 0.1% to about 4.5%, about 0.1% to about 4%, about 0.1% to about 3.5%, about 0.1% to about 3%, about 0.1% to about 2.5%, about 0.1% to about 2%, about 0.1% to about 1.5%, about 0.1% to about 1%, about 0.5% to about 15%, about 0.5% to about 12%, about 0.5% to about 10%, about 0.5% to about 9%, about 0.5% to about 8%, about 0.5% to
30 about 7%, about 0.5% to about 6%, about 0.5% to about 5.5%, about 0.5% to about 5%, about 0.5% to about 4.5%, about 0.5% to about 4%, about 0.5% to about 3.5%, about 0.5% to about 3%, about 0.5% to about 2.5%, about 0.5% to about 2%, about 0.5% to about 1.5%, about 0.5% to about 1%, about 1% to about 15%, about 1% to about 12%, about 1% to about 10%, about 1% to about 9%, about 1% to about 8%,

about 1% to about 7%, about 1% to about 6%, about 1% to about 5.5%, about 1% to about 5%, about 1% to about 4.5%, about 1% to about 4%, about 1% to about 3.5%, about 1% to about 3%, about 1% to about 2.5%, about 1% to about 2%, about 1% to about 1.5%, about 1.5% to about 15%, about 1.5% to about 12%, about 1.5% to about 10%, about 1.5% to about 9%, about 1.5% to about 8%, about 1.5% to about 7%, about 1.5% to about 6%, about 1.5% to about 5.5%, about 1.5% to about 5%, about 1.5% to about 4.5%, about 1.5% to about 4%, about 1.5% to about 3.5%, about 1.5% to about 3%, about 1.5% to about 2.5%, about 1.5% to about 2%, about 2% to about 15%, about 2% to about 12%, about 2% to about 10%, about 2% to about 9%, about 2% to about 8%, about 2% to about 7%, about 2% to about 6%, about 2% to about 5.5%, about 2% to about 5%, about 2% to about 4.5%, about 2% to about 4%, about 2% to about 3.5%, about 2% to about 3%, about 2% to about 2.5%, about 2.5% to about 15%, about 2.5% to about 12%, about 2.5% to about 10%, about 2.5% to about 9%, about 2.5% to about 8%, about 2.5% to about 7%, about 2.5% to about 6%, about 2.5% to about 5.5%, about 2.5% to about 5%, about 2.5% to about 4.5%, about 2.5% to about 4%, about 2.5% to about 3.5%, about 2.5% to about 3%, about 3% to about 15%, about 3% to about 12%, about 3% to about 10%, about 3% to about 9%, about 3% to about 8%, about 3% to about 7%, about 3% to about 6%, about 3% to about 5.5%, about 3% to about 5%, about 3% to about 4.5%, about 3% to about 4%, about 3% to about 3.5%, about 3.5% to about 15%, about 3.5% to about 12%, about 3.5% to about 10%, about 3.5% to about 9%, about 3.5% to about 8%, about 3.5% to about 7%, about 3.5% to about 6%, about 3.5% to about 5.5%, about 3.5% to about 5%, about 3.5% to about 4.5%, about 3.5% to about 4%, about 4% to about 15%, about 4% to about 12%, about 4% to about 10%, about 4% to about 9%, about 4% to about 8%, about 4% to about 7%, about 4% to about 6%, about 4% to about 5.5%, about 4% to about 5%, about 4% to about 4.5%, about 4.5% to about 15%, about 4.5% to about 12%, about 4.5% to about 10%, about 4.5% to about 9%, about 4.5% to about 8%, about 4.5% to about 7%, about 4.5% to about 6%, about 4.5% to about 5.5%, or about 4.5% to about 5% by weight, relative to the total weight of the composition. In preferred embodiments, the total amount of amino acids ranges from about 2.5% to about 7.5%, about 3% to about 7%, about 3.5% to about 6.5%, about 3.75% to about 6.25%, about 4% to about 6%, about 4.25% to about 5.75%, about 4.5% to about 5.5%, about 4.75% to about 5.25%, or about 4.8% to about 5.2% by weight, relative to the total weight of the composition. For example, the total amount of amino acids may be about 4.5%, about

4.6%, about 4.7%, about 4.8%, about 4.9%, about 5.0%, about 5.1%, about 5.2%, about 5.3%, about 5.4%, or about 5.5% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits. In some preferred embodiments, the compositions comprise a total amount of basic amino acids in any of the foregoing ranges and amounts.

In one preferred embodiment, the treatment compositions comprise arginine and/or a salt thereof. In another preferred embodiment, where more than one amino acid is present, arginine is present in the composition in an amount greater than the combined amounts of the other amino acid(s) present, for example arginine comprises greater than about 50%, such as greater than about 60%, greater than about 70%, greater than about 80%, greater than about 90%, greater than about 95%, greater than about 98%, or greater than about 99% of all amino acids present in the composition. In a further preferred embodiment, arginine is the only the basic amino acid in the composition.

In various preferred embodiments, the treatment composition comprises arginine in an amount ranging from about 1% to about 10%, such as from about 2.5% to about 7.5%, preferably from about 3% to about 7%, more preferably from about 3.5% to about 6.5%, more preferably from about 3.75% to about 6.25%, more preferably from about 4% to about 6%, more preferably from about 4.25% to about 5.75%, more preferably still from about 4.5% to about 5.5%, yet more preferably from about 4.75% to about 5.25%, and most preferably from about 4.8% to about 5.2%, or may be present in an amount of about 4.5%, about 4.6%, about 4.7%, about 4.8%, about 4.9%, about 5.0%, about 5.1%, about 5.2%, about 5.3%, about 5.4%, or about 5.5% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits.

In another preferred embodiment, treatment compositions that can be used in methods according to the disclosure comprise serine and/or a salt thereof. If present, the amount of serine may range from about 0.01% to about 2%, such as from about 0.01% to about 1.5%, about 0.01% to about 1%, about 0.01% to about 0.5%, about 0.01% to about 0.4%, about 0.01% to about 0.3%, about 0.01% to about 0.2%, about 0.01% to about 0.1%, about 0.05% to about 2%, about 0.05% to about 1.5%, about 0.05% to about 1%, about 0.05% to about 0.5%, about 0.05% to about 0.4%, about 0.05% to about 0.3%, about 0.05% to about 0.2%, about 0.05% to about 0.1%, about 0.1% to about 2%, about 0.1% to about 1.5%, about 0.1% to about 1%, or about

0.1% to about 0.5% by weight, relative to the total weight of the composition. For example, in some preferred embodiments, the compositions may comprise serine in an amount ranging from about 0.05% to about 1.5%, preferably from about 0.1% to about 1%, more preferably from about 0.25% to about 0.75%, and most preferably from about 0.4% to about 0.6%, such as about 0.1%, about 0.25%, about 0.5%, about 0.75%, or about 1% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits.

In some embodiments, it may be advantageous to choose at least one basic amino acid and at least one additional amino acid chosen from acidic and/or neutral amino acids. For example, in preferred embodiments it may be advantageous to include at least one basic amino acid and serine in compositions that can be used in methods according to the disclosure, and to choose total amounts of basic amino acids and serine such that the composition has a weight ratio of the total amount of basic amino acids to the total amount of serine that is greater than about 2, such as greater than about 3, greater than about 4, greater than about 5, or greater than about 6. For example, the composition may have a weight ratio of the total amount of basic amino acids to the total amount of serine ranging from about 2 to about 15, such as from about 4 to about 14, from about 6 to about 13, from about 8 to about 12, or from about 9 to about 11. In further examples, the weight ratio of the total amount of basic amino acids to serine may be about 8, about 9, about 10, about 11, or about 12. In some preferred embodiments, the composition comprises serine and has a weight ratio of the total amount of basic amino acids to serine ranging from about 2 to about 15, preferably from about 8 to about 12, more preferably from about 9 to about 11, or is about 8, about 9, about 10, about 11, or about 12, including all ranges and subranges using any of the foregoing as upper and lower limits.

In still further preferred embodiments, the treatment compositions comprise serine and arginine, and have a weight ratio of arginine to serine ranging from about 2 to about 15, preferably from about 8 to about 12, more preferably from about 9 to about 11, or is about 8, about 9, about 10, about 11, or about 12, including all ranges and subranges using any of the foregoing as upper and lower limits.

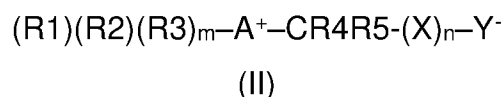
Osmolytes

Osmolytes are molecules, typically of lower molecular weight, used by cells to maintain cell volume, regulate osmotic pressure, and maintain cellular homeostasis, for example in response to environmental stressors. Organic osmolytes

include amino carboxylic acids, amino sulfonic acids, salts thereof, and derivatives thereof, carbohydrates such as sugars and sugar alcohols (polyols), polyamines, betaines, methylsulfonium compounds (e.g. dimethylsulfonopropionate), and urea. For purposes of this disclosure, "osmolytes" includes derivatives of amino carboxylic acids, derivatives of amino sulfonic acids, and salts of the derivatives (referred to herein collectively as "amino acid derivatives"), but does not include amino carboxylic acids, amino sulfonic acids, or salts thereof which are described above, and does not include polyols.

Compositions that can be used in methods according to the disclosure comprise one or more osmolytes, preferably one or more organic osmolytes. In some embodiments, the treatment compositions comprise more than one osmolyte. Without intending to be bound by theory, it is believed that the use of osmolytes in combination with amino acids according to the disclosure limits uptake of minerals into hair fibers, and/or removes minerals from hair fibers, with the osmolytes and amino acids working together in the hair fibers to prevent the uptake of and/or eliminate the presence of such minerals.

In preferred embodiments, useful osmolytes are chosen from carbohydrate sugars, polyamines, amino acid derivatives such as betaines, and more preferably are chosen from compounds of formula (II) or salts thereof:



wherein:

- R1, R2, and R3 are independently chosen from C1-C4 alkyl groups, preferably C1-C2 alkyl groups, more preferably methyl;

- A is N or S;

- m and n are independently 0 or 1;

- X is a divalent alkyl group (= an alkylene group), linear or branched, saturated or unsaturated, having 1 to 6 carbon atoms, preferably 1 to 4 carbon atoms, optionally substituted by one or more groups chosen from hydroxyl (–OH) or amino (–NH₂); and

- Y[–] is –COO[–] or –OSO₃[–];

with the provisos that:

- when A is S, then m = 0 and R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched, and/or cyclic (including aromatic and polycyclic chains), (C1-C10) hydrocarbon chain,

preferably (C1-C6), more preferably (C1-C4); optionally interrupted by one or more heteroatoms or groups chosen from $-S-$, $-N=$, $-NH-$, or $-C(NH)-$ and/or optionally substituted by one or more groups chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-SH$, $-COOH$, or $-CONH_2$;

- 5 ○ when A is N and $m = 0$, R4 represents a hydrogen atom or a saturated, linear or branched (C1-C8)alkyl, preferably (C1-C4)alkyl, group; and R5 forms, with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 to 6 ring members, it being possible for this ring to be substituted by one or more groups chosen from hydroxyl or (C1-C4)alkyl; and
- 10 ○ when A is N and $m = 1$, then R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched and/or cyclic (including aromatic and polycyclic chains) (C1-C10) hydrocarbon chain, preferably (C1-C6), more preferably (C1-C4); optionally interrupted by one or more heteroatoms or groups chosen from $-S-$, $-N=$, $-NH-$, or $-C(NH)-$ and/or
- 15 optionally substituted by one or more groups chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-SH$, $-COOH$, or $-CONH_2$.

Useful and non-limiting polyamine compounds may comprise primary and/or secondary and/or tertiary and/or quaternary amine functional groups. By way of example, polyamines that can be chosen include diamines, triamines,

20 tetramines, pentamines, and polymeric polyamines or polyimines, such as, for example, hexamethylenediamine, diethylenetetramine, diethylenetriamine, polyethyleneimine (PEI), polyvinyl amine, polyether amine, polylysine, ethylene diamine, 1,3-diaminopropane, cadaverine, spermidine, spermine, putrescine, tetraethylmethylenediamine, triethylenetetramine, or combinations of two or

25 more thereof. In some embodiments, useful polyamines are chosen from putrescine, spermidine, and/or spermine.

Useful and nonlimiting examples of betaines include glycine betaine, valine betaine, alanine betaine, proline betaine, hydroxyproline betaine, etc. Salts of betaines can also be used and are expressly included in the term "betaine"

30 unless expressly stated otherwise. In particularly preferred embodiments, betaines are chosen from those corresponding to formula (II). Exemplary useful compounds of formula (II) include the compounds shown in FIGS. 5A-5B. As shown in FIG. 5A, in some embodiments the compounds of formula (II) are in zwitterionic form, and as shown in FIG. 5B, in some embodiments the

compounds of formula (II) have a corresponding counterion, X^- . The counterion is not limited, and can be any suitable counterion, for example a chloride ion, bromide ion, iodide ion, sulfate anion, sulfonate anion, methyl sulfate anion, phosphate anion, nitrate anion, etc. Thus, as used herein a “compound of formula (II)” expressly includes both the ionic form of the compound as well as salt forms, whether or not so stated.

As shown in FIGS. 5A-5B, exemplary useful compounds of formula (II) include betaine and betaine derivatives (referred to herein as “betaines”), for example valine betaine, glutamic acid betaine, glutamine betaine, trimethyl lysine, glycine betaine (trimethyl glycine), histidine betaine, N-methyl histidine betaine, alanine betaine, beta-alanine betaine, choline sulfate, pipecolic acid betaine, proline betaine, hydroxyproline betaine, tyrosine betaine, phenylalanine betaine, tryptophan betaine, leucine betaine, isoleucine betaine, and/or dimethylsulfoniopropionate. In a preferred embodiment, the osmolyte is glycine betaine (trimethyl glycine), alone or in combination with one or more additional osmolytes, for example one or more additional compounds of formula (II).

In some preferred embodiments, treatment compositions according to the disclosure comprise at least one compound of formula (II). In additional preferred embodiments, compositions according to the disclosure comprise one or more compounds of formula (II) that is a zwitterionic amino acid derivative bearing a quaternary ammonium group and comprising in total from 1 to 12 carbon atoms, such as from 2 to 10 carbon atoms, or from 3 to 8 carbon atoms.

In some preferred embodiments, compositions according to the disclosure comprise at least one compound of formula (II) wherein $R_1 = R_2 = \text{methyl}$; A is N; and/or Y is COO^- . In some other preferred embodiments, compositions according to the disclosure comprise at least one compound of formula (II) wherein R_3 is methyl. In other preferred embodiments, compositions according to the disclosure comprise at least one compound of formula (II) wherein X is a divalent alkyl group, linear or branched, preferably saturated, having from 1 to 6 carbon atoms, preferably 1 to 4 carbon atoms, optionally substituted by one group chosen from hydroxyl or amino. In still other preferred embodiments, compositions according to the disclosure comprise at least one compound of formula (II) wherein X is a divalent alkyl group, linear or branched, preferably saturated, having from 1 to 6 carbon atoms, preferably 1 to 4 carbon atoms, more preferably 1 to 2 carbon atoms (not substituted), such as

methylene or ethylene. In other preferred embodiments, compositions according to the disclosure comprise at least one compound of formula (II) wherein R4 and R5, which may be the same or different, are chosen from a hydrogen atom, a saturated, linear or branched (C1-C10) alkyl group, preferably (C1-C6)alkyl, more preferably (C1-C4) alkyl; a phenyl group; a benzyl group; an alkyl group substituted by a cyclic group (saturated or not, mono or bi-cyclic); a cyclic group (saturated or not, mono or bi-cyclic) substituted by an alkyl group; all these groups being optionally interrupted by one or more heteroatoms or groups chosen from $-S-$, $-N=$, $-NH-$, or $-C(NH)-$ and/or optionally substituted by one or more groups chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-SH$, $-COOH$, $-CONH_2$; more preferably where R4 is hydrogen and/or where R5 is a hydrogen atom or a saturated, linear or branched (C1-C6)alkyl, more preferably (C1-C4) alkyl; optionally substituted by one group chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-COOH$, or $-CONH_2$. In some preferred embodiments, when A is N and $m = 0$, R5 forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 to 6 ring members, optionally substituted by one hydroxy group. In further preferred embodiments, $R1 = R2 = methyl$, A is N, Y is $COO-$, and X (if present) is a divalent alkyl group that may be linear or branched, saturated or unsaturated, having from 1 to 6 carbon atoms, preferably from 1 to 4 carbon atoms, more preferably from 1 to 2 carbon atoms.

In one preferred embodiment, the treatment composition comprises at least one compound of formula (II) wherein $R1 = R2 = R3 = methyl$; A is N; Y is $COO-$; X is a divalent alkyl group, linear or branched, preferably saturated, having from 1 to 4 carbon atoms, optionally substituted by one group chosen from hydroxyl or amino, more preferably 1 to 2 carbon atoms (not substituted), such as methylene or ethylene; R4 is hydrogen; and R5 forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 to 6 ring members, optionally substituted by one hydroxy group.

In preferred embodiments, the osmolyte in the composition comprises, consists essentially of, or consists of one or more of the compounds shown in FIGS. 5A-5B. In more preferred embodiments, compositions according to the disclosure comprise trimethyl glycine (referred to interchangeably as glycine betaine), optionally in combination with at least one additional osmolyte, and in particularly preferred embodiments the osmolyte in the composition comprises, consists essentially of, or

consists of glycine betaine optionally with at least one additional compound of formula (II).

Useful and non-limiting examples of carbohydrate sugars that can be used include C3-C6 monosaccharides, for example pentoses and/or derivatives thereof, or hexoses and/or derivatives thereof. For example, the sugars may optionally be chosen from xylose, arabinose, ribose, 2-deoxy-ribose, ribulose, deoxy-ribulose, arabinose, xylulose, allose, altrose, glucose (including dextrose), glucosamine, mannose, gulose, idose, galactose, talose, sorbose, psicose, fructose, tagatose, or combinations of two or more thereof. In at least some embodiments, the sugars are chosen from disaccharides, for example sucrose (also saccharose), maltose, lactose, cellobiose, trehalose, dextran, or from polysaccharides, for example maltotriose, starch, dextrans, cellulose, glycogen, or combinations of two or more thereof. In some embodiments, the sugars are preferably chosen from trehalose, glucose, sucrose, fructose, fructans, or combinations of two or more thereof.

In various embodiments, the total amount of osmolytes present in the composition may range from about 0.01% to about 15%, such as, for example, from about 0.1% to about 10%, from about 0.1% to about 9%, from about 0.1% to about 8%, from about 0.1% to about 7%, from about 0.1% to about 6%, from about 0.1% to about 5%, from about 0.1% to about 4%, from about 0.1% to about 3%, from about 0.1% to about 2%, from about 0.1% to about 1%, from about 0.5% to about 10%, from about 0.5% to about 9%, from about 0.5% to about 8%, from about 0.5% to about 7%, from about 0.5% to about 6%, from about 0.5% to about 5%, from about 0.5% to about 4%, from about 0.5% to about 3%, from about 0.5% to about 2%, from about 0.5% to about 1%, from about 1% to about 10%, from about 1% to about 9%, from about 1% to about 8%, from about 1% to about 7%, from about 1% to about 6%, from about 1% to about 5%, from about 1% to about 4%, from about 1% to about 3%, from about 1% to about 2%, from about 1.5% to about 10%, from about 1.5% to about 9%, from about 1.5% to about 8%, from about 1.5% to about 7%, from about 1.5% to about 6%, from about 1.5% to about 5%, from about 1.5% to about 4%, from about 1.5% to about 3%, from about 1.5% to about 2%, from about 2% to about 10%, from about 2% to about 9%, from about 2% to about 8%, from about 2% to about 7%, from about 2% to about 6%, from about 2% to about 5%, from about 2% to about 4%, from about 2% to about 3%, from about 2.25% to about 10%, from about 2.25% to about 9%, from about 2.25% to about 8%, from about 2.25% to about 7%, from about 2.25% to about 6%, from

about 2.25% to about 5%, from about 2.25% to about 4%, from about 2.25% to about 3%, from about 2.5% to about 10%, from about 2.5% to about 9%, from about 2.5% to about 8%, from about 2.5% to about 7%, from about 2.5% to about 6%, from about 2.5% to about 5%, from about 2.5% to about 4%, from about 2.5% to about 3% by weight, relative to the total weight of the composition. For example, the total amount of osmolytes present in the composition may be about 2.0%, about 2.1%, about 2.2%, about 2.3%, about 2.4%, about 2.5%, about 2.6%, about 2.7%, about 2.8%, about 2.9%, or about 3.0% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits.

In preferred embodiments, the treatment compositions comprise at least one betaine, and the total amount of betaines ranges from about 0.5% to about 5%, for example from about 1% to about 5%, preferably from about 1.25% to about 4%, more preferably from about 1.5% to about 3.5%, more preferably from about 2% to about 3% or from about 2% to about 2.5%, more preferably still from about 2.25% to about 2.75%, and most preferably from about 2.3% to about 2.6%, or may be about 2.0%, about 2.1%, about 2.2%, about 2.3%, about 2.4%, about 2.5%, about 2.6%, about 2.7%, about 2.8%, about 2.9%, or about 3.0% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits.

In a particularly preferred embodiment, the treatment composition comprises glycine betaine in an amount ranging from about 0.5% to about 5%, for example about 1% to about 5%, preferably from about 1.25% to about 4%, more preferably from about 1.5% to about 3.5%, more preferably from about 2% to about 3% or from about 2% to about 2.5%, more preferably still from about 2.25% to about 2.75%, and most preferably from about 2.3% to about 2.6%, or the glycine betaine may be present in an amount of about 2.0%, about 2.1%, about 2.2%, about 2.3%, about 2.4%, about 2.5%, about 2.6%, about 2.7%, about 2.8%, about 2.9%, or about 3.0% by weight, relative to the total weight of the composition, including all ranges and subranges using any of the foregoing as upper and lower limits.

It may be advantageous, in some embodiments, to choose amounts of amino acids and osmolytes to provide a weight ratio of the total amount of amino acid(s) and salts thereof in the composition to the total amount of osmolytes in the composition that is greater than about 0.1, for example greater than about 0.2, greater than about 0.5, greater than about 1, greater than about 1.25, greater than about 1.5,

greater than about 1.75, or greater than about 2. In various embodiments, the weight ratio of the total amount of amino acid(s) and salts thereof to the total amount of osmolytes may range from about 0.1 to about 10, such as from about 0.2 to about 8, from about 0.5 to about 6, from about 1 to about 5, from about 1.2 to about 4, or from about 1.5 to about 3.5. In other embodiments, the weight ratio of the total amount of amino acid(s) and salts thereof to the total amount of osmolytes may range from greater than 1 to about 4, such as from about 1.25 to about 3.5, from about 1.5 to about 3, from about 1.75 to about 2.5, from about 1.75 to about 2.25, or from about 1.8 to about 2.2. For example, the weight ratio of the total amount of amino acid(s) in the composition to the total amount of osmolytes in the composition may be about 1.1, about 1.2, about 1.3, about 1.4, about 1.5, about 1.6, about 1.7, about 1.8, about 1.9, about 2, about 2.1, about 2.2, about 2.3, about 2.4, or about 2.5, including all ranges and subranges using any of the foregoing as upper and lower limits.

In some embodiments, the compositions comprise a total amount of amino acids chosen from compounds of formula (I), and a total amount of osmolytes chosen from compounds of formula (II) such that a weight ratio of compounds of formula (I):compounds of formula (II) is greater than about 0.5, greater than about 0.75, or greater than about 1, for example greater than about 1.25, greater than about 1.5, greater than about 1.75, or greater than about 2. In some embodiments, the weight ratio of compounds of formula (I):compounds of formula (II) in the composition may range from about 0.5 to about 6, for example from about 1 to about 4, from about 1.25 to about 3.5, from about 1.5 to about 3, from about 1.75 to about 2.5, from about 1.75 to about 2.25, or from about 1.8 to about 2.2. For example, the weight ratio of compounds of formula (I):compounds of formula (II) in the composition may be about 0.5, about 0.6, about 0.7, about 0.8, about 0.9, about 1, about 1.1, about 1.2, about 1.3, about 1.4, about 1.5, about 1.6, about 1.7, about 1.8, about 1.9, about 2, about 2.1, about 2.2, about 2.3, about 2.4, or about 2.5, including all ranges and subranges using any of the foregoing as upper and lower limits.

In a particularly preferred embodiment, the treatment composition comprises arginine and glycine betaine and has a weight ratio of arginine to glycine betaine of greater than 1, for example greater than about 1.25, greater than about 1.5, greater than about 1.75, or greater than about 2, for example ranging from greater than 1 to about 4, preferably from about 1.5 to about 3, more preferably from about 1.75 to about 2.5, and most preferably from about 1.75 to about 2.25. In another particularly

preferred embodiment, the composition comprises arginine, serine, and glycine betaine and has a weight ratio of the total amount of [arginine + serine] to glycine betaine of greater than 1, for example greater than about 1.25, greater than about 1.5, greater than about 1.75, or greater than about 2, for example ranging from greater than 1 to about 4, preferably from about 1.5 to about 3, more preferably from about 1.75 to about 2.5, and most preferably from about 1.75 to about 2.25.

Carboxylic Acids

Compositions that can be used in methods according to the disclosure include at least one carboxylic acid. Optionally, the compositions may comprise at least two carboxylic acids, at least three carboxylic acids, etc. According to various embodiments of the disclosure, useful carboxylic acids include organic compounds that include, for example, one (mono-), two (di-), three (tri-), or more acid functional groups and at least one carbon atom.

Carboxylic acids that can be used may optionally have a molecular weight of less than about 500 g/mol, less than about 400 g/mol, less than about 300 g/mol, or less than about 200 g/mol. In preferred embodiments, the carboxylic acids have a molecular weight of less than about 300 g/mol, or less than about 200 g/mol.

Salts of carboxylic acids can also be used and are expressly included in the term "carboxylic acid" unless expressly stated otherwise. The salts include salts with organic or mineral bases, for example the salts of alkali metals, such as the lithium, sodium, or potassium salts; the salts of alkaline earth metals, such as the magnesium or calcium salts, and the zinc salts. The alkali metal or alkaline earth metal salts are preferred in some embodiments, and in particular the sodium salts.

In preferred embodiments, carboxylic acids comprise from 2 to 20 carbon atoms, such as from 2 to 18 carbon atoms, from 3 to 16 carbon atoms, or from 3 to 14 carbon atoms. In some preferred embodiments, the compositions comprise one or more hydroxylated (poly)carboxylic acids comprising from 2 to 10 carbon atoms, such as from 2 to 8 carbon atoms, or from 3 to 6 carbon atoms, and may be saturated or unsaturated, and linear or branched, and/or a salt thereof. These (poly)acids are different from the compounds of amino acids type described above. Useful (poly)acids comprise at least one -COOH group (in acid or salified form); they can thus comprise a single -COOH group (monoacid) or can comprise more than one, for example two -COOH groups (in acid or salified form), or two or three -COOH groups (in acid or salified form) (polyacids). Useful (poly)acids also comprise at least one -OH group,

such as from one to three or from two to three –OH groups, for example one, two, or three –OH groups. Preferably, the (poly)acids comprise in total from 2 to 8 or from 3 to 6 carbon atoms, and from two to three –OH groups, and their hydrocarbon chain is saturated or unsaturated, linear or branched, and preferably saturated and linear. In some preferred embodiments, the hydroxylated (poly)carboxylic acids and/or their salts comprise in total from 3 to 6 carbon atoms, from one to three -OH groups, and from two to three –COOH groups (in acid or salified form). Unless stated otherwise, as used herein the term “(poly)acid” includes both monoacids and polyacids.

Non-limiting examples of monocarboxylic acids that can be chosen include formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, enanthic acid, caprylic acid, lactic acid, salts thereof, or combinations of two or more thereof. In some embodiments, the carboxylic acid may comprise, consist essentially of, or consist of lactic acid and/or a salt thereof.

Non-limiting examples of dicarboxylic acids that can be chosen include oxalic acid, malonic acid, malic acid, glutaric acid, citraconic acid, succinic acid, adipic acid, tartaric acid, fumaric acid, maleic acid, salts thereof, or combinations of two or more thereof. In some embodiments, the compositions may include oxalic acid, malonic acid, malic acid, maleic acid, salts thereof, or combinations of two or more thereof.

Non-limiting examples of tricarboxylic acids include citric acid, isocitric acid, aconitic acid, propane-1,2,3-tricarboxylic acid, salts thereof, or combinations of two or more thereof. In some embodiments, the carboxylic acid may comprise, consist essentially of, or consist of citric acid and/or a salt thereof.

In some embodiments, the carboxylic acid(s) may be chosen from oxalic acid, malonic acid, glutaric acid, succinic acid, adipic acid, glycolic acid, citric acid, tartaric acid, malic acid, maleic acid, lactic acid, salts thereof, or combinations of two or more thereof. In particularly preferred embodiments, the carboxylic acids are chosen from α -hydroxy acids and their salts, and in particular from lactic acid, glycolic acid, tartaric acid, or citric acid, and their salts, in particular alkali metal or alkaline earth metal salts. It may in some embodiments be particularly advantageous to choose citric acid, lactic acid, and/or tartaric acid and/or their salts, in particular alkali metal or alkaline earth metal salts, such as sodium citrate and/or sodium tartrate; preferably citric acid and/or its salts, in particular alkali metal or alkaline earth metal salts, such as sodium citrate.

The total amount of carboxylic acid(s) may range from about 0.5% to about 20% by weight, relative to the total weight of the composition. For example, in some embodiments, the total amount of carboxylic acids ranges from about 1% to about 15%, such as about 1% to about 12%, about 1% to about 10%, about 1% to about 9%, about 1% to about 8%, about 1% to about 7%, about 1% to about 6%, about 1% to about 5.5%, about 1% to about 5%, about 1% to about 4.5%, about 1% to about 4%, about 1% to about 3.5%, about 1% to about 3%, about 1% to about 2.5%, about 1% to about 2%, about 1% to about 1.5%, about 1.5% to about 15%, about 1.5% to about 12%, about 1.5% to about 10%, about 1.5% to about 9%, about 1.5% to about 8%, about 1.5% to about 7%, about 1.5% to about 6%, about 1.5% to about 5.5%, about 1.5% to about 5%, about 1.5% to about 4.5%, about 1.5% to about 4%, about 1.5% to about 3.5%, about 1.5% to about 3%, about 1.5% to about 2.5%, about 1.5% to about 2%, about 2% to about 15%, about 2% to about 12%, about 2% to about 10%, about 2% to about 9%, about 2% to about 8%, about 2% to about 7%, about 2% to about 6%, about 2% to about 5.5%, about 2% to about 5%, about 2% to about 4.5%, about 2% to about 4%, about 2% to about 3.5%, about 2% to about 3%, about 2% to about 2.5%, about 2.5% to about 15%, about 2.5% to about 12%, about 2.5% to about 10%, about 2.5% to about 9%, about 2.5% to about 8%, about 2.5% to about 7%, about 2.5% to about 6%, about 2.5% to about 5.5%, about 2.5% to about 5%, about 2.5% to about 4.5%, about 2.5% to about 4%, about 2.5% to about 3.5%, about 2.5% to about 3%, about 3% to about 15%, about 3% to about 12%, about 3% to about 10%, about 3% to about 9%, about 3% to about 8%, about 3% to about 7%, about 3% to about 6%, about 3% to about 5.5%, about 3% to about 5%, about 3% to about 4.5%, about 3% to about 4%, about 3% to about 3.5%, about 3.5% to about 15%, about 3.5% to about 12%, about 3.5% to about 10%, about 3.5% to about 9%, about 3.5% to about 8%, about 3.5% to about 7%, about 3.5% to about 6%, about 3.5% to about 5.5%, about 3.5% to about 5%, about 3.5% to about 4.5%, about 3.5% to about 4%, about 4% to about 15%, about 4% to about 12%, about 4% to about 10%, about 4% to about 9%, about 4% to about 8%, about 4% to about 7%, about 4% to about 6%, about 4% to about 5.5%, about 4% to about 5%, about 4% to about 4.5%, about 4.5% to about 15%, about 4.5% to about 12%, about 4.5% to about 10%, about 4.5% to about 9%, about 4.5% to about 8%, about 4.5% to about 7%, about 4.5% to about 6%, about 4.5% to about 5.5%, about 4.5% to about 5%, about 5% to about 15%, about 5% to about 12%, about 5% to about 10%, about 5% to about 9%, about 5% to about 8%,

about 5% to about 7%, about 5% to about 6.5%, about 5% to about 6%, about 5% to about 5.5%, about 5.5% to about 15%, about 5.5% to about 12%, about 5.5% to about 10%, about 5.5% to about 9%, about 5.5% to about 8%, about 5.5% to about 7%, about 5.5% to about 6.5%, about 5.5% to about 6%, about 6% to about 15%, about 6% to about 12%, about 6% to about 10%, about 6% to about 9%, about 6% to about 8%, about 6% to about 7%, or about 6% to about 6.5% by weight, relative to the total weight of the composition.

In preferred embodiments, the total amount of carboxylic acid(s) ranges from about 0.5% to about 20%, such as from about 2% to about 15%, from about 4% to about 10%, about 4.5% to about 8%, about 5% to about 7%, about 5.5% to about 6.5%, about 5.7% to about 6.3%, or about 5.8% to about 6.2% by weight, relative to the total weight of the composition. For example, in some preferred embodiments, the treatment composition comprises at least one carboxylic acid chosen from citric acid, lactic acid, tartaric acid, salts thereof, or combinations thereof, and has a total amount of carboxylic acids and salts ranging from about 0.5% to about 20%, such as from about 2% to about 15%, from about 4% to about 10%, preferably from about 4.5% to about 8%, more preferably from about 5% to about 7%, more preferably from about 5.5% to about 6.5%, more preferably still from about 5.7% to about 6.3%, and most preferably from about 5.8% to about 6.2% by weight, relative to the total weight of the composition.

It may be advantageous in some embodiments to choose amounts of amino acids and carboxylic acids such that the composition has a weight ratio of the total amount of amino acids to the total amount of carboxylic acids of greater than about 0.75. For example, in various embodiments, the composition has a weight ratio of the total amount of amino acids to the total amount of carboxylic acids of greater than about 0.8, such as greater than about 0.9, greater than about 1, greater than about 1.1, greater than about 1.2, greater than about 1.3, greater than about 1.4, or greater than about 1.5. In some embodiments, the composition has a weight ratio of the total amount of amino acids to the total amount of carboxylic acids ranging from about 0.75 to about 2, such as from about 0.8 to about 1.5, from about 0.8 to about 1.35, or from about 0.8 to about 1.2. In some preferred embodiments, the composition comprises arginine and at least one carboxylic acid chosen from citric acid, lactic acid, tartaric acid, salts thereof, or combinations thereof, and has a weight ratio of the total amount of amino acids and salts thereof to the total amount of carboxylic acids and

salts thereof ranging from about 0.75 to about 2, preferably from about 0.8 to about 1.5, more preferably from about 0.8 to about 1.35, and most preferably from about 0.8 to about 1.2.

Solvents

5 Compositions that can be used in methods according to the disclosure comprise at least one solvent. In various embodiments, solvents may be chosen from water, non-aqueous solvents, or a combination thereof.

 In preferred embodiments, the solvent includes water. In certain embodiments, the composition comprises from about 50% to about 98% of water, by
10 weight, relative to the total weight of the composition. In certain embodiments, the composition comprises water in an amount ranging from about 50% to about 95% water by weight, such as from about 50% to about 90%, about 55% to about 90%, about 60% to about 90%, or about 60% to about 80% by weight, relative to the total weight of the composition.

15 In further preferred embodiments, the solvent includes at least one non-aqueous solvent. Exemplary and non-limiting non-aqueous solvents that can be used include, for example, glycerin, C₁₋₄ alcohols, organic solvents, fatty alcohols, fatty ethers, fatty esters, polyols, glycols, vegetable oils, mineral oils, liposomes, laminar lipid materials, or combinations thereof. The non-aqueous solvent may be chosen from
20 organic solvents, for example, monoalcohols and polyols such as ethyl alcohol, isopropyl alcohol, propyl alcohol, benzyl alcohol, and phenylethyl alcohol, or glycols or glycol ethers such as, for example, monomethyl, monoethyl and monobutyl ethers of ethylene glycol, propylene glycol or ethers thereof such as, for example, monomethyl ether of propylene glycol, butylene glycol, hexylene glycol, dipropylene glycol as well
25 as alkyl ethers of diethylene glycol, for example monoethyl ether or monobutyl ether of diethylene glycol.

 Preferably, the treatment compositions comprise at least one polyol. The polyols can be chosen from diols and triols. In other embodiments, the polyols can be chosen from C₂-C₁₆ polyols, such as C₂-C₁₂ polyols, C₂-C₈ polyols, or C₃-C₈
30 polyols. In various embodiments, the polyols that can be used are linear or branched, saturated or unsaturated, and substituted or unsubstituted polyols. Thus, in various embodiments, one or more polyols can be chosen from C₂-C₁₆, C₂-C₁₂, C₂-C₈, or C₃-C₈ diols, or C₂-C₁₆, C₂-C₁₂, C₂-C₈, or C₃-C₈ triols, any of which may be linear or branched, saturated or unsaturated, and substituted or unsubstituted.

By way of non-limiting example, polyols such as isopropyl alcohol, propyl alcohol, benzyl alcohol, and phenylethyl alcohol, or glycols or glycol ethers such as, for example, monomethyl, monoethyl, and monobutyl ethers of ethylene glycol, propylene glycol or ethers thereof such as, for example, monomethyl ether of propylene glycol, butylene glycol, hexylene glycol, dipropylene glycol as well as alkyl ethers of diethylene glycol, for example monoethyl ether or monobutyl ether of diethylene glycol may be chosen. In some embodiments, the polyols are chosen from propanediol, butanediol, pentanediol, hexanediol, heptanediol, octanediol, 1,2,6-hexanetriol, 1,2,4-butanetriol, trimethylolpropane, 2-butene-1,4-diol, 2-ethyl-1,3-hexanediol, 2-methyl-2,4-pentanediol, caprylyl glycol, 1,2-hexanediol, 1,2-pentanediol, 2-ethyl-2-methyl-1,3-propanediol, 3,3-dimethyl-1,2-butanediol, 2,2-diethyl-1,3-propanediol, 2-methyl-2-propyl-1,3-propanediol, 2,4-dimethyl-2,4-pentanediol, 2,5-dimethyl-2,5-hexanediol, 5-hexene-1,2-diol, 2-ethyl-1,3-hexanediol, 4-methyl-1,2-pentanediol, or combinations of two or more thereof. In some preferred embodiments, the polyols are chosen from glycols such as ethylene glycol, propylene glycol, butylene glycol, hexylene glycol, pentylene glycol, 1,3-propanediol, diethylene glycol, triethylene glycol, tetraethylene glycol, pentaethylene glycol, dipropylene glycol, caprylyl glycol, glycerin, diglycerin, and combinations of two or more thereof. In a particularly preferred embodiment, the solvent comprises at least one polyol chosen from propylene glycol, dipropylene glycol, tripropylene glycol, propanediol, propylene carbonate, PPG-3 methyl ether, dimethyl isosorbide, hexylene glycol, ethanol, glycerin, or combinations of two or more thereof. In at least certain preferred embodiments, the solvent comprises water and at least one polyol, wherein the polyol(s) comprises, consists essentially of, or consists of one or more C2-C16 diols and/or C2-C16 triols, for example C2-C8 diols and/or C2-C8 triols. In other preferred embodiments, the solvent comprises water and at least one polyol, wherein the polyol(s) comprises, consists essentially of, or consists of one or more glycols, for example propylene glycol and/or dipropylene glycol, and in particularly preferred embodiments, the solvent comprises water and at least one polyol, wherein the polyol(s) comprises, consists essentially of, or consists of dipropylene glycol.

If present, the total amount of the non-aqueous solvents in the composition may range from about 0.1% to about 20%, such as from about 1% to about 20%, from about 1.5% to about 15%, or from about 2% to about 12% by weight, relative to the total weight of the composition. In some preferred embodiments, the

solvent comprises water and at least one non-aqueous solvent, preferably chosen from polyols. In some embodiments, the composition comprises water and at least one non-aqueous solvent, wherein the total amount of non-aqueous solvents ranges from about 0.5% to about 18%, preferably from about 1% to about 15%, more preferably from about 1.5% to about 12%, more preferably still from about 2% to about 11%, and most preferably from about 3% to about 10% by weight, relative to the total weight of the composition, and optionally further wherein the non-aqueous solvent comprises at least one solvent chosen from propylene glycol, dipropylene glycol, tripropylene glycol, propanediol, propylene carbonate, PPG-3 methyl ether, dimethyl isosorbide, hexylene glycol, ethanol, or mixtures of two or more thereof, preferably chosen from propylene glycol, dipropylene glycol, or a mixture of two or more thereof.

Surfactants

Compositions that can be used in methods according to the disclosure may optionally comprise at least one surfactant. For example, the compositions may comprise one or more cationic surfactants and/or amphoteric surfactants, and in some embodiments the compositions may comprise mixtures of surfactants having the same or different ionicities.

Although the compositions may optionally include one or more anionic surfactants and/or nonionic surfactants, in at least some embodiments, the compositions are free or substantially free of anionic surfactants and/or nonionic surfactants. For example, in some embodiments the compositions comprise less than about 3%, such as less than about 2.5%, less than about 2%, less than about 1.75%, less than about 1.5%, less than about 1.25%, less than about 1%, less than about 0.75%, less than about 0.5%, less than about 0.25%, less than about 0.2%, less than about 0.1%, less than about 0.05%, less than about 0.01%, or less than about 0.001% of anionic surfactants and/or nonionic surfactants.

In at least some embodiments, the compositions comprise at least one cationic surfactant. The term "cationic surfactant" means a surfactant that is positively charged when it is contained in the composition(s) according to the disclosure. This surfactant may bear one or more positive permanent charges or may contain one or more functions that are cationizable in the composition according to the disclosure. Non-limiting examples of useful cationic surfactants include brassicamidopropyl dimethylamine, behentrimonium chloride, cetrimonium chloride, behenalkonium chloride, benzethonium chloride, cetylpyridinium chloride, lauralkonium chloride,

5 cetalkonium chloride, cetrimonium bromide, cethylamine hydrofluoride, chlorallylmethenamine chloride (Quaternium-15), distearyldimonium chloride (Quaternium-5), dodecyl dimethyl ethylbenzyl ammonium chloride (Quaternium-14), Quaternium-22, Quaternium-26, Quaternium-18 hectorite, dimethylaminoethylchloride
10 hydrochloride, cysteine hydrochloride, diethanolammonium POE (10) oleyl ether phosphate, diethanolammonium POE (3)oleyl ether phosphate, tallow alkonium chloride, dimethyl dioctadecylammoniumbentonite, stearalkonium chloride, domiphen bromide, denatonium benzoate, myristalkonium chloride, laurtrimonium chloride, ethylenediamine dihydrochloride, guanidine hydrochloride, pyridoxine HCl, iofetamine
15 hydrochloride, meglumine hydrochloride, methylbenzethonium chloride, myrtrimonium bromide, oleyltrimonium chloride, polyquaternium-1, procainehydrochloride, cocobetaine, stearalkonium bentonite, stearalkoniumhectonite, stearyl trihydroxyethyl propylenediamine dihydrofluoride, tallowtrimonium chloride, hexadecyltrimethyl ammonium bromide, stearamidopropyl dimethylamine, or combinations thereof. In
20 preferred embodiments, the compositions comprise at least one cationic surfactant chosen from brassicamidopropyl dimethylamine, behentrimonium chloride, cetrimonium chloride, stearamidopropyl dimethylamine, or combinations of two or more thereof.

If present, the total amount of cationic surfactants may range up to about
20 10%, such as up to about 9%, up to about 8%, up to about 7%, up to about 6%, up to about 5%, up to about 4%, up to about 3.5%, up to about 3%, up to about 2.5%, up to about 2%, up to about 1.5%, up to about 1%, or up to about 0.5% by weight, relative to the total weight of the composition. For example, the total amount of cationic surfactants may range from about 0.001% to about 10%, from about 0.01% to about
25 8%, from about 0.1% to about 6%, or from about 0.5% to about 4% by weight, relative to the total weight of the composition. In at least some preferred embodiments, the compositions comprise at least one cationic surfactant, and have a total amount of cationic surfactants ranging from about 0.25% to about 8%, preferably from about 0.5% to about 7%, more preferably from about 0.75% to about 6%, and most preferably from
30 about 1% to about 5% by weight, relative to the total weight of the composition.

In at least some embodiments, the compositions comprise at least one amphoteric surfactant. Non-limiting examples of useful amphoteric surfactants include derivatives of aliphatic secondary and tertiary amines where the aliphatic radical can be straight or branched chain and one of the aliphatic substituents contains from about

8 to about 18 carbon atoms and one contains an anionic group such as carboxy, sulfonate, sulfate, phosphate, or phosphonate. Exemplary amphoteric surfactants include sodium cocaminopropionate, sodium cocaminodipropionate, sodium cocoamphoacetate, sodium cocoamphohydroxypropylsulfonate, sodium cocoamphopropionate, sodium cornamphopropionate, sodium lauraminopropionate, sodium lauroamphoacetate, sodium lauroamphohydroxypropylsulfonate, sodium lauroamphopropionate, sodium cornamphopropionate, sodium lauriminodipropionate, ammonium cocaminopropionate, ammonium cocaminodipropionate, ammonium cocoamphoacetate, ammonium cocoamphohydroxypropylsulfonate, ammonium cocoamphopropionate, ammonium cornamphopropionate, ammonium lauraminopropionate, ammonium lauroamphoacetate, ammonium lauroamphohydroxypropylsulfonate, ammonium lauroamphopropionate, ammonium cornamphopropionate, ammonium lauriminodipropionate, triethanolamine cocaminopropionate, triethanolamine cocaminodipropionate, triethanolamine cocoamphoacetate, triethanolamine cocoamphohydroxypropylsulfonate, triethanolamine cocoamphopropionate, triethanolamine cornamphopropionate, triethanolamine lauraminopropionate, triethanolamine lauroamphoacetate, triethanolamine lauroamphohydroxypropylsulfonate, triethanolamine lauroamphopropionate, triethanolamine cornamphopropionate, triethanolamine lauriminodipropionate, cocoamphodipropionic acid, disodium caproamphodiacetate, disodium caproamphoadipropionate, disodium capryloamphodiacetate, disodium capryloamphodipropionate, disodium cocoamphocarboxyethylhydroxypropylsulfonate, disodium cocoamphodiacetate, disodium cocoamphodipropionate, disodium dicarboxyethylcocopropylenediamine, disodium laureth-5 carboxyamphodiacetate, disodium lauriminodipropionate, disodium lauroamphodiacetate, disodium lauroamphodipropionate, disodium oleoamphodipropionate, disodium PPG-2-isodecethyl-7 carboxyamphodiacetate, lauraminopropionic acid, lauroamphodipropionic acid, lauryl aminopropylglycine, and lauryl diethylenediaminoglycine.

Betaine surfactants may also be used. For example, coco dimethyl carboxymethyl betaine, lauryl dimethyl carboxymethyl betaine, lauryl dimethyl alphacarboxyethyl betaine, cetyl dimethyl carboxymethyl betaine, cetyl dimethyl betaine, lauryl bis-(2-hydroxyethyl) carboxymethyl betaine, stearyl bis-(2-hydroxypropyl) carboxymethyl betaine, oleyl dimethyl gamma-carboxypropyl betaine,

lauryl bis-(2-hydroxypropyl) alpha-carboxyethyl betaine, coco dimethyl sulfopropyl betaine, stearyl dimethyl sulfopropyl betaine, lauryl dimethyl sulfoethyl betaine, lauryl bis-(2-hydroxyethyl) sulfopropyl betaine, oleyl betaine, or cocamidopropyl betaine may be chosen.

5 If present, the total amount of amphoteric surfactants may range up to about 10%, such as up to about 9%, up to about 8%, up to about 7%, up to about 6%, up to about 5%, up to about 4%, up to about 3.5%, up to about 3%, up to about 2.5%, up to about 2%, up to about 1.5%, up to about 1%, or up to about 0.5% by weight, relative to the total weight of the composition. For example, the total amount of
10 amphoteric surfactants may range from about 0.001% to about 6%, from about 0.01% to about 4%, from about 0.1% to about 3%, or from about 0.5% to about 2% by weight, relative to the total weight of the composition. In at least some embodiments, the compositions are free or substantially free of amphoteric surfactants.

 In some preferred embodiments, the surfactant does not include
15 behentrimonium chloride. In some preferred embodiments, the surfactant comprises, consists essentially of, or consists of one or more alkylamidoamines, for example brassicamidopropyl dimethylamine.

Fatty Compounds

 Optionally, compositions that can be used in methods according to the
20 disclosure may include at least one fatty compound. In certain embodiments, the at least one fatty compound may be chosen from lower alkanes, fatty alcohols, fatty acids, esters of fatty acids, esters of fatty alcohols, oils such as mineral, vegetable, animal, silicone and non-silicone oils, silicone and non-silicone waxes, or combinations of any two or more thereof.

25 In some embodiments, compositions according to the disclosure include at least one fatty compound chosen from volatile and non-volatile silicone oils, which may optionally be amino functionalized. Non-limiting examples of silicone oils that can be used include dimethicone, amodimethicone, cyclomethicone, polysilicone-11, phenyl trimethicone, trimethylsilylamodimethicone, and stearoxytrimethylsilane. For
30 example, the composition may comprise at least one silicone chosen from amodimethicone, PEG-7 Dimethicone, PEG- 8 Dimethicone, PEG-9 Dimethicone, PEG-10 Dimethicone, PEG-12 Dimethicone, PEG-14 Dimethicone, PEG-17 Dimethicone, PEG/PPG-3/10 Dimethicone, PEG/PPG-4/12 Dimethicone, PEG/PPG-17/18 Dimethicone, cetyl PEG/PPG-10/1 dimethicone, Dimethicone PEG-8 Benzoate,

Dimethicone PEG-7 Phosphate, Dimethicone PEG-8 Phosphate, Dimethicone PEG-10 Phosphate, or a mixture of two or more thereof. In some preferred embodiments, the compositions comprise a silicone oil component that comprises, consists essentially of, or consists of dimethicone, amodimethicone, or a mixture thereof.

5 As further examples, the silicone oil may be chosen from polydimethylsiloxanes (PDMSs), polydimethylsiloxanes comprising alkyl or alkoxy groups which are pendent and/or at the end of the silicone chain, which groups each contain from 2 to 24 carbon atoms, or phenyl silicones, such as phenyl trimethicones, phenyl dimethicones, phenyl(trimethylsiloxy)diphenylsiloxanes, diphenyl
10 dimethicones, diphenyl(methyl-diphenyl)trisiloxanes, or (2-phenylethyl)trimethylsiloxysilicates.

In some embodiments, compositions that can be used in methods according to the disclosure include at least one fatty compound chosen from fatty alcohols. In certain embodiments, "fatty alcohol" refers to any alcohol with a carbon
15 chain of C5 or greater, such as, for example, C8 or greater, C10 or greater, or C12 or greater, such as from 6 to 30 carbon atoms or from 8 to 30 carbon atoms. The fatty alcohols may be alkoxyated or non-alkoxyated, saturated or unsaturated, and linear or branched.

By way of example, fatty alcohols may be chosen from arachidyl alcohol, behenyl alcohol, caprylic alcohol, cetearyl alcohol, cetyl alcohol, coconut alcohol, decyl
20 alcohol, hydrogenated tallow alcohol, jojoba alcohol, lauryl alcohol, myristyl alcohol, oleyl alcohol, palm alcohol, palm kernel alcohol, stearyl alcohol, tallow alcohol, tridecyl alcohol, or combinations of two or more thereof. In some preferred embodiments, the compositions comprise a fatty alcohol component that comprises, consists essentially
25 of, or consists of cetyl alcohol, stearyl alcohol, cetearyl alcohol, or mixtures thereof.

Useful and non-limiting fatty acids may be straight or branched chain acids and/or may be saturated or unsaturated. Non-limiting examples of fatty acids include diacids, triacids, and other multiple acids as well as salts of these fatty acids. For example, the fatty acid may optionally include or be chosen from lauric acid,
30 palmitic acid, stearic acid, behenic acid, arichidonic acid, oleic acid, isostearic acid, sebacic acid, or combinations thereof.

In some embodiments, fatty acid esters or fatty alcohol esters may be chosen. For example, esters of saturated or unsaturated, linear or branched C1-C26 aliphatic mono- or polyacids and of saturated or unsaturated, linear or branched C1-

C26 aliphatic mono- or polyalcohols, the total carbon number of the esters more particularly being greater than or equal to 10 may be used. In other embodiments, esters of C4-C22 dicarboxylic or tricarboxylic acids and of C1-C22 alcohols and esters of mono-, di- or tricarboxylic acids and of C2-C26 di-, tri-, tetra-, or pentahydroxy alcohols may also be used. As non-limiting examples, isostearyl lactate, lauryl lactate, linoleyl lactate, oleyl lactate, (iso)stearyl octanoate, isocetyl octanoate, octyl octanoate, cetyl octanoate, decyl oleate, isocetyl isostearate, isocetyl laurate, isocetyl stearate, isodecyl octanoate, isodecyl oleate, isononyl isononanoate, isostearyl palmitate, methyl acetyl ricinoleate, myristyl stearate, octyl isononanoate, 2-ethylhexyl isononanoate, octyl palmitate, octyl pelargonate, octyl stearate, octyldodecyl erucate, oleyl erucate, ethyl and isopropyl palmitates, 2-ethylhexyl palmitate, 2-octyldecyl palmitate, alkyl myristates such as isopropyl, butyl, cetyl, 2-octyldodecyl, myristyl or stearyl myristate, hexyl stearate, butyl stearate, isobutyl stearate, dioctyl malate, hexyl laurate, 2-hexyldecyl laurate, diethyl sebacate, diisopropyl sebacate, diisopropyl adipate, di-n-propyl adipate, dioctyl adipate, diisostearyl adipate, dioctyl maleate, glyceryl undecylenate, octyldodecyl stearyl stearate, pentaerythrityl monoricinoleate, pentaerythrityl tetraisononanoate, pentaerythrityl tetrapelargonate, pentaerythrityl tetraisostearate, pentaerythrityl tetraoctanoate, propylene glycol dicaprylate, propylene glycol dicaprinate, tridecyl erucate, triisopropyl citrate, triisostearyl citrate, glyceryl trilactate, glyceryl trioctanoate, trioctyldodecyl citrate, trioyleyl citrate, propylene glycol dioctanoate, neopentyl glycol diheptanoate, diethylene glycol diisononanoate, and/or polyethylene glycol distearates may be chosen. In a preferred embodiment, the composition comprises at least one fatty acid ester and/or fatty alcohol ester, for example pentaerythrityl tetraisostearate.

In some embodiments, compositions that can be used in methods according to the disclosure comprise at least one wax. Non-limiting examples of waxes that can be used include beeswax, hydrogenated alkyl olive esters, carnauba wax, candelilla wax, ouricoury wax, Japan wax, cork fibre wax or sugar cane wax, rice wax, rice bran wax, montan wax, paraffin wax, lignite wax or microcrystalline wax, ceresin or ozokerite, palm kernel glycerides/hydrogenated palm glycerides, palm butter, sumac wax, citrus aurantium dulcis (orange) peel wax, theobroma grandiflorum seed butter, helianthus annuus (sunflower) seed wax, siliconyl candellila wax, Chinese wax, cetyl palmitate, lanolin, shellac, spermaceti, cetyl esters, hydrogenated castor wax; triglyceride esters such as tribehenin (glyceryl tribehenate); synthetic waxes such as

those of the hydrocarbon type and polyethylene waxes obtained from the polymerization or copolymerization of ethylene, polypropylene waxes, or mixtures of two or more of any of these waxes. In some preferred embodiments, the compositions comprise a wax component that comprises, consists essentially of, or consists of cetyl
5 esters.

In some embodiments, the composition comprises one or more fatty compounds chosen from oils of animal, vegetable, or mineral origin (e.g. lanolin, squalene, fish oil, perhydrosqualene, mink oil, turtle oil, soybean oil, grape seed oil, sesame oil, maize oil, rapeseed oil, sunflower oil, cottonseed oil, avocado oil, olive oil,
10 castor seed oil, jojoba seed oil, peanut oil, sweet almond oil, palm oil, cucumber oil, hazelnut oil, apricot kernel oil, wheat germ oil, calophyllum oil, macadamia oil, coconut oil, cereal germ oil, candlenut oil, thistle oil, candelilla oil, safflower oil, or shea butter), linear or branched hydrocarbons (e.g. polybutene, hydrogenated polyisobutene, polyisoprene, polydecenes such as hydrogenated polydecene, or also linear, branched
15 and/or cyclic alkanes which are optionally volatile, such as, for example, isohexadecane, isododecane, isodecane, or isohexadecane), mono- and/or polyesters of fatty acids and/or of fatty alcohols (e.g. mono- and polyesters of hydroxy acids and of fatty alcohols, esters of benzoic acid and of fatty alcohols, polyesters of polyols, dipentaerythrityl C5-C9 esters, trimethylolpropane polyesters, propylene glycol
20 polyesters, or polyesters of hydrogenated castor oil), perfluorinated and/or organofluorinated oils, fluorosilicone oils, or mixtures of two or more thereof. Non-limiting examples of fatty acids that may be used include optionally branched and/or unsaturated fatty acids such as myristic acid, palmitic acid, stearic acid, behenic acid, oleic acid, linoleic acid, linolenic acid, isostearic acid, or mixtures of two or more
25 thereof.

If present, the total amount of fatty compounds in the composition may range from about 0.1% to about 20%, such as from about 1% to about 20%, from about 2% to about 15%, from about 3% to about 12%, or from about 5% to about 10% by weight, relative to the total weight of the composition. In some preferred embodiments,
30 the compositions comprise at least one fatty compound chosen from silicone oils, fatty alcohols, waxes, or combinations thereof, where the total amount of fatty compounds in the composition ranges from about 1% to about 20%, preferably from about 2% to about 15%, more preferably from about 3% to about 12%, and most preferably from about 5% to about 10% by weight, relative to the total weight of the composition.

Thickening Agents

Compositions that can be used in methods according to the disclosure optionally comprise at least one thickening agent. Useful thickening agents include, but are not limited to, semisynthetic polymers, such as semisynthetic cellulose derivatives, synthetic polymers, such as carbomers, poloxamers, and acrylates/behent-25 methacrylate copolymer, acrylates copolymer, polyethyleneimines (e.g., PEI-10), naturally occurring polymers, such as acacia, tragacanth, alginates (e.g., sodium alginate), carrageenan, vegetable gums, such as xanthan gum, guar gum, petroleum jelly, waxes, particulate associate colloids, such as bentonite, colloidal silicon dioxide, and microcrystalline cellulose, celluloses such as hydroxyethylcellulose and hydroxypropylcellulose, and guar gums such as hydroxypropyl guar.

In some embodiments, the thickening agent may be chosen from associative thickening polymers such as anionic associative polymers, amphoteric associative polymers, cationic associative polymers, or nonionic associative polymers. A non-limiting example of an amphoteric associative polymer is acrylates/behent-25 methacrylate copolymer, and non-limiting examples of anionic associative polymers include acrylates copolymer and acrylates crosspolymer-4.

If present, the total amount of thickening agents may range from about 0.01% to about 8%, such as from about 0.05% to about 5%, from about 0.1% to about 4%, from about 0.2% to about 3%, or from about 0.3% to about 2% by weight, relative to the total weight of the composition.

Auxiliary Components

Compositions that can be used in methods according to the disclosure may optionally include one or more auxiliary components. Non-limiting examples include preservatives, fragrances, pH adjusters, salts, antioxidants, vitamins, vitamin derivatives, ceramides, botanical extracts, proteins, protein hydrolysates, protein isolates, hydrotropes, pearlescent agents, buffers, sequestering agents, and the like.

The total amount of auxiliary components, if present, typically ranges from about 0.01% to about 10% based on the total weight of the composition. For example, in some embodiments the individual amounts of each component or the total amount of components may range from about 0.1% to about 10%, about 0.1% to about 8%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 1% to about 10%, about 1% to about 8%, about 1% to about

5%, about 1% to about 4%, about 1% to about 3%, or about 1% to about 2% by weight, based on the total weight of the composition.

Compositions that can be used in methods to the disclosure typically have a pH of less than or equal to 7, such as less than or equal to about 6, less than or equal to about 5, less than or equal to about 4.5, or less than or equal to about 4. For example, the compositions may have a pH ranging from about 1 to about 7, such as from about 2 to about 6, from about 2.5 to about 5.5, from about 2.5 to about 5, from about 2.5 to about 4.5, or from about 3 to about 4. In some embodiments, the pH of the composition may be, for example, about 3, about 3.25, about 3.5, about 3.75, or about 4, including all ranges and subranges thereof.

The compositions may be in any suitable form. For example, the compositions may be a liquid, a gel, a gel cream, a high-, medium- or low-density cream, a serum, a lotion, etc.

II. METHODS

The disclosure relates to methods of treating hair, for example for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers. Without intending to be bound by theory, it is believed that the compositions described herein work in an entirely different and novel manner compared to known chelating or complexing agents which typically attach themselves to minerals. Surprisingly, hair treated according to the disclosure exhibits increased shine and reduced signs of damage including greater strength and/or decreased elasticity, in particular hair that has been damaged by harsh chemical treatments such as bleaching, dyeing, permanent waving, straightening, relaxing, etc., even when compared to hair treated with other products that are asserted to repair similarly damaged hair.

The methods comprise applying a treatment composition according to the disclosure onto the hair, optionally leaving the composition on the hair for a period of time ("processing time," "resting period," or "leave-in period"), and optionally rinsing the composition from the hair.

The leave-in period may last for a period of time deemed appropriate to allow the active agents to provide benefits to the hair, such as about 30 seconds, about 1 minute, about 2 minutes, about 5 minutes, about 10 minutes, about 15 minutes, about 20 minutes, about 30 minutes, about 45 minutes, about 1 hour, about 2 hours, about 4 hours, about 6 hours, about 8 hours, about 10 hours, about 12 hours, about 16 hours, about 20 hours, about 24 hours, etc., or may range from a period of time using any of

the foregoing as upper and lower limits. By way of non-limiting example, the leave-in period may range from about 2 minutes to about 4 hours, from about 5 minutes to about 2 hours, from about 10 minutes to about 1.5 hours, from about 20 minutes to about 1 hour, from about 1 hour to about 12 hours, from about 2 hours to about 10 hours, from about 4 hours to about 8 hours, from about 8 hours to about 24 hours, from about 8 hours to about 12 hours, etc. For example, a leave-in time may be overnight, or may be until the hair is next rinsed or shampooed in the user's ordinary course of hygiene.

Although not required, methods of using treatment compositions according to the disclosure may also include a step of heating the hair to which the composition has been applied, for example during the resting period while the composition is on the hair. For example, a blow dryer, hood dryer, etc., may be used.

At least in some embodiments, hair that can be treated according to the methods described may be hair that has been previously bleached, dyed, straightened, relaxed, etc. It will be understood that hair which is treated according to various methods described herein can be hair that was previously subjected to such chemical treatments and is therefore in need of repair, mineral removal, or the like. Thus, the methods may occur within any period of time after such chemical treatment that the repair, mineral removal, etc., benefits are desired. For example, the methods may occur within six months of a chemical treatment such as a bleaching, dyeing, straightening, relaxing, etc., treatment, such as within five months, within four months, within three months, within two months, within one month, within three weeks, within two weeks, within one week, within five days, within four days, within three days, within two days, within one day, within 12 hours, within 8 hours, within 6 hours, within 4 hours, within 2 hours, or within 1 hour after such treatment. The time period within which the methods according to the disclosure are contemplated to be implemented is not limited.

In one exemplary embodiment, a hair treatment composition according to the disclosure may be applied to hair, for example to limit mineral uptake into and/or remove minerals from the hair fiber, to improve the general health and appearance of the hair, to improve the elasticity of the hair fibers, to prevent or reduce damage to the hair fibers, etc., by applying a composition to wet, damp, or dry hair, leaving the composition on the hair for a suitable processing time, optionally rinsing the hair, and

then optionally drying and/or styling the hair according to the individual's normal course.

In further exemplary embodiments, a hair treatment composition according to the disclosure may be applied to hair before, during, and/or after a chemical hair treatment process. For example, one such routine may include applying a composition according to the disclosure to wet, damp, or dry hair, leaving the composition on the hair for a suitable processing time, optionally rinsing the hair, and then substantially immediately thereafter (i.e. within the same chemical hair treatment process), preferably with intermediate rinsing of the hair, applying a chemical treatment such as a bleaching, dyeing, straightening, relaxing, or permanent waving composition to the hair. Another such routine may include applying a chemical treatment such as a bleaching, dyeing, straightening, relaxing, or permanent waving composition to the hair, and substantially immediately thereafter (i.e. within the same chemical hair treatment process), preferably with intermediate rinsing of the hair, applying a hair treatment composition according to the disclosure to the hair. Thus, it is contemplated that compositions according to the disclosure may be incorporated into a chemical hair treatment process, thereby reducing, minimizing, or preventing damage to the hair that would otherwise be expected to result from such harsh chemical treatments.

Surprisingly, hair treated with compositions and methods according to the disclosure has less damage than hair not treated with compositions and methods according to the disclosure, at least in part due to the decreased presence of minerals in the hair fiber. The reduction in damage is particularly notable in hair that has been damaged due to harsh chemical treatments such as bleaching, dyeing, permanent waving, straightening, relaxing, etc., as well as due to repeated styling such as with heat or styling tools. The hair repaired using compositions and methods according to the disclosure may have lower elasticity and/or greater tensile strength than hair similarly damaged but not treated according to the disclosure, even compared to hair treated with other products that are intended to repair hair damage.

Having described the many embodiments of the present invention in detail, it will be apparent that modifications and variations are possible without departing from the scope of the disclosure defined in the appended claims. Furthermore, it should be appreciated that all examples in the present disclosure, while illustrating many embodiments of the disclosure, are provided as non-limiting examples

and are, therefore, not to be taken as limiting the various aspects so illustrated. It is to be understood that all definitions herein are provided for the present disclosure only.

In this application, the use of the singular includes the plural unless specifically stated otherwise. The singular forms “a,” “an,” “the,” and “at least one” are understood to encompass the plural as well as the singular unless the context clearly dictates otherwise. The expression “one or more” means “at least one” and thus includes individual components as well as mixtures/combinations. Likewise, the term “a salt thereof” also relates to “salts thereof.” Thus, where the disclosure refers to “an element selected from the group consisting of A, B, C, D, E, F, a salt thereof, or mixtures thereof,” it indicates that that one or more of A, B, C, D, and F may be included, one or more of a salt of A, a salt of B, a salt of C, a salt of D, a salt of E, or a salt of F may be included, or a mixture of any two of A, B, C, D, E, F, a salt of A, a salt of B, a salt of C, a salt of D, a salt of E, and a salt of F may be included.

The term “and/or” should be understood to include both the conjunctive and the disjunctive. For example, “amino acids and/or salts thereof” means “amino acids and salts thereof” as well as “amino acids or salts thereof,” and expressly covers instances of either.

As used herein, the term “salts” referred to throughout the disclosure may include salts having a counterion such as an alkali metal, alkaline earth metal, or ammonium counterion. This list of counterions, however, is non-limiting. Salts also include a dissociated form of a compound, e.g. in an aqueous solution.

As used herein, the phrases “and mixtures thereof,” “and mixtures of two or more thereof,” “and a mixture thereof,” “and combinations thereof,” “and a combination thereof,” and combinations of two or more thereof,” “and a combination of two or more thereof,” “or mixtures thereof,” “or a mixture thereof,” “or combinations thereof,” “or combinations of two or more thereof,” “or a combination thereof,” and the like are used interchangeably to denote that the listing of components immediately preceding the phrase, such as “A, B, C, D, or mixtures thereof” signify that the component(s) may be chosen from A, from B, from C, from D, from A+B, from A+B+C, from A+D, from A+C+D, etc., without limitation on the variations thereof. Thus, the components may be used individually or in any combination thereof.

For purposes of the present disclosure, it should be noted that to provide a more concise description, some of the quantitative expressions given herein are not qualified with the term “about.” It is understood that whether the term “about” is used

explicitly or not, every quantity given herein is meant to refer to the actual given value, and it is also meant to refer to the approximation to such given value that would reasonably be inferred based on the ordinary skill in the art, including approximations due to the experimental and/or measurement conditions for such given value, unless
5 otherwise stated.

All ranges and amounts given herein are intended to include sub-ranges and amounts using any disclosed point as an end point, and all endpoints are intended to be included unless expressly stated otherwise. Thus, a range of "1% to 10%, such as 2% to 8%, such as 3% to 5%," is intended to encompass ranges of "1% to 8%," "1%
10 to 5%," "2% to 10%," and so on. All numbers, amounts, ranges, etc., are intended to be modified by the term "about," whether or not expressly stated, unless expressly stated otherwise. Similarly, a range given of "about 1% to 10%" is intended to have the term "about" modifying both the 1% and the 10% endpoints. The term "about" is used herein to indicate a difference of up to +/- 10% from the stated number, such as
15 +/- 9%, +/- 8%, +/- 7%, +/- 6%, +/- 5%, +/- 4%, +/- 3%, +/- 2%, or +/- 1%. Unless expressly stated otherwise, "about" means +/- 5%. Likewise, all endpoints of ranges are understood to be individually disclosed, such that, for example, a range of 1:2 to 2:1 is understood to disclose a ratio of both 1:2 and 2:1.

As used herein, if a component is described as being present "in an
20 amount up to" a certain amount, it is intended that such component is, in fact, present in the composition, i.e. is present in an amount greater than 0%.

All amounts given herein are relative to the amount of active material, unless otherwise indicated.

All percentages, parts and ratios herein are based upon the total weight
25 of the compositions of the present disclosure, unless otherwise indicated.

As used herein, all ranges provided are meant to include every specific range within, and combination of sub ranges between, the given ranges. Thus, a range from 1-5, includes specifically 1, 2, 3, 4 and 5, as well as sub ranges such as 2-5, 3-5, 2-3, 2-4, 1-4, etc.

30 As used herein, the phrase "applying a composition onto hair" and variations thereof are intended to mean contacting the hair with at least one of the compositions of the disclosure, in any manner. It may also mean contacting the hair in an effective amount.

The term “treating hair” (and its grammatical variations) as used herein refers to the application of the compositions of the present disclosure onto the surface of hair. The term “treating hair” (and its grammatical variations) as used herein also refers to contacting hair with the compositions of the present disclosure.

5 As used herein, the terms “limiting mineral uptake of hair fibers,” “removing minerals from hair fibers,” and similar language means that hair treated with compositions according to the disclosure have lower amounts of minerals present within the hair fiber compared to hair not treated according to the disclosure. Although the limiting or removing of minerals achieved will vary, it is intended that any amount
10 of decreased mineral content in hair is encompassed within the methods of the disclosure. It is possible to determine the content and amount of minerals present in the hair fiber by various methods known in the art such as various spectroscopy techniques, for example atomic absorption spectrometry, atomic fluorescence spectrometry, etc.

15 The use of the term “minerals,” which may also be referred to as “metals” by those skilled in the art, is intended to mean minerals such as calcium, magnesium, copper, iron, zinc, or the like, which are generally not present in natural hair. The term “mineral” encompasses both ionic forms as well as the salt forms, unless stated otherwise.

20 Unless otherwise defined for any specific embodiment, the term “substantially free” or “essentially free” as used herein means that there is less than about 5% by weight of a specific material added to a composition, based on the total weight of the composition. For example, the compositions may include less than about 4%, less than about 3%, less than about 2%, less than about 1.5%, less than about
25 1%, less than about 0.5%, less than about 0.1%, less than about 0.01%, less than about 0.001%, or less than about 0.0001% of the specified material. As such, it is contemplated that any component described herein for use in the hair treatment compositions can be present in the compositions in amounts less than about 5%, less than about 4%, less than about 3%, less than about 2%, less than about 1%, less than
30 about 0.5%, less than about 0.1%, less than about 0.01%, less than about 0.001%, or less than about 0.0001%, and the composition will be considered “substantially free” of such material. A composition that is “free” of a component is understood to contain none of the specified component. However, it is understood that the terms “free” and “substantially free” refer to the amount of a component added to the composition,

without including an amount of the component present in the composition as a minor component in a raw material. For example, a composition that is “free” of waxes may not have wax included as an intended component but may nevertheless contain a pigment that is coated with a wax, as such wax would be considered a minor component of the pigment material and would not be expected to provide benefits to the composition that would be expected by including a wax per se as an intended component.

Unless otherwise expressly stated, it is in no way intended that any method set forth herein be construed as requiring that its steps be performed in a specific order. Accordingly, where a method claim does not expressly recite an order to be followed by its steps or it is not specifically stated in the claims or descriptions that the steps are to be limited to a specific order, it not intended that any particular order be inferred.

The examples that follow serve to illustrate embodiments of the present disclosure without, however, being limiting in nature. It will be apparent to those skilled in the art that various modifications and variations can be made in the compositions and methods of the invention without departing from the spirit or scope of the invention. Thus, it is intended that the present disclosure covers the modifications and variations that come within the scope of the appended claims and their equivalents.

EXAMPLES

The following Examples are intended to be non-limiting and explanatory in nature only. In the Examples, amounts are expressed in percentage by weight (wt%) of active materials, relative to the total weight of the composition, unless otherwise indicated.

Example 1 – Treatment Compositions

Compositions 1A-1G according to the disclosure were prepared as shown in Table 1. The pH of each of compositions 1A-1G was about 3.5.

TABLE 1

	1A	1B	1C	1D	1E	1F	1G
Basic amino acid(s)	5.0	5.0	5.0	5.0	5.0	5.0	2.0
Glycine betaine	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Citric and/or lactic acid	6.1	6.1	6.1	6.1	6.1	6.1	4.1

Neutral amino acid(s)							0.5
Preservative(s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Solvents (water and/or non-aqueous solvents)	QS	QS	QS	QS	QS	QS	QS

The compositions contained a synergistic combination of components: carboxylic acids (citric and/or lactic acid), osmolytes (glycine betaine), and amino acids (arginine and/or serine).

Example 2 – Evaluation of Damage Repair

5 In order to evaluate the ability of compositions that can be used in methods according to the disclosure to minimize, prevent, or repair damage to hair, the following studies were conducted.

Example 2A – Ultra Bleached Hair

10 Eight swatches (S1-S8) of virgin Caucasian hair were bleached with a composition prepared by mixing a commercial bleach powder with a commercial oxidizing composition (40V hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition) and processed at a temperature of about 55°C for about 45 minutes. The swatches were rinsed and then seven of the swatches (S1-S7) were subjected to the following treatment routines (swatch S8 did not have any treatment
15 after the bleaching composition was rinsed from the hair).

Swatch S1 was cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available
20 conditioner composition was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. This treatment protocol was repeated every day for five days.

Swatches S2-S7 were each cleansed with a commercially available
25 shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available conditioner composition was applied and distributed to ensure the hair was fully

coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, one of compositions 1A-1F (Table 2A) was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. This treatment protocol was repeated every day for five days.

TABLE 2A

	1A	1B	1C	1D	1E	1F
Swatch	S2	S3	S4	S5	S6	S7

The integrity of the hair fibers of each of swatches S1-S8 was studied after the first and fifth days. Elasticity was evaluated to determine whether the hair fibers stretched, and if so, whether they returned to their original state (lower elasticity, i.e. healthy), whether the fibers stretched easily and remained stretched (higher elasticity, i.e. damaged), or whether the hair fibers broke upon testing.

The evaluation was performed by stretching a standardized amount of wet hair fibers, with two experts independently evaluating each swatch. The experts were trained to stretch the area of the swatch being evaluated by uniformly applying manual pulling force using the hands/fingers. The behavior of the swatch was classified by each expert according to a 6-level scale as follows, with the result reported for each swatch as the average of the two:

0 = Natural, healthy hair (no damage);

1 = Low elasticity (when stretched, hair fibers present slight elasticity, returning to the initial state after the test);

2 = Moderate elasticity (when stretched, hair fibers present elasticity, returning to the initial state after the test);

3 = High elasticity (when stretched, hair fibers present elasticity and some of the hair fibers do not return to the initial state after the test);

4 = Very high elasticity (when stretched, hair fibers present elasticity and most of the hair fibers do not return to the initial state after the test); and

5 = Immediate break (when stretched, hair fibers present high elasticity and break during the test).

The results showed that the hair fibers of swatches S2-S7, treated with one of compositions 1A-1F, surprisingly had lower elasticity than the fibers of swatches S1 or S8 after both day 1 (FIG. 1A) and day 5 (FIG. 1B). In other words, the hair of swatches S1 and S8 was damaged by the harsh bleaching process, leading to

increased elasticity, whereas the damage to swatches S2-S7 had been repaired by treatment with one of compositions 1A-1F.

Example 2B – Straightened and Ultra Bleached Hair

Eight swatches (S9-S16) of Caucasian hair that had been previously
5 straightened using formaldehyde were bleached with a composition prepared by
mixing a commercial bleach powder with a commercial oxidizing composition (40V
hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition)
and processed at a temperature of about 55°C for about 45 minutes. The swatches
were rinsed and then seven of the swatches (S9-S15) were subjected to the following
10 treatment routines.

Swatch S9 was cleansed with a commercially available shampoo by
wetting the swatch, applying the shampoo to the swatch, lathering the shampoo,
allowing it to rest on the swatch for a period of about one minute, then rinsing the
swatch until all shampoo was removed. Immediately, a commercially available
15 conditioner composition was applied to the swatch and distributed to ensure the hair
was fully coated, allowed to remain for a resting period of about five minutes, and then
the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat
iron serum were applied to the hair. The treatment was repeated a second time. This
treatment protocol was repeated every day for five days.

20 Swatches S10-S15 were each cleansed with a commercially available
shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the
shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing
the swatch until all shampoo was removed. Immediately, one of compositions 1A-1F
(Table 2B) was applied to the swatch and distributed to ensure the hair was fully
25 coated, allowed to remain for a resting period of about five minutes, and then the
swatch was thoroughly rinsed. Immediately, a commercially available conditioner
composition was applied and distributed to ensure the hair was fully coated, allowed
to remain for a resting period of about five minutes, and then the swatch was thoroughly
rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to
30 the hair. This treatment protocol was repeated every day for five days.

TABLE 2B

	1A	1B	1C	1D	1E	1F
Swatch	S10	S11	S12	S13	S14	S15

The integrity of the hair fibers of each of swatches S9-S16 was studied in the same manner as described in Example 2A. The results showed that the hair fibers of swatches S10-S15, treated with one of compositions 1A-1F, surprisingly had lower elasticity than the fibers of swatches S9 and S16 after both day 1 (FIG. 2A) and day 5 (FIG. 2B).

Examples 2A-2B therefore demonstrate that treating hair that has been damaged by harsh chemical processes with a composition according to the disclosure surprisingly repairs the damage, leaving hair less elastic than without treatment.

Example 3 – Treatment Compositions

Compositions 2A-2E according to the disclosure were prepared as shown in Table 3.

TABLE 3

	2A	2B	2C	2D	2E
Basic amino acid(s)	5.0	5.0	5.0	5.0	5.0
Glycine betaine	2.5	2.5	2.5	2.5	2.5
Citric acid	6.1	6.1	6.1	6.1	6.1
Silicone oil(s) (dimethicone and/or amodimethicone)	3.3	3.3	3.3	3.3	1.0
Fatty alcohol(s) (stearyl alcohol and/or cetearyl alcohol)	4.5	4.5	6.0	5.0	6.0
Cetyl esters				1.0	
Cationic surfactant(s) (cetrimonium chloride, behentrimonium chloride, and/or stearamidopropyl dimethylamine)	1.6	1.6	1.6	2.5	1.6
Cocamidopropyl betaine	1.1	1.1	1.1	0.2	
Hydroxyethylcellulose	0.8	1.0	1.5	1.5	0.4
Auxiliary component(s) (pH adjusters, preservatives, vitamins, extracts)	< 2	< 2	< 2	< 2	< 2
Solvents (water and non-aqueous solvents)	QS	QS	QS	QS	QS
Measured pH	3.7	3.7	3.7	3.7	4.0

The compositions contained a synergistic combination of components: carboxylic acids (citric acid), osmolytes (glycine betaine), and amino acids (arginine).

Example 4 – Evaluation of Damage Repair

5 In order to evaluate the ability of compositions according to the disclosure to minimize, prevent, or repair damage to hair, the following studies were conducted.

A comparative product, C1, had the following listing of ingredients on the package: Water (Aqua/Eau), Bis-Aminopropyl Diglycol Dimaleate, Propylene Glycol, Cetearyl Alcohol, Behentrimonium Methosulfate, Cetyl Alcohol, Phenoxyethanol, Glycerin, Hydroxyethyl Ethylcellulose, Stearamidopropyl Dimethylamine, Quaternium-
10 91, Sodium Benzoate, Cetrimonium Methosulfate, Cetrimonium Chloride, Fragrance (Parfum), Tetrasodium EDTA, Polyquaternium-37, Benzyl Benzoate, Etidronic Acid, Ascorbic Acid, Phytantriol, Tocopheryl Acetate, Aloe Barbadensis Leaf Juice, Panthenol, Simmondsia Chinensis (Jojoba) Seed Oil, Citric Acid, Potassium Sorbate. Composition C1, which is described as a “pre-shampoo hair treatment that reduces
15 breakage and split ends for visibly healthier hair,” is advertised as part of a system that asserts it can “relink broken disulfide bonds damaged by chemical services, heat, and styling.” The instructions for composition C1 are to use the product prior to using the shampoo (“C1-S”) and conditioner (“C1-C”) that form part of this system, both of which include bis-aminopropyl diglycol dimaleate as the stated active agent.

Example 4A – Ultra Bleached Hair: Elasticity and Strength

Five swatches (S17-S21) of virgin Caucasian hair were bleached with a composition prepared by mixing a commercial bleach powder with a commercial oxidizing composition (40V hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition) and processed at a temperature of about 55°C for about
25 45 minutes. The swatches were rinsed and then four of the swatches (S17-S20) were subjected to the following treatment routines (swatch S21 did not have any treatment after the bleaching composition was rinsed from the hair).

Swatch S17 was cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo,
30 allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available conditioner composition was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then

the swatch was thoroughly rinsed. This treatment protocol was repeated four more times.

Swatches S18 and S19 were each cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available conditioner composition was applied and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, one of compositions 2D (S18) or 2B (S19) was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. This treatment protocol was repeated four more times.

Swatch S20 was treated with composition C1 by applying the composition to the swatch and distributing it to ensure the hair was fully coated. Composition C1 was allowed to remain on the hair for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, the swatch was cleansed with shampoo C1-S by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, conditioner C1-C was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. This treatment protocol was repeated four more times.

Once all five treatments of swatches S17-S20 were completed, the integrity of the hair fibers of each of swatches S17-S21 was studied in the same manner as described in Example 2A. The results showed that the hair fibers of swatches S18 and S19, treated with compositions 2D and 2B respectively, had lower elasticity than the fibers of swatches S17 and S20-S21 (FIG. 3).

Next, the strength was evaluated using a fiber tensile testing instrument from Dia-Stron known as an MTT (Miniature Tensile Tester). The results showed that the hair of swatches S18 and S19, treated with compositions 2D and 2B respectively, was surprisingly stronger than the hair of swatches S17 or S20, meaning that more force was required to break the individual hair fibers of swatches S18-S19. FIG. 4A shows the break stress (MPa) for a control swatch (CTL), which was the same hair but unbleached, swatch S17, which was bleached but without subsequent treatment, and

swatches S18 and S19, treated with compositions 2D and 2B respectively, and S20, treated with the comparative compositions. As FIG. 4A shows, the break stress of the control swatch (CTL) was more than twice that of swatch S17, demonstrating the significant damage caused by the bleaching process. After five (5) treatments with either composition 2D (swatch S18), 2B (swatch S19), or the comparative compositions (S20), the break stress of the treated swatches was increased compared to swatch S17. Surprisingly, the increase in break stress for swatches S18-S19 was considered to be statistically significant compared to that of swatch S20, meaning that compositions 2D and 2B repaired the hair to a greater degree than the comparative compositions.

Example 4B – Straightened and Ultra Bleached Hair: Elasticity

Four swatches (S22-S25) of Caucasian hair that had been previously straightened using formaldehyde were bleached with a composition prepared by mixing a commercial bleach powder with a commercial oxidizing composition (40V hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition) and processed at a temperature of about 55°C for about 45 minutes. The swatches were rinsed and for a treatment period of five weeks, all four swatches were subjected to the following routine twice a week.

First, the swatches were cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available conditioner composition was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

Three of the swatches (S22-S24) were subjected to the following additional treatment routines one time each week for the 5-week period.

Swatch S22 was cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. A mask composition was applied to the hair and allowed to remain on the hair, after which the hair was rinsed. Immediately, a commercially available conditioner composition was applied to the swatch and

distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

Swatch S23 was cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, composition 2C was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, a commercially available conditioner composition was applied and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

Swatch S24 was treated with composition C1 by applying the composition to the swatch and distributing it to ensure the hair was fully coated. Composition C1 was allowed to remain on the hair for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, the swatch was cleansed with shampoo C1-S by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, conditioner C1-C was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

After the five-week treatment period, the elasticity and strength of the hair fibers of each of swatches S22-S25 were studied in the same manner as described in Example 2A. The results showed that the hair fibers of swatch S23, treated with composition 2C, had lower elasticity than the fibers of any of swatches S22 or S24-S25.

Example 4C – Straightened and Ultra Bleached Hair: Strength

Four swatches (S26-S29) of Caucasian hair that had been previously straightened using formaldehyde were bleached with a composition prepared by mixing a commercial bleach powder with a commercial oxidizing composition (40V hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition)

and processed at a temperature of about 55°C for about 45 minutes. The swatches were rinsed and for a treatment period of five weeks, all four swatches were subjected to the following routine.

First, the swatches were cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, a commercially available conditioner composition was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

Three of the swatches (S27-S29) were subjected to the following additional treatment routines one time each week for the 5-week period.

Swatches S27 and S28 were cleansed with a commercially available shampoo by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. One of either composition 2B (S28) or 2D (S27) was applied to the hair and allowed to remain on the hair, after which the hair was rinsed. Immediately, a commercially available conditioner composition was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

Swatch S29 was treated with composition C1 by applying the composition to the swatch and distributing it to ensure the hair was fully coated. Composition C1 was allowed to remain on the hair for a resting period of about five minutes, and then the swatch was thoroughly rinsed. Immediately, the swatch was cleansed with shampoo C1-S by wetting the swatch, applying the shampoo to the swatch, lathering the shampoo, allowing it to rest on the swatch for a period of about one minute, then rinsing the swatch until all shampoo was removed. Immediately, conditioner C1-C was applied to the swatch and distributed to ensure the hair was fully coated, allowed to remain for a resting period of about five minutes, and then the swatch was thoroughly rinsed. A leave-on conditioning product and a leave-on flat iron serum were applied to the hair.

MTT testing was performed in the same manner as described in Example 4A. The results showed that the hair of swatches S27 and S28, treated with compositions 2D and 2B respectively, was surprisingly stronger than the hair of swatches S26 or S29, meaning that more force was required to break the individual hair fibers of swatches S27-S28. FIG. 4B shows the break stress (MPa) for a control swatch (CTL), which was the same hair but unbleached, swatch S26, which was bleached but without subsequent treatment, swatches S27 and S28, treated with compositions 2D and 2B respectively, and S29, treated with the comparative compositions. As FIG. 4B shows, the break stress of the control swatch (CTL) was approximately three times that of swatch S26, showing the significant damage caused by the bleaching process. After five (5) treatments with either composition 2B (swatch S28), 2D (swatch S27), the break stress of the treated swatches was increased compared to swatch S26, and the improvement was considered to be statistically significant. FIG. 4B shows, however, that the break stress of the swatch treated with the comparative composition (S29) had no improvement in break stress.

Examples 4A-4C thus demonstrate that treating hair that has been damaged by harsh chemical processes with a composition according to the disclosure surprisingly repairs the damage. The damage repair achieved with compositions according to the disclosure is also surprisingly greater than that achieved with a commercial product that asserts to do the same.

Example 5 – Compositions

Composition 3A according to the disclosure and a comparative composition C1 were prepared as shown in Table 4A.

TABLE 4A

	3A	C1
Basic amino acid(s)	5.0	5.0
Glycine betaine	2.5	
Citric acid	6.1	6.1
Preservative(s)	0.5	0.5
Water	QS	QS

Composition 3A contained a synergistic combination of components that work together to limit uptake of minerals into hair fibers, and/or remove minerals from hair fibers (carboxylic acids (citric acid), osmolytes (glycine betaine), and amino acids (arginine)), whereas composition C1 did not include any osmolytes.

In order to evaluate the ability of hair treatment compositions to limit mineral uptake into the hair fibers, the following study was conducted. Three swatches of virgin Caucasian hair were shampooed with a commercially available shampoo, rinsed, and dried. The swatches were then bleached with a composition prepared by mixing a commercial bleach powder with a commercial oxidizing composition (40V hydrogen peroxide) at a mixing ratio of 1:1.5 (bleach powder:oxidizing composition) and processed at a temperature of about 55°C for about 45 minutes. The swatches were again shampooed, rinsed, and dried. The foregoing process steps used tap water.

Finally, two of the swatches were treated by applying equal amounts of either composition 3A or composition C1 to one of the swatches, leaving the compositions on the hair for a resting time of five minutes, and then rinsed with deionized water. This process was repeated four more times for a total of five treatments per swatch. One swatch was not treated with any composition and served as the control.

The swatches were then analyzed for calcium concentration using X-ray fluorescence, and the results are shown in Table 4B.

TABLE 4B

	Control	3A	C1
Ca concentration (ppm)	2746	1712	1819

The data in Table 4B show that the combination of carboxylic acids, osmolytes, and amino acids, reduces the uptake of minerals such as calcium from the tap water into the hair and/or removes the calcium from the hair fiber.

These results were surprising. Although the comparative composition provided reduction of mineral uptake into hair, it was not known that the addition of osmolytes would improve the results as shown.

Example 6 – Additional Compositions

Compositions 4A-4D according to the disclosure were prepared as shown in Table 5.

TABLE 5

	4A	4B	4C	4D
Basic amino acid(s)	5.50	5.50	3.80	3.80
Thickening agent(s)	0.30		0.90	0.90
Nonionic surfactant(s)	0.30	1.50	0.50	0.50

Amphoteric surfactant(s)	0.30			
Conditioning agent(s)	0.80			
Cationic surfactant(s)	2.10	3.84	3.00	3.00
Glycine betaine	2.50	2.50	1.80	1.80
Citric acid	6.00	6.00	5.50	5.50
Wax(es)			0.50	0.50
Fatty alcohol(s)			6.30	6.30
Vegetable oil(s)				0.50
Fatty acid ester(s)			2.50	1.50
Additives (preservatives, fragrance)	≤ 2	≤ 2	≤ 2	≤ 2
Solvents (water and non-aqueous solvents)	QS	QS	QS	QS

Compositions 4A-4D, which contained a synergistic combination of components (carboxylic acids (citric acid), osmolytes (glycine betaine), and amino acids (arginine)), are expected minimize, prevent, and/or repair damage to hair, and to limit uptake of minerals into hair fibers and/or remove minerals from hair fibers.

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Example 7 – Additional Compositions

The following compositions according to the disclosure can be prepared, and are expected to similarly limit uptake of minerals into hair fibers, and/or remove minerals from hair fibers, and minimize, prevent, and/or repair damage to hair.

TABLE 6

	5A	5B	5C	5D	5E
Arginine	2.0	9.8	2.5		
Lysine			2.5	2.0	10
Valine betaine	2.0	4.5	2.0	1.0	4.0
Citric acid			3	2.0	9.8
Lactic acid	2.0	10	2		
Serine	0.05	0.5		0.05	0.5
Fatty compound(s)	10	8.0		9.0	15
Cationic and/or amphoteric surfactant(s)	3.0		0.5	2.5	5.0

Additional component(s) (e.g. pH adjusters, vitamins, preservatives, extracts, thickeners)	< 5	< 5	< 5	< 5	< 5
Solvent(s) (water and/or non-aqueous solvents)	QS	QS	QS	QS	QS

The above examples demonstrate that the compositions and methods according to the disclosure surprisingly minimize, prevent, and/or repair damage to hair, and to limit uptake of minerals into hair fibers and/or remove minerals from hair fibers.

SET OF CLAIMS

1. A method for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers in hair, comprising:

(i) applying a hair treatment composition to hair, comprising:

a) at least one compound chosen from amino acids or salts thereof;

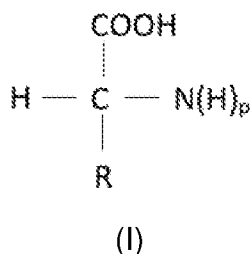
b) at least one osmolyte;

c) at least one compound chosen from carboxylic acids or salts thereof; and

d) at least one solvent, and

(ii) optionally rinsing the hair.

2. The method of claim 1, wherein the hair treatment composition comprises a) at least one amino acid chosen from compounds of formula (I) or salts thereof:



wherein:

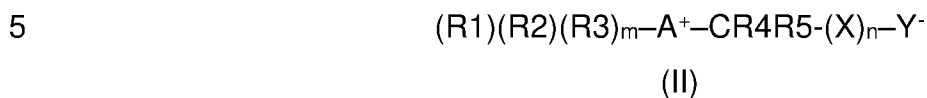
- p is an integer equal to 1 or 2, and

- when p = 1, R forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 ring members, optionally substituted by one or more groups chosen from hydroxyl or (C1-C4)alkyl; or

- when p = 2, R represents a hydrogen atom or a saturated, linear, or branched (C1-C12)alkyl group, preferably a (C1-C4)alkyl group, optionally interrupted by one or more heteroatoms or groups chosen from -S-, -NH-, or -C(NH)-, and/or optionally substituted by one or more groups chosen from hydroxyl (-OH), amino (-NH₂), -SH, -COOH, -CONH₂, -NH-C(NH)-NH₂, or an imidazole ring.

3. The method of claim 1 or claim 2, wherein the hair treatment composition comprises a) at least one amino acid chosen from arginine, glycine, proline, methionine, serine, lysine, histidine, salts thereof, or combinations of two or more thereof.

4. The method of any one of claims 1 to 3, wherein the hair treatment composition comprises b) at least one osmolyte chosen from carbohydrate sugars, polyamines, betaines, or combinations of two or more thereof, preferably comprising at least one betaine chosen from compounds of formula (II) or salts thereof:



wherein:

- R1, R2, and R3 are independently chosen from C1-C4 alkyl groups;
 - A is N or S;
 - m and n are independently 0 or 1;
 - X is a divalent C1-C6 alkyl group, linear or branched, saturated or unsaturated, optionally substituted by one or more groups chosen from hydroxyl (–OH) or amino (–NH₂); and
 - Y[–] is –COO[–] or –OSO₃[–];
- with the provisos that:
- when A is S, then m = 0 and R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched and/or cyclic (including aromatic and polycyclic chains), (C1-C10) hydrocarbon chain, optionally interrupted by one or more heteroatoms or groups chosen from –S–, –N=, –NH–, or –C(NH)–, and/or optionally substituted by one or more groups chosen from hydroxyl (–OH), amino (–NH₂), –SH, –COOH, or –CONH₂;
 - when A is N and m = 0, R4 represents a hydrogen atom or a saturated, linear, or branched (C1-C8)alkyl, and R5 forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, optionally substituted by one or more groups chosen from hydroxyl or (C1-C4)alkyl; and
 - when A is N and m = 1, then R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched and/or cyclic (including aromatic and polycyclic chains) (C1-C10) hydrocarbon chain, optionally interrupted by one or more heteroatoms or groups chosen from –S–, –N=, –NH–, or –C(NH)–,

and/or optionally substituted by one or more groups chosen from hydroxyl (–OH), amino (–NH₂), –SH, –COOH, or –CONH₂.

5. The method of any one of claims 1 to 4, wherein the hair treatment composition comprises a) at least one basic amino carboxylic acid and b) at least one betaine.

6. The method of any one of claims 1 to 5, wherein the hair treatment composition comprises b) at least one osmolyte chosen from carbohydrate sugars, preferably from C3-C6 monosaccharides, more preferably from pentoses, hexoses, derivatives thereof, or combinations of two or more thereof.

7. The method of any one of claims 1 to 6, wherein the hair treatment composition comprises b) at least one polyamine chosen from diamines, triamines, tetramines, pentamines, or combinations of two or more thereof.

8. The method of any one of claims 1 to 7, wherein the hair treatment composition comprises b) at least one compound of formula (II) chosen from zwitterionic amino acid derivatives bearing a quaternary ammonium group and comprising from 1 to 12 carbon atoms, preferably from 2 to 10 carbon atoms, more preferably from 3 to 8 carbon atoms.

9. The method of any one of claims 1 to 8, wherein the hair treatment composition comprises b) at least one compound of formula (II) chosen from valine betaine, glutamic acid betaine, glutamine betaine, trimethyl lysine, glycine betaine, histidine betaine, N-methyl histidine betaine, alanine betaine, beta-alanine betaine, choline sulfate, pipecolic acid betaine, proline betaine, hydroxyproline betaine, tyrosine betaine, phenylalanine betaine, tryptophan betaine, leucine betaine, isoleucine betaine, salts thereof, or combinations of two or more thereof, preferably comprising glycine betaine.

10. The method of any one of claims 1 to 9, wherein the hair treatment composition comprises b) at least one compound of formula (II), wherein:

R1 and R2 are methyl;

A is N; and/or

Y is COO–.

11. The method of any one of claims 1 to 10, wherein the hair treatment composition comprises c) at least one compound chosen from formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, enanthic acid, caprylic acid, lactic acid, oxalic acid, malonic acid, malic acid, glutaric acid, citraconic

acid, succinic acid, adipic acid, tartaric acid, fumaric acid, maleic acid, citric acid, isocitric acid, aconitic acid, propane-1,2,3-tricarboxylic acid, salts thereof, or combinations of two or more thereof.

12. The method of any one of claims 1 to 11, wherein the total amount
5 of amino acids and salts thereof in the hair treatment composition ranges from about 2% to about 15%, preferably from about 2.5% to about 12%, more preferably from about 3% to about 10%, and most preferably from about 3.5% to about 8% by weight, relative to the total weight of the composition.

13. The method of any one of claims 1 to 12, wherein the total amount
10 of osmolytes in the hair treatment composition ranges from about 0.5% to about 10%, preferably from about 1% to about 8%, more preferably from about 1% to about 5%, and most preferably from about 1.5% to about 3.5% by weight, relative to the total weight of the composition.

14. The method of any one of claims 1 to 13, wherein the total amount
15 of carboxylic acids and salts thereof in the hair treatment composition ranges from about 3% to about 15%, preferably from about 3% to about 12%, more preferably from about 3.5% to about 10%, and most preferably from about 4% to about 8% by weight, relative to the total weight of the composition.

15. The method of any one of claims 1 to 14, wherein the pH of the
20 hair treatment composition ranges from about 2 to about 6, preferably from about 2.5 to about 5, more preferably from about 2.5 to about 4.5, and most preferably from about 3 to about 4.

16. The method of any one of claims 1 to 15, wherein the hair treatment composition further comprises at least one film former.

25 17. The method of any one of claims 1 to 16, wherein the hair treatment composition comprises:

- a) at least one compound chosen from basic amino acids or salts thereof;
- b) at least one compound chosen from compounds of formula (II) or
30 salts thereof;
- c) at least one compound chosen from citric acid, lactic acid, or salts thereof; and
- d) water and optionally at least one polyol.

18. The method of any one of claims 1 to 17, wherein the hair treatment composition comprises:

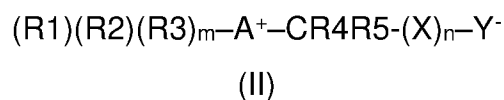
- 5
- a) at least one compound chosen from arginine or salts thereof;
 - b) glycine betaine or a salt thereof;
 - c) at least one compound chosen from citric acid or salts thereof;
 - d) water and at least one polyol; and
 - e) optionally at least one compound chosen from serine or salts thereof.

10 19. The method of any one of claims 1 to 18, wherein the hair treatment composition is rinsed from the hair after a leave-in period of time ranging from about 1 minute to about 24 hours.

20. The method of any one of claims 1 to 19, wherein the hair to which the hair treatment composition is applied has increased shine compared to the untreated hair.

15 21. A method for limiting uptake of minerals into hair fibers, and/or removing minerals from hair fibers in hair, comprising:

- (i) applying a hair treatment composition to hair, comprising:
 - a) at least one compound chosen from basic amino acids or salts thereof;
 - 20 b) at least one osmolyte chosen from compounds of formula (II) or salts thereof:



wherein:

- 25
- R1, R2, and R3 are independently chosen from C1-C4 alkyl groups;
 - A is N or S;
 - m and n are independently 0 or 1;
 - X is a divalent C1-C6 alkyl group, linear or branched,
 - 30 saturated or unsaturated, optionally substituted by one or more groups chosen from hydroxyl (–OH) or amino (–NH₂); and
 - Y[–] is –COO– or –OSO₃–;
- with the provisos that:

- 5 ○ when A is S, then $m = 0$ and R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched and/or cyclic (including aromatic and polycyclic chains), (C1-C10) hydrocarbon chain, optionally interrupted by one or more heteroatoms or groups chosen from $-S-$, $-N=$, $-NH-$, or $-C(NH)-$, and/or optionally substituted by one or more groups chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-SH$, $-COOH$, or $-CONH_2$;
- 10 ○ when A is N and $m = 0$, R4 represents a hydrogen atom or a saturated, linear, or branched (C1-C8)alkyl, and R5 forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, optionally substituted by one or more groups chosen from hydroxyl or (C1-C4)alkyl; and
- 15 ○ when A is N and $m = 1$, then R4 and R5 are independently chosen from a hydrogen atom or a saturated, unsaturated, linear, branched and/or cyclic (including aromatic and polycyclic chains) (C1-C10) hydrocarbon chain, optionally interrupted by one or more heteroatoms or groups chosen from $-S-$, $-N=$, $-NH-$, or $-C(NH)-$, and/or optionally substituted by one or more groups chosen from hydroxyl ($-OH$), amino ($-NH_2$), $-SH$, $-COOH$, or $-CONH_2$;
- 20 c) at least one compound chosen from carboxylic acids or salts thereof; and
- d) water and optionally at least one polyol; and
- 25 (ii) optionally rinsing the hair.
22. The method of claim 21, wherein the hair treatment composition comprises b) at least one compound of formula (II) wherein:
- R1, R2, and R3 are methyl;
- A is N;
- 30 Y is $COO-$;
- X is a divalent alkyl group, linear or branched, preferably saturated, having from 1 to 4 carbon atoms, optionally substituted by methylene or ethylene;
- R4 is hydrogen; and

R5 forms, together with the nitrogen atom, a saturated heterocycle comprising from 5 to 8 ring members, preferably 5 to 6 ring members, optionally substituted by one hydroxy group.

23. The method of claim 21 or claim 22, wherein the hair treatment composition comprises c) at least one compound chosen from formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, enanthic acid, caprylic acid, lactic acid, oxalic acid, malonic acid, malic acid, glutaric acid, citraconic acid, succinic acid, adipic acid, tartaric acid, fumaric acid, maleic acid, citric acid, isocitric acid, aconitic acid, propane-1,2,3-tricarboxylic acid, salts thereof, or combinations of two or more thereof.

24. The method of any one of claims 21 to 23, wherein the hair treatment composition further comprises at least one film former.

25. The method of any one of claims 21 to 24, wherein the hair treatment composition further comprises at least one additional component chosen from fatty compounds, surfactants, thickening agents, or combinations of two or more thereof.

26. The method of any one of claims 21 to 25, wherein the pH of the hair treatment composition ranges from about 2.5 to about 5, preferably from about 2.5 to about 4.5, more preferably from about 3 to about 4.

27. The method of any one of claims 21 to 26, wherein the total amount of amino acids and salts thereof in the hair treatment composition ranges from about 2% to about 15%, preferably from about 2.5% to about 12%, more preferably from about 3% to about 10%, and most preferably from about 3.5% to about 8% by weight, relative to the total weight of the composition.

28. The method of any one of claims 21 to 27, wherein the total amount of osmolytes in the hair treatment composition ranges from about 0.5% to about 10%, preferably from about 1% to about 8%, more preferably from about 1% to about 5%, and most preferably from about 1.5% to about 3.5% by weight, relative to the total weight of the composition.

29. The method of any one of claims 21 to 28, wherein the total amount of carboxylic acids and salts thereof in the hair treatment composition ranges from about 3% to about 15%, preferably from about 3% to about 12%, more preferably from about 3.5% to about 10%, and most preferably from about 4% to about 8% by weight, relative to the total weight of the composition.

30. The method of any one of claims 21 to 29, wherein the hair treatment composition comprises:

- a) at least one compound chosen from basic amino acids or salts thereof;
- b) glycine betaine or a salt thereof;
- c) at least one compound chosen from carboxylic acids having from 3 to 14 carbon atoms or salts thereof; and
- d) water and optionally at least one polyol.

31. The method of any one of claims 21 to 29, wherein the hair treatment composition comprises:

- a) at least one compound chosen from arginine or salts thereof;
- b) at least one osmolyte chosen from compounds of formula (II) or salts thereof;
- c) at least one compound chosen from carboxylic acids having from 3 to 14 carbon atoms or salts thereof; and
- d) water and at least one polyol.

32. The method of any one of claims 21 to 29, wherein the hair treatment composition comprises:

- a) at least one compound chosen from arginine or salts thereof;
- b) glycine betaine or a salt thereof;
- c) at least one compound chosen from carboxylic acids having from 3 to 14 carbon atoms or salts thereof, preferably chosen from citric acid, lactic acid, salts thereof, or combinations thereof;
- d) water and optionally at least one polyol; and
- e) optionally at least one film former.

33. The method of any one of claims 21 to 32, wherein the hair treatment composition is rinsed from the hair after a leave-in period of time ranging from about 1 minute to about 24 hours.

34. The method of any one of claims 21 to 33, wherein the hair to which the hair treatment composition is applied has increased shine compared to the untreated hair.

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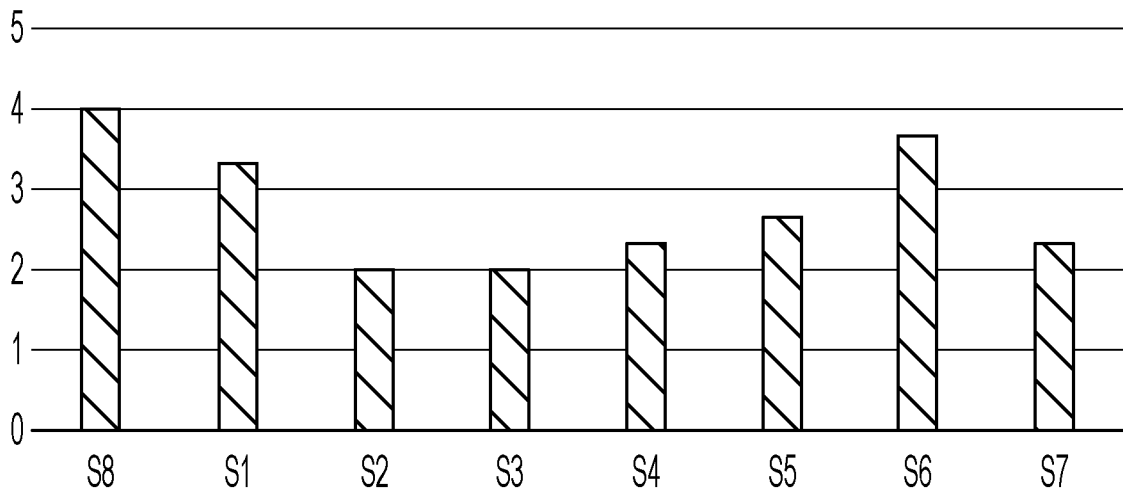


FIG. 1A

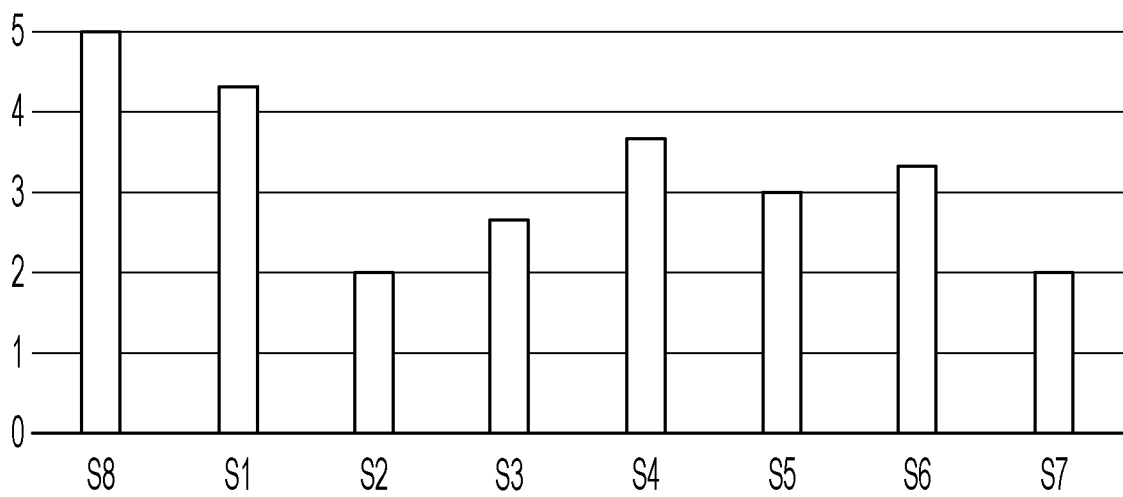


FIG. 1B

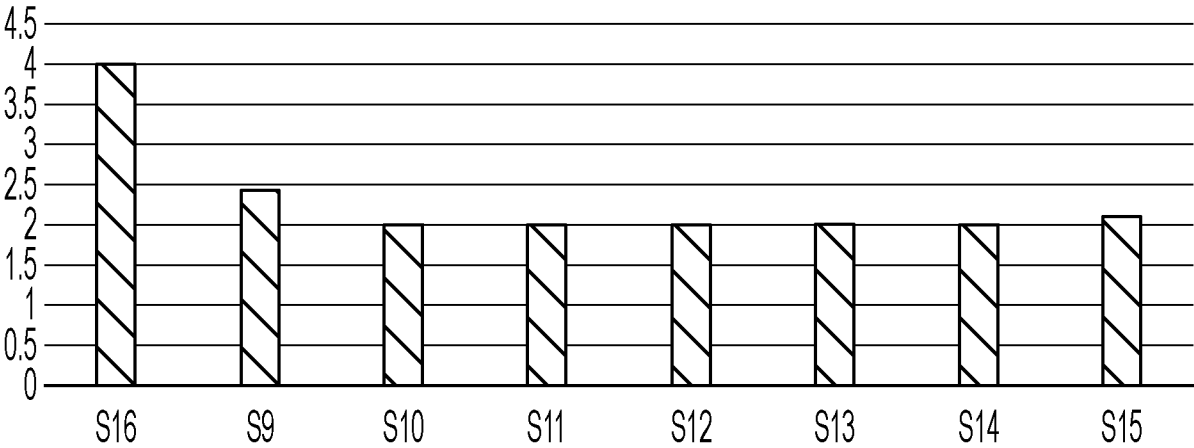


FIG. 2A

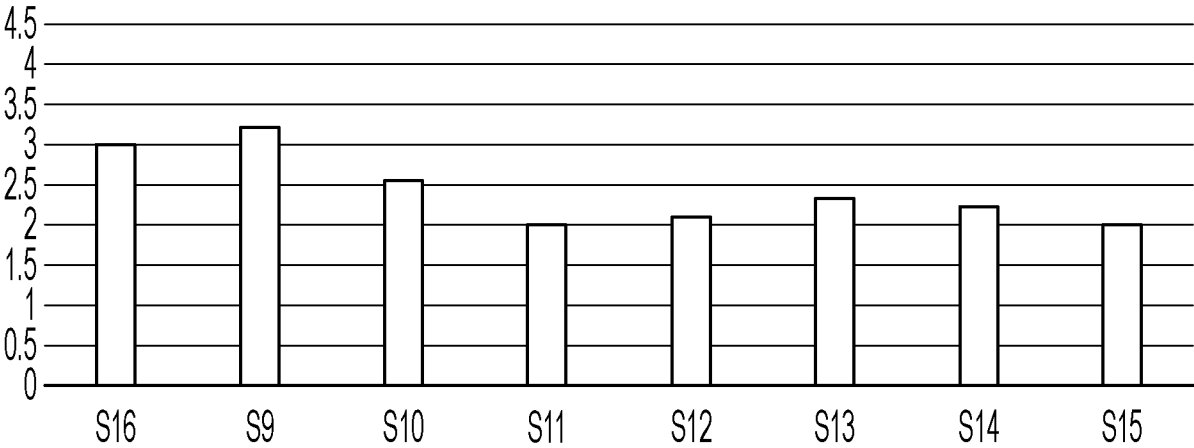


FIG. 2B

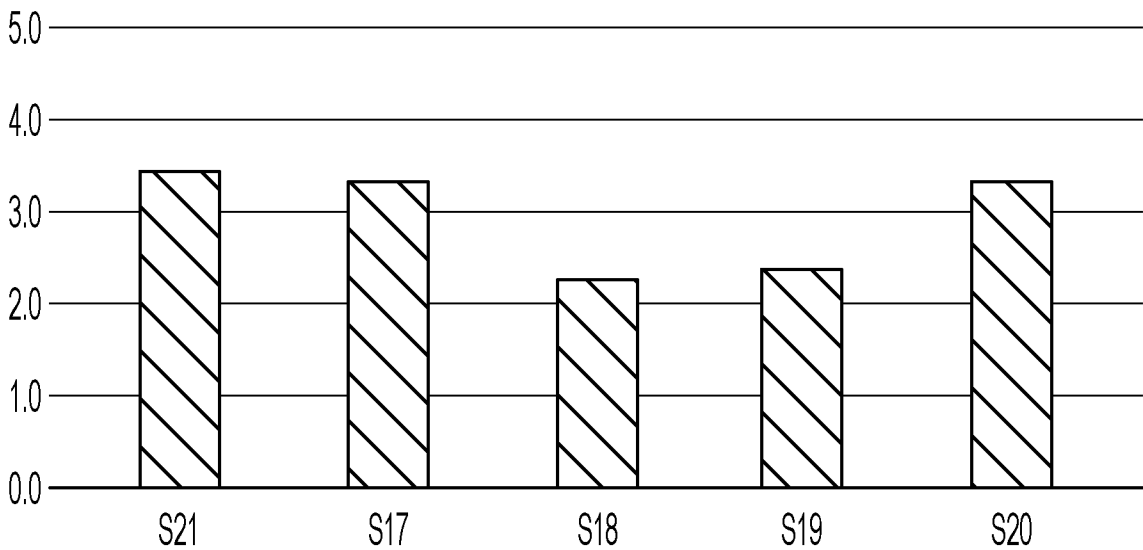


FIG. 3

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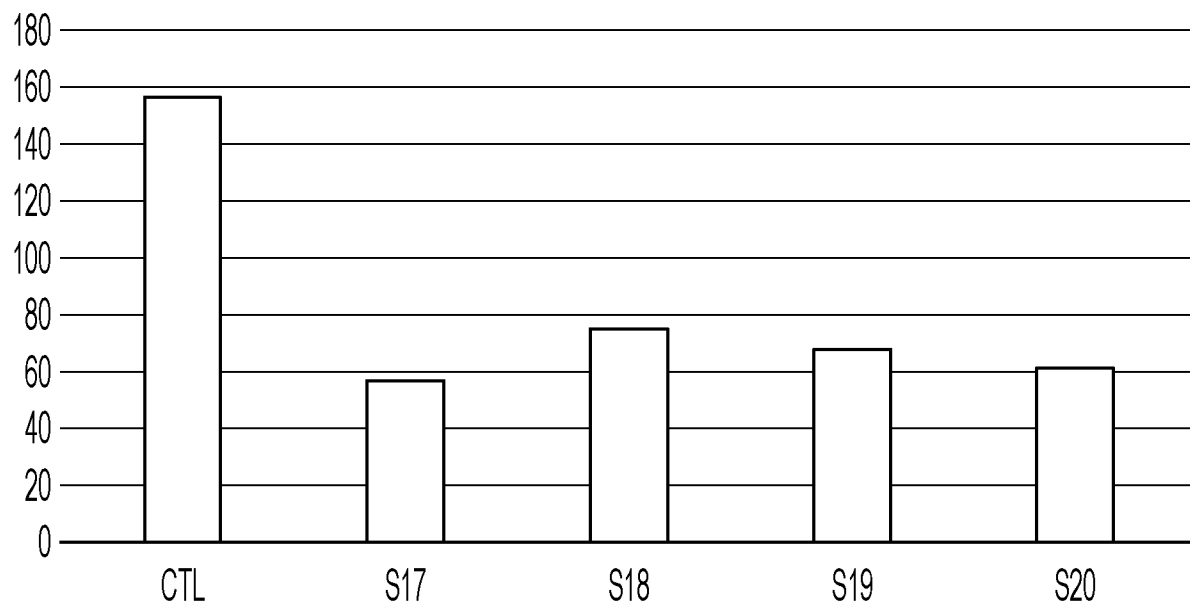


FIG. 4A

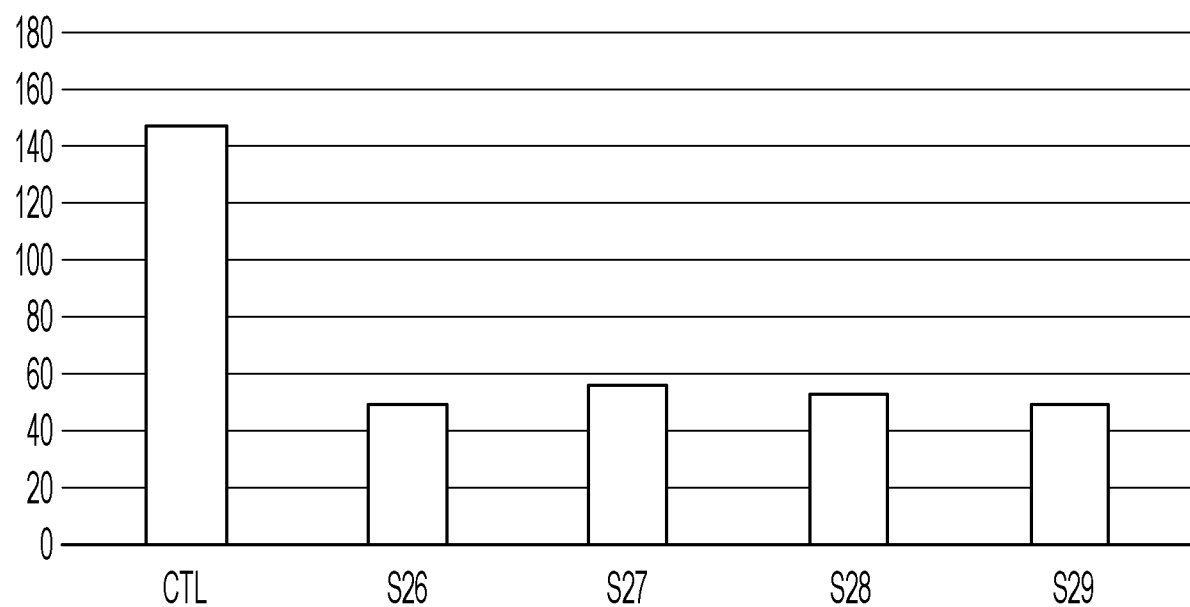


FIG. 4B

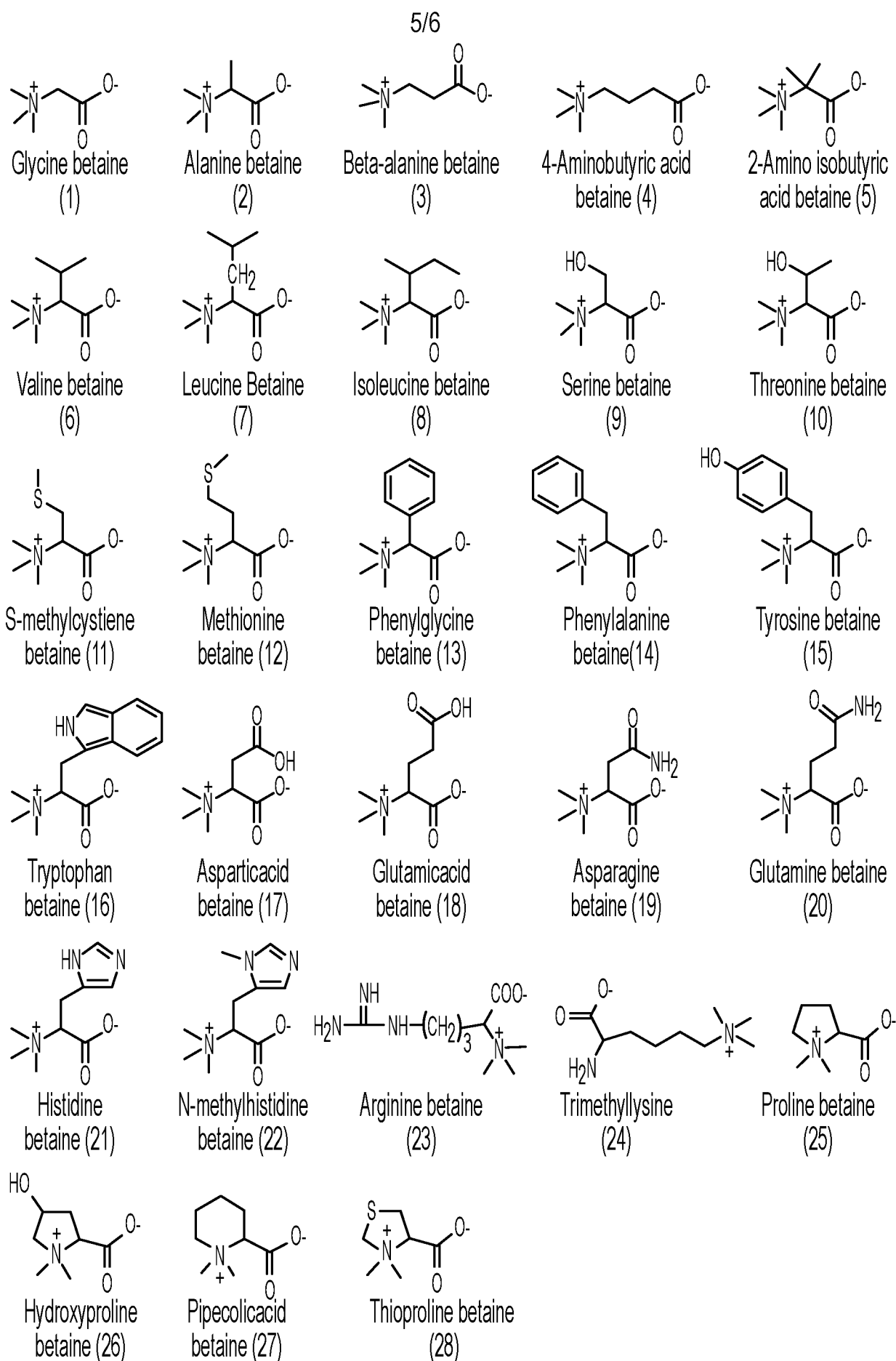


FIG. 5A

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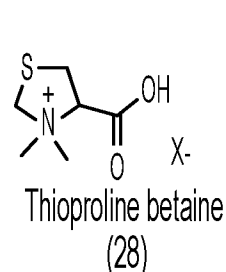
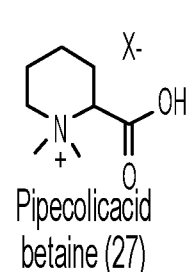
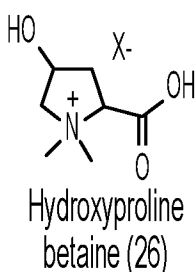
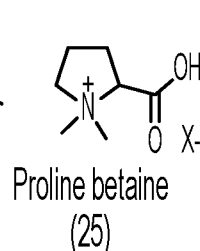
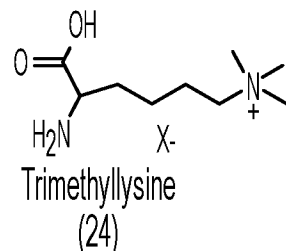
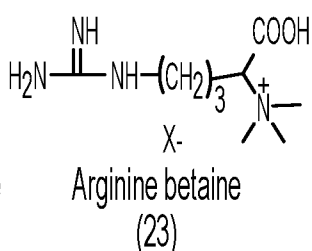
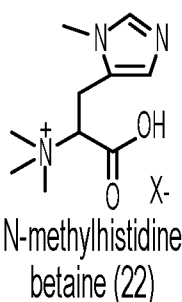
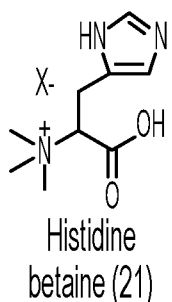
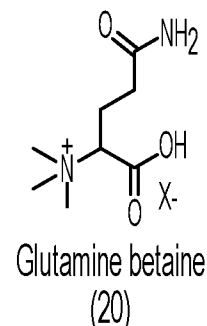
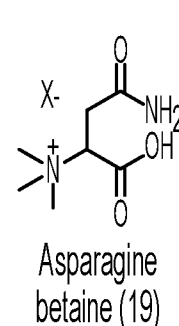
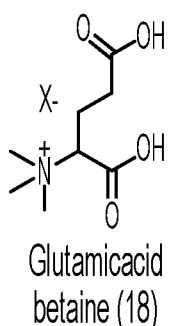
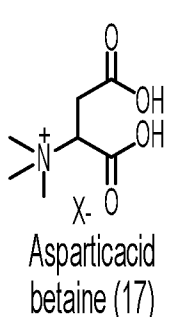
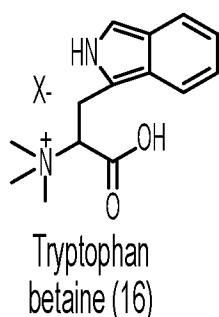
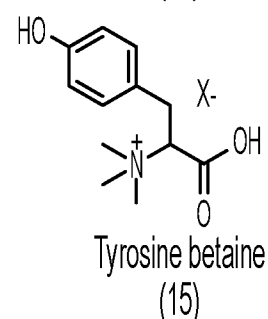
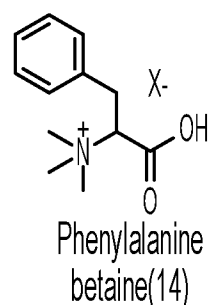
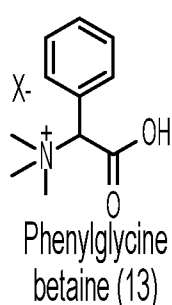
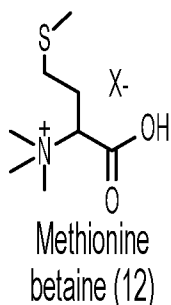
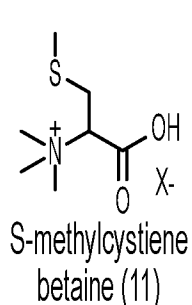
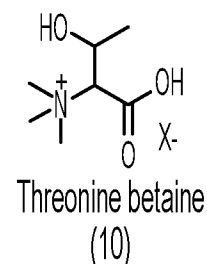
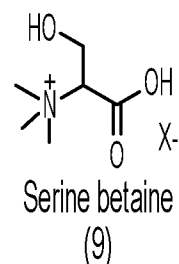
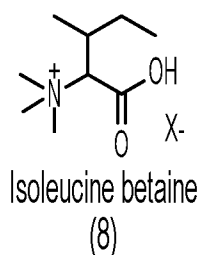
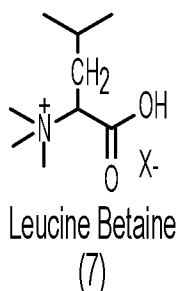
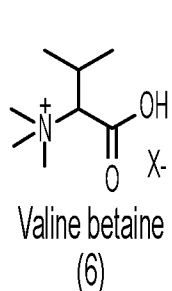
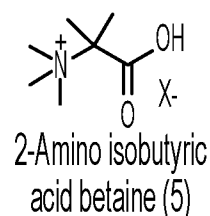
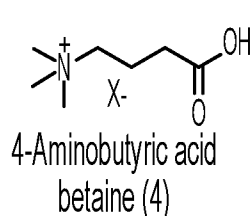
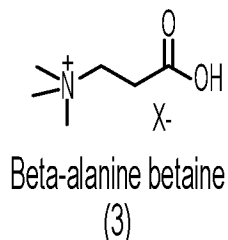
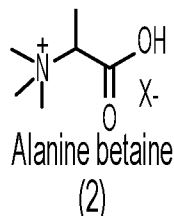
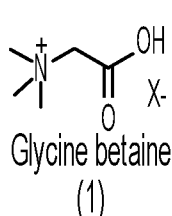


FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No
PCT/BR2023/050482

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	A61K8/365	A61K8/41
	A61K8/60	A61Q5/00
		A61K8/44
		A61Q5/04
		A61Q5/02
		A61Q5/06
		A61Q5/12
		A61K8/49
ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
A61K A61Q		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, CHEM ABS Data, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2023/232840 A1 (OREAL [FR]) 7 December 2023 (2023-12-07)	1 - 34
Y	page 45; claim 1; example 1B -----	1 - 34
X	WO 2023/164280 A1 (RUGHANI RONAK [US]; KHINE CHO CHO [US] ET AL.) 31 August 2023 (2023-08-31)	1 - 34
Y	claim 1; examples 5A, 5B, 6E, 6F -----	1 - 34
X	WO 2023/232894 A1 (OREAL [FR]) 7 December 2023 (2023-12-07)	1 - 34
Y	the whole document -----	1 - 34
	- / - -	
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
13 June 2024		05/07/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Bader, Karl Günther

INTERNATIONAL SEARCH REPORT

International application No

PCT/BR2023/050482

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE GNPD [Online] MINTEL; 21 November 2023 (2023-11-21), anonymous: "Conditioner", XP093171949, Database accession no. 11283226	1 - 34
Y	abstract -----	1 - 34
X	DATABASE GNPD [Online] MINTEL; 21 November 2023 (2023-11-21), anonymous: "Shampoo", XP093171945, Database accession no. 11283224	1 - 34
Y	abstract -----	1 - 34

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/BR2023/050482

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2023232840 A1	07-12-2023	FR 3136161 A1 WO 2023232840 A1	08-12-2023 07-12-2023
WO 2023164280 A1	31-08-2023	US 2023285256 A1 WO 2023164280 A1	14-09-2023 31-08-2023
WO 2023232894 A1	07-12-2023	FR 3136163 A1 WO 2023232894 A1	08-12-2023 07-12-2023